9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Tan Nguyen, whose telephone number is (703) 305-9755. The examiner can normally be reached on Monday-Thursday from 7:30 AM-5:00 PM. The examiner can also be reached on alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kevin J. Teska, can be reached on (703) 305-9704.

Any inquiry of a general nature or relating to the status of this application should be directed to the Group receptionist whose telephone number is (703) 305-3900.

Any response to this action should be mailed to:

Commissioner of Patents and Trademarks
Washington, D.C. 20231

or faxed to:

(703) 308-9051, (for formal communications intended for entry)

Or:

(703) 308-5357 (for informal or draft communications, please label "PROPOSED" or "DRAFT")

Hand-delivered responses should be brought to Crystal Park II, 2121 Crystal Drive, Arlington. VA., Sixth Floor (Receptionist).

/tqn
November 20, 1997

Tan Nguyen
TAN Q. NGUYEN
PATENT EXAMINER

Notice of References Cited	Application No. 08/587,731	Applicant(s) MARGOLIN	
	Examiner TAN NGUYEN	Group Art Unit 2763	Page 1 of 1

U.S. PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	NAME	CLASS	SUBCLASS
	A	4,660,157	04/1987	BECKWITH ET AL.	345	421
	B	4,835,532	05/1989	FANT	382	284
	C	5,381,338	01/1995	WYSOCKI ET AL.	348	116
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		DOCUMENT NO.	DATE	COUNTRY	NAME	CLASS	SUBCLASS
	N						
	O						
	P						
	Q						
	R						
	S						
	T						

NON-PATENT DOCUMENTS

*		DOCUMENT (Including Author, Title, Source, and Pertinent Pages)	DATE
	U		
	V		
	W		
	X		

* A copy of this reference is not being furnished with this Office action.
(See Manual of Patent Examining Procedure, Section 707.05(a).)

Attorney's Docket No. 2055.P004 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

OIPE MAR 0 2 1998 JC30 PATENT & TRADEMARK OFFICE

#9/IDS 4/1/98

In re Application of:
Jed Margolin

Application No. 08/587,731

Filed: January 19, 1996

For: A Method and Apparatus for Remotely Piloting an Aircraft

Examiner: T. Nguyen

Art Unit: 3614

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Assistant Commissioner for Patents
Washington, D.C. 20231

INFORMATION DISCLOSURE STATEMENT

Sir:

Enclosed is a copy of Information Disclosure Citation Form PTO-1449 together with copies of the documents cited on that form. It is respectfully requested that the cited documents be considered and that the enclosed copy of Information Disclosure Citation Form PTO-1449 be initialed by the Examiner to indicate such consideration and a copy thereof returned to applicant(s).

Pursuant to 37 C.F.R. § 1.97, the submission of this Information Disclosure Statement is not to be construed as a representation that a search has been made and is not to be construed as an admission that the information cited in this statement is material to patentability.

Pursuant to 37 C.F.R. § 1.97, this Information Disclosure Statement is being submitted under one of the following (as indicated by an "X" to the left of

240.00 OP

FIRST CLASS CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231 on February 27, 1998
(Date of Deposit)

Conny Van Dalen
Name of Person Mailing Correspondence

Conny Van Dalen — 2-27-98
Signature — Date

the appropriate paragraph):

_____ 37 C.F.R. §1.97(b).

_X___ 37 C.F.R. §1.97(c). If so, then enclosed with this Information Disclosure Statement is one of the following:

_____ A certification pursuant to 37 C.F.R. §1.97(e) or

_X__ A check for $240.00 for the fee under 37 C.F.R. § 1.17(p).

_____ 37 C.F.R. §1.97(d). If so, then enclosed with this Information Disclosure Statement are the following:

(1) A certification pursuant to 37 C.F.R. §1.97(e);

(2) A petition requesting consideration of the Information Disclosure Statement; and

(3) A check for $_________ for the fee under 37 C.F.R. §1.17(i) for submission of the Information Disclosure Statement.

If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

ORIGINAL SIGNED BY

Dated: 2/27, 1998

DMD

Daniel M. De Vos
Reg. No. 37,813

12400 Wilshire Blvd.
Seventh Floor
Los Angeles, CA 90025-1026
(408) 720-8598

#9

Sheet 1 of 1

Form PTO-1449 (REV. 8-83) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTY. DOCKET NO. 02055.P004	SERIAL NO. 08/587,731
INFORMATION DISCLOSURE CITATION	APPLICANT Jed Margolin	
(Use several sheets if necessary)	FILING DATE 1-19-96	GROUP 3614

OIPE
MAR 0 2 1998
PATENT & TRADEMARK OFFICE

U.S. PATENT DOCUMENTS

*EXAMINER INITIAL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
TN		4964598	10/23/90	Berejik, et al.	244	190	12/19/88

FOREIGN PATENT DOCUMENTS

		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	TRANSLATION NO

OTHER DOCUMENTS *(Including Author, Title, Date, Pertinent Pages, Etc.)*

TN — Shifrin, Carole A., "Gripen Likely to Fly Again Soon," Aviation Week & Space Technology, August 23, 1993, p.72-73.

EXAMINER	DATE CONSIDERED
Tan Nguyen	04/30/98

*EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

002055.P004 Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

#10 B 4/1/98

OIPE MAR 02 1998 PATENT & TRADEMARK OFFICE

In re Application of:
Jed Margolin
Serial No. 08/587,731
Filed: January 19, 1996
For: A Method and Apparatus for Remotely Piloting an Aircraft

Examiner: T. Nguyen
Art Unit: 2304

RECEIVED 98 MAR 20 PM 5:42 GROUP 3100

Assistant Commissioner for Patents
Washington, D.C. 20231

AMENDMENT AND REMARK

Sir:

Responsive to the Office Action mailed on November 28, 1997, the Applicant respectfully requests the Examiner to enter the following amendment and to consider the following remark:

AMENDMENT

In the Specification:

On page 3, line 22, please replace "many" with --may--.

On page 3, line 23, please replace "cameras" with --camera--.

In the Claims:

Please cancel claims 10, 11, 19 and 20, without prejudice.

Please amend the claims as follows:

FIRST CLASS CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231 on February 27, 1998
(Date of Deposit)

Conny Van Dalen
Name of Person Mailing Correspondence

Conny VanDalen 2-27-98
Signature Date

6

1. (Once Amended) A system comprising:

a remotely piloted aircraft including,

a position determining system to locate said remotely piloted aircraft's position in three dimensions; and

an orientation determining system for determining said remotely piloted aircraft's orientation in three dimensional space;

a communications system for communicating flight data between a computer and said remotely piloted aircraft, said flight data including said remotely piloted aircraft's position and orientation, said flight data also including flight control information for controlling said remotely piloted aircraft;

a digital database comprising terrain data;

said computer to access said terrain data according to said remotely piloted aircraft's position and to transform said terrain data to provide three dimensional projected image data according to said remotely piloted aircraft's orientation;

a display for displaying said three dimensional projected image data; and

a set of one or more remote flight controls coupled to said computer for inputting said flight control information, wherein said computer is also for determining a delay time for communicating said flight data between said computer and said remotely piloted aircraft, and wherein said computer adjusts the sensitivity of said set of one or more remote flight controls based on said delay time.

2. (Once Amended) The system of claim 1, wherein:

said remotely piloted aircraft [including:] includes a device for capturing image data; and

said system operates in at least a first mode in which said image data is not transmitted from said remotely piloted aircraft to said computer at a sufficient data rate to allow for real time piloting of the remotely piloted aircraft [a position determining system for locating said remotely piloted aircraft's position in three dimensions; and

an orientation determining system for determining said remotely piloted aircraft's orientation in three dimensional space].

---

13 ~~14~~. (Once Amended) A station for flying a remotely piloted aircraft that is real or simulated comprising:

a database comprising terrain data;

a set of remote flight controls for inputting flight control information;

a computer having a communications unit configured to receive status information identifying said remotely piloted aircraft's position and orientation in three dimensional space, said computer configured to access said terrain data according to said status information and configured to transform said terrain data to provide three dimensional projected image data representing said remotely piloted aircraft's environment, said computer coupled to said set of remote flight controls and said communications unit for transmitting said flight control information to control said remotely piloted aircraft, said computer also to determine a delay time for communicating said flight control information between said computer and said remotely piloted aircraft, and said computer to adjust the sensitivity of said set of remote flight controls based on said delay time; and

a display configured to display said three dimensional projected image data.

~~24. (Once Amended) A remotely piloted aircraft comprising:~~

a position determining system to locate said remotely piloted aircraft's position in three dimensions;

an orientation determining system to determine said remotely piloted aircraft's orientation in three dimensional space;

a communications system for transmitting status information, including said remotely piloted aircraft's position and orientation, to a pilot station for transformation into a three dimensional projected image of said remotely piloted aircraft's environment according to a database representing real terrestrial terrain using polygons, said communications system also for receiving from said pilot station flight control information; and

a control system for adjusting said remotely piloted aircraft's flight in response to said flight control information.

Please add the following new claims:

50. (New) The system of claim 1, wherein:

said remotely piloted aircraft includes a device for capturing image data; and said system operates in at least a first mode in which said image data is not transmitted from said remotely piloted craft to said computer but stored in said remotely piloted aircraft.

51. (New) The remotely piloted aircraft of claim 24 further comprising:

a device for capturing image data, wherein said remotely piloted aircraft operates in at least a first mode in which said image data is not transmitted from said remotely piloted aircraft to said computer at a sufficient data rate to allow for real time piloting of the remotely piloted aircraft.

52. (New) The method of claim 32 further comprising the step of:

generating said flight control information responsive to said simulated three dimensional view and without any image transmitted from said remotely piloted aircraft.

53. (New) The method of claim 34, wherein said step of generating said flight control information in response to manual manipulations of the set of manual flight controls on said pilot station includes the step of:

receiving input representing a current position of a directional control; and

interpreting said current position relative to the horizon, rather than a rate of rotation.

REMARK

Applicant respectfully requests reconsideration of this application as amended.

35 U.S.C. §103 rejection, over Lyons in view of Wysoki or Fant or Beckwith

The Examiner has rejected Claims <u>1-9, 14-18, 23-32, and 34-38</u> under 35 U.S.C. §103 as being obvious over Lyons in view of Wysoki or Fant or Beckwith.

According to M.P.E.P. § 2142, "[t]o establish a primary facia case of obviousness, ... <u>the prior art reference (or references when combined) must teach or suggest all the claim limitations.</u> The teaching or suggestion to make the claim combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." (emphasis added).

<u>CLAIMS 1 and 14</u>

Claim 1 has been amended to include the limitations of claims 2, 10 and 11. Similarly Claim 14 has been amended to include the limitations of claims 19 and 20. Thus, Claims 1 and 14 are discussed under the next rejection directed to claims 10, 11, 19, and 20.

CLAIMS 24 AND 32

1. The Office Action Misdescribes Lyons

The office action agrees that Lyons does not teach the generation of "three dimensional image data from the digital database and the navigation information." However, Lyons fails to teach more than just the generation of the 3D image.

Lyons teaches a pilot station that uses dead reckoning to estimate the location of the RPV. As is well known in the art, dead reckoned positions have accumulating error. To correct for this error, the RPV transmits some information to the pilot station. The information transmitted depends on the approach of which Lyons describes two:

1) The transmission of video or radar image data from the RPV to the pilot station. For the video and radar image data (Section 3, including Figure 8), the pilot station provides a two dimensional moving map on which the pilot station indicates the dead reckoned position. At various intervals, the pilot must use the video or radar image to correct the dead reckoned position (This is what Figure 8 shows).

2) The transmission of laser measurements from the RPV to the pilot station. For the laser measurements (Section 4, Figure 10-12), the pilot station includes a database. The pilot station identifies a search area in the database based on the dead reckoned position - where the current dead reckoned position is the center of the search area ("expected RPV position" in Figure 12) and the search area represents the locations the RPV could be due to the accumulating error in the current dead reckoned position. The pilot station then compares the laser measurement for various position in the search area in an effort to locate the correct position of the RPV. Once the database has been used to locate the correct position of the RPV, the pilot station indicates the RPVs actual position on the 2D moving map (this map is not generated based on the database).

One advantage of the laser system being that the error in the dead reckoned position is automatically corrected using the laser and database, whereas the video and radar image data system requires user intervention to update. Another advantage of the laser system is that the laser data requires less bandwidth than the video or radar image data. For a further description of Lyons, see footnote [1].

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[1] In summary, the Lyons reference teaches various techniques for updating the dead reckoned position of remotely piloted aircraft on a two dimensional moving map display available to the pilot. In particular, Lyons contemplates a RPV transmitting information to a control center (Figure 1). The control center is used by the pilot to fly the RPV. To display the position of the RPV to the pilot, the control center provides a "moving map display." As contemplated by Lyons, "the most convenient display mode for the present application is the rolling map or 'passing scene' technique where a new line is added to the top of the display and the scene is shifted slowly downwards" (page 5-3, end of first full paragraph). In particular, Lyons contemplates using film to generate the moving map (Figure 5). The moving map is moved based on the dead reckoned positions of the RPV.

As is well known in the art, dead reckoned positions have accumulating error. To adjust for this error, Lyons describes two basic concepts: 1) map matching (Section 3); and 2) terrain map correlation (Section 4). The map matching concept requires that the RPV transmit some kind of image data to the control center. In Figure 6, the control center is shown having the moving map display and the sensor display (i.e., a display generated from the image data transmitted by the RPV). Lyons contemplates the transmission of two kinds of image data: 1) side looking radar (SLR); and 2) real time forward-looking sensors. When using the SLR system, the SLR generated image data received by the control center allows it to make a downward-looking image. The pilot watches the sensor display (i.e., the display generated based on the transmitted image data) for "likely update features"—landmarks. When the pilot sees a landmark in the sensor display, the pilot presses a transfer button which causes the control center to superimpose the sensor display over the moving map (Figure 5). The pilot then adjusts the moving map so that it matches the overlaid sensor display image and presses an accept button. By adjusting the moving map in this manner, the dead reckoned position of the RPV is updated in an attempt to remove the error associated with the calculation of dead reckoned positions (Page 5-3, second, third, and fourth full paragraphs). The simulated SLR/map update system is illustrated in Figures 7A and 7B.

Having described the SLR-based map matching technique, the real time forward-looking sensor technique will now be described. Lyons describes basically two techniques of updating dead reckoned RPV positions on a moving map using only real time forward-looking sensors: 1) an anamorphic projection technique (page 5-3, fifth full paragraph; figure 8); and 2) a HUD based technique (page 5-3, sixth full paragraph; figure 9). Similar to the SLR based technique, the anamorphic projection technique requires the pilot to watch the sensor display (i.e., the image generated from the transmitted data) for landmarks, press a button which superimposes the transmitted image on the moving map, adjust the moving map, and press an accept button. As described in Lyons, in order to superimpose the forward-looking transmitted image on the moving map, the forward-looking image is transformed using anamorphic projection. Lyons goes on to describe various problems with the anamorphic projection technique, and then describes the HUD based technique.

In the HUD based technique, the pilot is presented with two images: 1) the moving map display (see left-hand image of Figure 9); and 2) the sensor display generated from the image data transmitted from the real time forward-looking sensor on the RPV. The HUD technology is used to allow the pilot to mark landmarks on the forward-looking sensor based image. These HUD markings are then superimposed on the moving map, and the pilot makes the necessary adjustments to the moving map (page 5-3, sixth full paragraph).

In summary, the map matching techniques use the following: 1) the transmission of image data from the RPV to the control center; 2) a display at the control center which shows an image based on the real time image data received from the RPV; 3) a moving map display that is moved based on the dead reckoned position of the RPV; and 4) some manner of superimposing the sensor image onto the moving map to allow the pilot to update the moving map in an effort to correct the error associated with the dead reckoned positions. Neither the sensor display's image nor the moving map can be equated to the generation of "a three-dimensional projected image" generated based upon "a digital database" stored in the control center. The sensor display's image is based on image data transmitted from the RPV, while the moving map contemplated by Lyons is a two-dimensional, top down view displayed using film (see Figures 5 and 7).

Having described the map matching techniques from Lyons, Applicant will now describe the terrain map correlation technique of Lyons. The terrain map correlation technique described in Lyons is also used for correcting the error in dead reckoned positions shown to the pilot by a two-dimensional moving map. In particular, Lyons states at page 5-3, last paragraph:

The office action states that Lyons teaches a remotely piloted aircraft that transmits its position and orientation. However, Lyons actually teaches the remotely piloted aircraft transmitting either: 1) video or radar image data; or 2) laser measurements (see above and footnote). Neither the video/radar image or the laser measurements are the RPVs position, but are data used to either manually or automatically update the dead reckoned position of the Lyons system. Thus, Lyons does not teach the claimed transmission of the remotely piloted aircraft's position and orientation in three dimensional space (see claims 24 and 32).

In addition, the office action cites pages 5-4, third paragraph, and Figure 8 as disclosing a <u>single</u> system that accesses a database based on the remotely piloted aircraft's <u>transmitted</u> position and orientation and <u>transforms</u> the <u>terrain data</u> into a projected image. However, Figure 8 is for a first system in which the RPV uses a "forward looking sensor" to transmit a video image and the pilot station uses anamorphic projection to overlay that image on a 2D moving map, which is not generated by transforming a database of polygons (see page 5-3, paragraph 6), while pages 5-4, third

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> Reconnaissance or forward-looking sensors provide a convenient method of updating the navigation system. However, these sensors required large datalink bandwidth to transmit the video picture to the control center and hence are vulnerable to ECM... Hence, an alternative method of <u>updating the navigation system</u> is desirable. (emphasis added)

The phrase "updating the navigation system" is used throughout Lyons to refer to the adjustment of a two-dimensional moving map in an effort to correct for error due to dead reckoning.

Rather than requiring the user to actively update the moving map display (i.e., push a button which causes the images to be superimposed, adjusting the moving map, and pushing an accept button), the terrain map correlation technique attempts to adjust the moving map (i.e., correct for the dead reckoned error) without pilot intervention using a laser range measurements and a digital elevation database. In operation, the RPV transmits to the control center a set of laser range measurements (including an altimeter reading). The control center uses dead reckoned positions to both adjust the two-dimensional moving map and to estimate the location of the RPV over a digital database map of elevation points stored in the control center (Figure 10). Based on a calculation of the possible error associated with the dead reckoned positions, a search area is identified in the digital database (Figure 12). A search is then performed within this search area to identify the position that most closely matches the transmitted laser range data. The RPV's position is then updated to the location that best matches the transmitted laser ranges in an attempt to correct the error associated with the dead reckoned positions. The moving map is then automatically adjusted (without pilot intervention) to reflect the updated RPV position.

Thus, the digital database of Lyons (conceptually illustrated in Figure 10) is not used to generate a three-dimensional projected image, but is used to update the two-dimensional moving map in an effort to correct for the error in the dead reckoned positions. In addition to the description in Lyons, further support for the fact that the digital database of Lyons is not used to generate a three-dimensional projected image is that the image of Figure 10 is generated using square polygons. Square polygons are not guaranteed to be planar, and therefore, typically are not used for generating images. In contrast, triangular polygons are guaranteed to be planar and are typically used for displaying images.

paragraph describe a second system in which the RPV transmits laser measurements in lieu of a video stream - Lyons describes the advantages of using one over the other.

With reference to the laser system, the database is simply used to correct for the accumulating error in the dead reckoned position. Once the actual location of the RPV is corrected using the database and laser measurements, the database is no longer used or transformed. In contrast, the image generated by Lyon's pilot station is the 2D moving map with an indication of the corrected RPV location (see footnote 1 for support). Thus, Lyons does not teach the claimed transformation of the terrain data in the database to generate a projected image based on the position and orientation transmitted by the RPV.

2. The Combination of Lyons and Wysoki or Fant or Beckwith

The office action cites Wysoki or Fant or Beckwith as teaching the generation of three dimensional image data from a digital database. However, the claimed invention requires that the database represent the terrain using polygons (see Applicant's claim 24, lines 9 - 10 and claim 32, lines 10-11). None of Lyons, Wysoki, Fant or Beckwith generate a projected image using polygons[2]. Furthermore, none of Wysoki, Fant or Beckwith teach the limitations of the claims discussed above with reference to Lyons. Therefore, the combination does not teach the transmission by the RPV of its position and orientation in three dimensional space, and the pilot station using the received position and orientation to transform a database representing real terrestrial terrain using polygons into a three dimensional projected image of the remotely piloted aircraft's environment.

[2] As described above, the data in the database of Lyons is not used to generate an image, but simply to update the dead reckoned position.

With respect to Beckwith, the digital elevation data in the database is points with a constant north up position, not polygons (see col. 6, lines 52-61; col. 7, lines 30-36).

Fant describes the use of two databases: 1) the object library database which contains real-world images; and 2) the gaming area database which provides the information necessary for the placement of the contents of the object library, surfaces, and special effect on a grid or gaming area (see col. 6, line 38 - col. 7, line 10). In particular, the Fant patent is for a high performance computer graphics system that combines Computer Generated Imagery (CGI) with Computer Synthesized Imagers (CSI) to form Computer Generated Synthesized Imagery (CGSI) (see col. 2, line 53 - col. 3, line 12).

Wysoki describes a database of digital orthophotographs (see col. 4, lines 43-51). Digital orthophotographs are computerized images generated by making geometric corrections to scanned aerial photographs. In particular, an aerial photograph contains some degree of distortion. In contrast, maps maintain a constant scale, but lack the detail of an aerial photograph. Orthophotography combines the features of maps and aerial photographs. The aerial photographs are unwrapped (to remove the distortion) and fitted to a particular map projection to create an image map that has uniform scale and known accuracy.

As a result, in certain embodiments of the invention, the remote pilot can fly the RPV without any image data being transmitted by the RPV, but based on the 3D projected image generated by transforming the database, with respect to the RPV position and orientation received by the pilot station from the RPV, into a 3D image. In other words, the pilot in the claimed system need not rely on image data transmitted from the RPV to fly the RPV. For at least this reason, it is respectfully submitted that these claims are allowable over the cited prior art.

35 U.S.C. §103 rejection, over Lyons in view of Wysoki or Fant or Beckwith, and further in view of Kanaly

The Examiner has rejected Claims 10, 11, 19, 20, and 33 under 35 U.S.C. §103 as being obvious over Lyons in view of Wysoki or Fant or Beckwith, and further in view of Kanaly.

As stated above, claim 1 has been amended to include the limitations of claims 2, 10 and 11. Similarly Claim 14 has been amended to include the limitations of claims 19 and 20. Thus, Claims 1 and 14 are discussed under this rejection.

Similar to the limitations of Claims 24 and 32, Claims 1 and 14 require that the RPV transmit its position and orientation in three dimensional space to the pilot station and that the pilot station transform the terrain data with respect to the position and orientation to generate a three dimensional projected image. As previously stated, the combination of reference does not teach these limitations.

In addition, Claims 1, 14 (as amended) and claim 33 include the limitations of determining the delay time for communication between the pilot station and RPV, as well as adjusting the sensitivity of the flight controls based on the determined delay time.

Kanaly does not teach or suggest these limitations. In contrast, Kanaly deals with a system in which a remote operator wears a helmet (on which an oculometer is mounted) that determines where the remote operator is looking. Signals indicating where the remote operator is looking are sent to the RPV. The RPV includes a camera. The prior art system over which Kanaly distinguishes is one in which the camera on the RPV provides high resolution data in the center and low resolution data on the periphery. As a result, the prior art system must move the camera in response to the remote operators movements. This camera movement introduces a delay in the image provided to the remote operator.

To reduce or remove this delay (not measure it or adjust flight controls) due to movement of the camera, Kanaly teaches having the camera store high resolution data over the whole scene in a memory on board the RPV. The RPV transmits the high resolution imagery corresponding to the center of where the remote operator is looking and low resolution imagery (based on the stored high resolution data) corresponding to the remote operator's peripheral vision. As a result, movement of the remote operator's head merely requires the RPV adjust from where in the memory the high and low resolution data is accessed - the camera need not be moved. "Because the high resolution data is obtained from memory and not from the camera equipment directly, as in the prior art, the scheme in accordance with the present invention permits the camera to be effectively decoupled from the data link." (see col. 2, line 56 - col. 3, line 24; col. 8, line 54 - col. 9, line 6).

Thus, Kanaly does not teach the measurement of a communication delay in order to adjust the sensitively of flight controls based on that delay (see claims 1, 14, and 33). For at least this reason, it is respectfully submitted that these claims are allowable.

35 U.S.C. §103 rejection, over Lyons in view of Wysoki or Fant or Beckwith, and further in view of Thornberg

The Examiner has rejected Claims 12-13 and 21-22 under 35 U.S.C. §103 as being obvious over Lyons in view of Wysoki or Fant or Beckwith, and further in view of Thornberg.

Claims 12-13 and 21-22 are each dependent on one of the allowable base claims 1 and 14. For at least this reason, Applicant respectfully submits that claims 12-13 and 21-22 are allowable.

New claims 50 -53

Claims 50 - 52 each require that the remotely piloted aircraft include some device for capturing image data but that the system operate in at least a first mode in which that image data is not transmitted and/or not used to pilot the aircraft. In other words, the pilot in the claimed system cannot rely on image data transmitted from the RPV (as in certain systems of Lyons - radar and video data) to fly the RPV. In certain embodiments of the invention, the remote pilot can fly the RPV based on the 3D projected image generated by transforming the database with respect to the RPV position and orientation received by the pilot station from the RPV. Of course, additional information that is not image data could also be transmitted.

Claim 53 specifies the manner in which the flight controls used to pilot the aircraft are operated. In particular, certain joystick controls on aircraft operate to indicate a rate of rotation (e.g., pushing a joystick to the right means the aircraft should start turning right at the speed indicated by the orientation of the joystick - if the position is held, the plane will roll). However, the claimed manner of operation requires the joystick position indicate the orientation of the aircraft with respect to the horizon (e.g., joystick centered causes the aircraft to fly straight; joystick pushed to the right causes the aircraft to bank to the right at the angle indicated by the joystick - not roll; etc.).

Conclusion

Applicant respectfully submits that the rejections have been overcome by the amendments and remarks, and that the Claims are now in condition for allowance.

Accordingly, Applicant respectfully requests the rejections be withdrawn and the Claims as amended be allowed.

Drawing Corrections

The drawings have been objected to by the draftsman. The Applicant will file amended drawings at the time of allowance of the present application.

Invitation for a telephone interview

The Examiner is invited to call the undersigned at 408-720-8598 if there remains any issue with allowance of this case.

Charge our Deposit Account

Please charge any shortage to our Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Date: 2/27, 1998

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PATENT & TRADEMARK OFFICE

Attorney's Docket No.: 002055.P004 Patent

In re the Application of: Jed Margolin
(inventor(s))

Application No.: 08/587,731

Filed: January 19, 1996

For: A Method and Apparatus for Remotely Piloting an Aircraft
(title)

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Washington, D.C. 20231

SIR: Transmitted herewith is an Amendment for the above application.

_____ Small entity status of this application under 37 C.F.R. §§ 1.9 and 1.27 has been established by a verified statement previously submitted.
_____ A verified statement to establish small entity status under 37 C.F.R. §§ 1.9 and 1.27 is enclosed.
__X__ No additional fee is required.

The fee has been calculated as shown below:

	(Col. 1) Claims Remaining After Amd.		(Col. 2) Highest No. Previously Paid For	(Col. 3) Present Extra	SMALL ENTITY Rate	SMALL ENTITY Additional Fee	OTHER THAN A SMALL ENTITY Rate	OTHER THAN A SMALL ENTITY Additional Fee
Total Claims	* 38	Minus	** 49	0	x11	$ 0	x22	$
Indep. Claims	* 3	Minus	*** 5	0	x41	$ 0	x82	$
☐ First Presentation of Multiple Dependent Claim(s)					+135	$ 0	+270	$
					Total Add. Fee	$ 0	Total Add. Fee	$ 0

* If the entry in Col. 1 is less than the entry in Col. 2, write "0" in Col. 3.

** If the "Highest No. Previously Paid For" IN THIS SPACE is less than 20, write "20" in this space.

*** If the "Highest No. Previously Paid For" IN THIS SPACE is less than 3, write "3" in this space. The "Highest No. Previously Paid For" (Total or Independent) is the highest number found from the equivalent box in Col. 1 of a prior amendment or the number of claims originally filed.

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231

on February 27, 1998.
Date of Deposit

Conny Van Dalen
Name of Person Mailing Correspondence

Conny VanDalen
Signature

2-27-98
Date

(LJV/cak 10/25/96)

_______ A check in the amount of $____________ is attached for presentation of additional claim(s).

_______ Applicant(s) hereby Petition(s) for an Extension of Time of _________ month(s) pursuant to 37 C.F.R. § 1.136(a).

_______ A check for $___________ is attached for processing fees under 37 C.F.R. § 1.17.

_______ Please charge my Deposit Account No. 02-2666 the amount of $______________. **A duplicate copy of this sheet is enclosed.**

__X__ The Commissioner of Patents and Trademarks is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. 02-2666 **(a duplicate copy of this sheet is enclosed)**:

__X__ Any additional filing fees required under 37 C.F.R. § 1.16 for presentation of extra claims.

__X__ Any extension or petition fees under 37 C.F.R. § 1.17.

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP

Date: 2/27, 1998

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(LJV/cak 10/25/96)

08/587,731

UNITED STATES DEPARTMENT OF COMMERCE
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Washington, DC 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/587,731	01/19/96	MARGOLIN J	002055.P004

PM21/0504

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EXAMINER	
NGUYEN, T	
ART UNIT	**PAPER NUMBER**
3614	11

DATE MAILED: 05/04/98

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Tan Nguyen

TAN Q. NGUYEN
PATENT EXAMINER

PTO-90C (REV. 2/95)

1-File Copy

Office Action Summary	Application No. 08/587,731	Applicant(s) MARGOLIN
	Examiner TAN Q. NGUYEN	Group Art Unit 3614

☒ Responsive to communication(s) filed on 3/2/98.

☒ This action is FINAL.

☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire THREE month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

☒ Claim(s) *1-9, 12-18, 21-38, and 50-53* is/are pending in the application.

Of the above, claim(s) ______ is/are withdrawn from consideration.

☐ Claim(s) ______ is/are allowed.

☒ Claim(s) *1-9, 12-18, 21-38, and 50-53* is/are rejected.

☐ Claim(s) ______ is/are objected to.

☐ Claims ______ are subject to restriction or election requirement.

Application Papers

☐ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on ______ is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on ______ is ☐approved ☐disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) ______.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: ______

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☐ Notice of References Cited, PTO-892

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). 9

☐ Interview Summary, PTO-413

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

— SEE OFFICE ACTION ON THE FOLLOWING PAGES —

DETAILED ACTION

Notice to Applicant(s)

1. This office action is responsive to the amendment filed on March 02, 1998. As per request, claims 10, 11, 19 and 20 have been canceled. Thus, claims 1, 2, 14, and 24 are amended. Claims 50-53 have been added. Thus claims 1-9, 12-18, 21-38 and 50-53 are pending.

2. The prior art submitted on March 02 has been considered.

Drawings

3. The drawings are objected to under 37 CFR § 1.84 for the reasons set forth by the draftsman. See attached PTO-948 form for details. Correction is required. However, correction of the noted defect can be deferred until the application is allowed by the examiner.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. Claims 1-9, 14-18, 23-38, and 50-53 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Lyons et al. (an article entitled "Some Navigation Concepts For Remotely Piloted Vehicles", AGUARD Conference Proceedings No. 176 on Medium Accuracy Low Cost Navigation, September 1975, pages 5-1 to 5-15) in view of Wysocki et al. (5,381,338) or Fant (4,835,532) or Beckwith et al. (4,660,157), and further in view of Kanaly (4,405,843).

a. With respect to claims 1 and 14, Lyons et al. disclose the invention as claimed (see at least the abstract) including a remotely piloted aircraft (see figure 8, RPV), a communications system for communicating flight data between a computer and said remotely piloted aircraft, said flight data including said remotely piloted aircraft's position and orientation, said flight data also including flight control information for controlling said remotely piloted aircraft (see page 5-2, section Radio Navigation Using a Data Link, and figure 6 and the related text), a digital database comprising terrain data (see pages 5-3 and 5-4, section Terrain Map Correlation; and figure 8). Lyons et al. further disclose that the computer accesses said terrain data according to said remotely piloted aircraft's position and to transform said terrain data to provide a projected image data according to said remotely piloted aircraft's orientation; a display for displaying said projected image data (see page 5-4, third paragraph, and figure 8), and a remote flight control coupled to said computer for inputting said flight control information (see figure 6).

Lyon et al. do not explicitly disclose that the computer produce a three dimensional image data from the digital database and the navigation information. However such feature is well known at the time the invention was made (for examples, see columns 6, 8; figure 1 and the related text in Wysocki et al.; see figures 1, 3 and the related text in Fant; or see figures 1, 4 and the related text in Beckwith et al.). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the teaching of either Wysocki et al., Fant, or Beckwith et al. into the system of Lyon et al. in order to improve the system with the enhanced capability of displaying three-dimensional image of the remoted aircraft over the terrain data.

Lyons et al. disclose the claimed invention as discussed above except for the determination of a delay time for communicating said flight data between said computer and said remotely piloted aircraft, and adjusting the sensitivity of said set of one or more remote flight controls based on said delay time. However, Kanaly does suggest delay time for communicating between the ground station and the remote airborne into account of controlling the remote airborne (see at least column 3, lines 15-24, and column 8, line 54 to column 9, line 6). It would have been obvious to incorporate the teaching of Kanaly into the system of Lyons et al. in order to improve the system with the enhanced capability of providing more accurate the remote flight controls to the remoted vehicle and receiving the accurate position and heading data of the vehicle from the remoted vehicle.

Thus, because of the motivation set forth above, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to combine the teachings of Lyon, Kanaly, with either Wysocki et al., Fant, or Beckwith et al.

b. With respect to claims 2, 50, and 51, Kanaly discloses that the remotely piloted aircraft includes a device for capture image data (see figure 3, item 74) and the image data is stored in the memory (see figure 3, item 21 and the related text).

c. With respect to claim 3, Lyons et al. disclose that the flight data communicated between said remotely piloted aircraft and said computer is secured (see page 5-2, first paragraph of the Radio Navigation Using Data Link section).

d. With respect to claims 4, 5, 7, and 15, Lyons et al. disclose that said remotely piloted aircraft further comprises a infra red sensor image (video camera) and means for communicating and displaying video data representing images captured by the sensor image (see page 5-3, section Map Matching, and figure 8).

e. With respect to claims 6 and 16, Lyons et al. disclose that the video data is transmitted on a different communication link (wideband transmission of video signals) than said flight data (see page 5-2, first paragraph of section Radio Navigation Using a Data Link).

f. With respect to claims 8 and 17, Lyons et al. disclose that the display is a head mounted display (see figures 5 and 6).

g. With respect to claims 9 and 18, Lyons et al. also disclose that the remote flight control is responsive to manual manipulations (see figure 6).

h. With respect to claim 23, Lyons et al. disclose that the communications unit includes at least one of a communications transceiver and a simulation port (see page 5-4 and figure 6).

i. With respect to claim 24, Lyons et al. further disclose that the database representing terrain using polygons (see figure 10).

j. With respect to claims 25-28 and 30-31, the limitations of these claims have been noted in the rejection above. They are therefore considered rejected as set forth above.

k. With respect to claim 29, wherein said video data is transmitted real-time (see page 5-3, first paragraph of the section Map Matching).

l. Claims 32-38 and 52 are method claims corresponding to apparatus claims 24-31. Therefore, claims 32-38 and 52 are rejected for the same rationales set forth for claims 24-31.

m. With respect to claim 53, Kanaly disclose the step of receiving the input representing a current position of a directional control. The step of interpreting the current position relative to the horizon is not mentioned. However, it would have been obvious to one of ordinary skill in the art at the time the invention was made to interpret the current position relative to the horizon since it is well known for the control instrument as shown in the figure 1 can be performed such function.

6. Claims 12-13, and 21-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lyons et al., Wysocki et al. or Fant or Beckwith et al.; and Kanaly as applied to claims 1-9, 14-18, 23-38, and 50-53 above, and further in view of Thornberg et al. (5,552,983).

Lyons et al. disclose the claimed invention as discussed above except that the remote flight controls allows for inputting absolute pitch and roll angles. However, such feature is well known in the art at the time the invention was made. For example, Thornberg et al. suggest a variable referenced control system for remotely operated vehicles which includes means for inputting absolute pitch and roll angles for remotely control the unmanned aerial vehicle (see at least figures 5 and 6). It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the teaching of Thornberg et al. into the system of Lyons et al. in order to input the pitch and roll control signals as the flight control signals for remotely control the vehicle.

7. All claims are rejected.

Remarks

8. Applicant's arguments filed on October 27, 1997 have been fully considered but they are not deemed to be persuasive. Upon amended claims, the newly added claims, and the updated search, the new ground of rejections has been set forth as above.

9. In the amendment, applicants essentially argue that the Lyon reference "fails to teach more than just the generation of the 3D image". However, upon examination of the claims, the references cited clearly cover the subject matter AS CLAIMED by the applicants. Therefore, the rejection under 35 U.S.C. § 103 is considered to be proper.

10. Applicants also argue that none of Lyons, Wysocki, Fant or Beckwith generate a projected image using polygons. Applicant's attention is directed to figure 10 of the Lyon reference in which it discloses that the terrain model includes a plurality of polygons and in figure 1, 3, 5, and column 5, lines 42-49 of the Fant reference do suggest such feature.

11. Applicants further argue that the references cited do not disclose the determining of the delay time for communication. Applicant's attention is directed to column 8, line 54 to column 9 line 35 in which it disclose such feature. Therefore, the new rejection made is considered to be proper.

12. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Tan Nguyen, whose telephone number is (703) 305-9755. The examiner can normally be reached on Monday-Thursday from 7:30 AM-5:00 PM. The examiner can also be reached on alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, William Cuchlinski, can be reached on (703) 308-3873.

Any response to this action should be mailed to:

Box AF

Commissioner of Patents and Trademarks
Washington, D.C. 20231

or faxed to:

(703) 305-7687, (for formal communications, please mark "EXPEDITED PROCEDURE"; for informal or draft communications, please label "PROPOSED" or "DRAFT")

Hand-delivered responses should be brought to Crystal Park II, 2121 Crystal Drive, Arlington. VA., Sixth Floor (Receptionist).

Tan Nguyen
TAN Q. NGUYEN
PATENT EXAMINER

/tqn
May 01, 1998

Art Unit 3614

002055.P004 Patent

OIPE JUL 0 9 1998 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE #12 Req. for Recon 7/13/98

In re Application of:
Jed Margolin

Serial No. 08/587,731

Filed: January 19, 1996

For: A Method and Apparatus for Remotely Piloting an Aircraft

Examiner: T. Nguyen

Art Unit: 3614

98 JUL 13 AM 9:31 RECEIVED TECHNOLOGY CENTER 3600

RESPONSE UNDER 37 C.F.R. § 1.116 -- EXPEDITED PROCEDURE -- EXAMINING GROUP 3614

Assistant Commissioner for Patents
Washington, D.C. 20231

RESPONSE UNDER 37 C.F.R. § 1.116
EXPEDITED PROCEDURE -- EXAMINING GROUP 3614

Sir:

Responsive to the Office Action mailed on May 4, 1998, the Applicant respectfully requests reconsideration of this application in view of the following remark:

35 U.S.C. §103 rejection, over Lyons in view of Wysoki or Fant or Beckwith, and further in view of Kanaly

The Examiner has rejected Claims 1-9, 14-18, 23-38, and 50-53 under 35 U.S.C. §103 as being obvious over Lyons in view of Wysoki or Fant or Beckwith, and further in view of Kanaly.

FIRST CLASS CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231 on July 6, 1998
(Date of Deposit)

Conny Van Dalen
Name of Person Mailing Correspondence

Conny Van Dalen 7-6-98
Signature Date

As described in more detail below, the Office Action: 1) either clearly misdescribes Kanaly or clearly asserts an improper rejection regarding Kanaly; and 2) clearly misdescribes Lyons in stating that Lyons describes an RPV that communicates "flight data ... including said remotely piloted aircraft's <u>position</u>" (see Office Action page 3). In addition, Applicant submits that Lyons in view of Wysoki or Fant or Beckwith, and further in view of Kanaly does not teach the claimed invention

In order to address the numerous references used to support this rejection, Applicant discusses Kanaly; then Lyons; then the combination of Lyons and Kanaly and Wysoki or Fant or Beckwith; and finally why Applicant's claimed invention is not obvious over the asserted combination.

1) <u>The Office Action either Misdescribes Kanaly or Asserts an Improper Rejection Regarding Kanaly</u>

The Office Action states that <u>Lyons</u> does not disclose "the determination of a delay time for communicating said flight data between said remotely piloted aircraft, and adjusting the sensitivity of said set of one or more one or more flight controls based on said delay time." (see Office Action page 5) Then, the Office Action states that Kanaly "does suggest delay time for communicating between the ground station and the remote airborne into account of controlling the remote airborne." Id. Either, the Office Action is: 1) incorrectly asserting that Kanaly teaches that the computer monitors the time delay and adjusts the sensitivity of the controls; or 2) asserting an improper rejection because "the prior art reference (or references when combined)" do not "teach or suggest all the claim limitations," but rather teach away.

a) <u>Assuming the Office Action is Asserting that Kanaly Describes Monitoring the Time Delay for Communication and Adjusting the Sensitivity of the Controls Based on the Measured Time Delay</u>

Kanaly basically teaches the inclusion of a buffer in a remotely piloted vehicle to store high resolution image data to mask the time delay for slewing a camera.[1] However, Kanaly does **not** describe that the pilot station computer determine the time delay for communication and adjust the sensitivity of the controls accordingly. In particular, the Office Action cites the following two sections of Kanaly to support the rejection:

> It also substantially increases the speed of operation of the system. Namely, a considerably shorter period of time is required to simply fetch data from memory, as compared to having to slew the camera, as in the prior art system described above. The savings in time in fetching the data from the memory permits the use of more time for digitizing , formatting, processing, etc. without delaying the image so much as to be noticeable by the console operator. (col. 3, lines 15 - 24). (emphasis added)

The above quote deals with the delay resulting from having to slew the camera, not from the communications delay.

> At the ground station the incoming signals are down converted and demodulated from transceiver 54 and modem 51 equipment to obtain display control signals. The display control signals are used to control the scanning of the image pixels of the display 31, so as to generate high resolution data only at the portion corresponding to point of observation of the operator 10 and equated with that particular portion of the overall scene data stored in memory 21 aboard the remotely piloted vehicle. It has been found that the time delay from a step change in look angle by the

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[1] Kanaly deals with a system in which a remote operator wears a helmet (on which an oculometer is mounted) that determines where the remote operator is looking. Signals indicating where the remote operator is looking are sent to the RPV. The RPV includes a camera. The prior art system over which Kanaly distinguishes is one in which the camera on the RPV provides high resolution data in the center and low resolution data on the periphery. As a result, the prior art system must move the camera in response to the remote operator's movements. This camera movement introduces a delay in the image provided to the remote operator.

To reduce or remove this delay (not measure it or adjust flight controls) due to movement of the camera, Kanaly teaches having the camera store high resolution data over the whole scene in a memory on board the RPV. The RPV transmits the high resolution imagery corresponding to the center of where the remote operator is looking and low resolution imagery (based on the stored high resolution data) corresponding to the remote operator's peripheral vision. As a result, movement of the remote operator's head merely requires the RPV adjust from where in the memory the high and low resolution data is accessed - the camera need not be moved. "Because the high resolution data is obtained from memory and not from the camera equipment directly, as in the prior art, the scheme in accordance with the present invention permits the camera to be effectively decoupled from the data link." (see col. 2, line 56 - col. 3, line 24; col. 8, line 54 - col. 9, line 6).

> operator 10 to a look angle correction by the oculometer 33 and changes to a new location in memory 21 from which new high resolution data is to be read out and its subsequent transmission and appearance on the display device 31 as high resolution imagery data may be less than 0.2 seconds using present day modulation and transmission rates. This minimum time delay is substantially less than the approximate 0.5 seconds required normally by the human eye before the operator becomes aware of the high resolution data that he is viewing. (col. 8, line 54 to col. 9, line 6).

The above quote merely indicates that it takes 0.2 seconds to perform the following: "a look angle correction by the oculometer 33," "changes to a new location in memory 21 from which new high resolution data is to be read out," "its subsequent transmission," and "its appearance on the display." Thus, Kanaly is discussing the delay of the overall system and how it has been improved, not the specific time delay required for communication from the RPV to the pilot station. In addition, Kanaly just recognizes that there is delay and that the delay is not perceptible to the human eye (In fact, Kanaly states that the required "0.2 seconds" is "substantially less" "than the approximate 0.5 seconds required normally by the human eye"). Since Kanaly's delay is not perceptible to the human eye, it is not at all surprising that no where in Kanaly is the idea of having the computer in the pilot station measure the delay and adjust the sensitivity of the controls. As such, Kanaly teaches away from the claimed invention by teaching that the delay is not perceptible to the human eye.

b) Assuming the Office Action is Improperly basing the Rejection on the Mere Fact that Kanaly indicates that there Exist Delay in His System, and that Part of that Delay is Due to Transmission of Data

The second quote from Kanaly reproduced above clearly indicates that Kanaly has determined that the delay associated with "a look angle correction by the oculometer 33," "changes to a new location in memory 21 from which new high resolution data is to be read out," "its subsequent transmission," and "its appearance on the display" is less than 0.2 seconds. This provides no support for the rejection.

According to M.P.E.P. § 2142:

> [t]o establish a primary facia case of obviousness, ... the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claim combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure." (emphasis added).

The determination by Kanaly that the delay time for his overall system is imperceptible by the human eye does not even come close to teaching or suggesting the claimed limitation of having the computer in the pilot station measure the time delay, much less doing anything about that time delay (e.g., adjusting the sensitivity of the controls). In fact, Kanaly indicates that the delay is imperceptible (0.2 is "substantially less" than 0.5 seconds), and thereby indicates no need to do anything about the delay. Thus, if the Office Action is asserting that the mere fact that Kanaly has determined a static time of 0.2 seconds for his system and that this time is imperceptible to the human eye as teaching or suggesting the claimed limitations, the rejection is improper because claim limitations that are not taught or suggested by Kanaly are being ignored. In fact, Kanaly teaches away from the claimed invention by teaching that the delay is not perceptible to the human eye.

2) The Office Action Misdescribes Lyons

Although Lyons has been extensively described in Applicant's prior responses and discussed at length in an interview, the Office Action continues to assert that Lyons describes the transmission of flight data from the aircraft, where that flight data includes the aircraft's position. This is clearly not the case.

Lyons teaches the use of dead reckoning.[2] Dead reckoning is the determination of an **estimated** or dead reckoned position that is based on various elements (including

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[2] In summary, the Lyons reference teaches various techniques for updating the dead reckoned position of remotely piloted aircraft on a two dimensional moving map display available to the pilot. In particular, Lyons contemplates a RPV transmitting information to a control center (Figure 1). The control center is used by the pilot to fly the RPV. To display the position of the RPV to the pilot, the control center provides a "moving map display." As contemplated by Lyons, "the most convenient display mode for the present application is the rolling map or 'passing

scene' technique where a new line is added to the top of the display and the scene is shifted slowly downwards" (page 5-3, end of first full paragraph). In particular, Lyons contemplates using film to generate the moving map (Figure 5). The moving map is moved based on the dead reckoned positions of the RPV.

As is well known in the art, dead reckoned positions have accumulating error. To adjust for this error, Lyons describes two basic concepts: 1) map matching (Section 3); and 2) terrain map correlation (Section 4). The map matching concept requires that the RPV transmit some kind of image data to the control center. In Figure 6, the control center is shown having the moving map display and the sensor display (i.e., a display generated from the image data transmitted by the RPV). Lyons contemplates the transmission of two kinds of image data: 1) side looking radar (SLR); and 2) real time forward-looking sensors. When using the SLR system, the SLR generated image data received by the control center allows it to make a downward-looking image. The pilot watches the sensor display (i.e., the display generated based on the transmitted image data) for "likely update features"—landmarks. When the pilot sees a landmark in the sensor display, the pilot presses a transfer button which causes the control center to superimpose the sensor display over the moving map (Figure 5). The pilot then adjusts the moving map so that it matches the overlaid sensor display image and presses an accept button. By adjusting the moving map in this manner, the dead reckoned position of the RPV is updated in an attempt to remove the error associated with the calculation of dead reckoned positions (Page 5-3, second, third, and fourth full paragraphs). The simulated SLR/map update system is illustrated in Figures 7A and 7B.

Having described the SLR-based map matching technique, the real time forward-looking sensor technique will now be described. Lyons describes basically two techniques of updating dead reckoned RPV positions on a moving map using only real time forward-looking sensors: 1) an anamorphic projection technique (page 5-3, fifth full paragraph; figure 8); and 2) a HUD based technique (page 5-3, sixth full paragraph; figure 9). Similar to the SLR based technique, the anamorphic projection technique requires the pilot to watch the sensor display (i.e., the image generated from the transmitted data) for landmarks, press a button which superimposes the transmitted image on the moving map, adjust the moving map, and press an accept button. As described in Lyons, in order to superimpose the forward-looking transmitted image on the moving map, the forward-looking image is transformed using anamorphic projection. Lyons goes on to describe various problems with the anamorphic projection technique, and then describes the HUD based technique.

In the HUD based technique, the pilot is presented with two images: 1) the moving map display (see left-hand image of Figure 9); and 2) the sensor display generated from the image data transmitted from the real time forward-looking sensor on the RPV. The HUD technology is used to allow the pilot to mark landmarks on the forward-looking sensor based image. These HUD markings are then superimposed on the moving map, and the pilot makes the necessary adjustments to the moving map (page 5-3, sixth full paragraph).

In summary, the map matching techniques use the following: 1) the transmission of image data from the RPV to the control center; 2) a display at the control center which shows an image based on the real time image data received from the RPV; 3) a moving map display that is moved based on the dead reckoned position of the RPV; and 4) some manner of superimposing the sensor image onto the moving map to allow the pilot to update the moving map in an effort to correct the error associated with the dead reckoned positions. The sensor display's image is based on image data transmitted from the RPV, while the moving map contemplated by Lyons is a two-dimensional, top down view displayed using film (see Figures 5 and 7).

Having described the map matching techniques from Lyons, Applicant will now describe the terrain map correlation technique of Lyons. The terrain map correlation technique described in Lyons is also used for correcting the error in dead reckoned positions shown to the pilot by a two-dimensional moving map. In particular, Lyons states at page 5-3, last paragraph:

> Reconnaissance or forward-looking sensors provide a convenient method of updating the navigation system. However, these sensors required large datalink bandwidth to transmit the video picture to the control center and hence are vulnerable to ECM... Hence, an alternative method of <u>updating the navigation system</u> is desirable. (emphasis added)

The phrase "updating the navigation system" is used throughout Lyons to refer to the adjustment of a two-dimensional moving map in an effort to correct for error due to dead reckoning.

Rather than requiring the user to actively update the moving map display (i.e., push a button which causes the images to be superimposed, adjusting the moving map, and pushing an accept button), the terrain map correlation technique attempts to adjust the moving map (i.e., correct for the dead reckoned error) without pilot intervention using a laser range measurements and a digital elevation database. In operation, the RPV transmits to the control center a set of laser range measurements (including an altimeter reading). The control center uses dead reckoned positions to both adjust the two-dimensional moving map and to estimate the location of the RPV over a digital database map of elevation points stored in the control center (Figure 10). Based on a calculation of the possible error associated with the dead reckoned positions, a search area is identified in the digital database (Figure 12). A search is then performed within this search area to identify the position that most closely matches the transmitted laser range data. The RPV's position is then updated to the location that best matches the transmitted laser ranges in an attempt to correct the error associated with the dead reckoned positions. The moving map is then automatically adjusted (without pilot intervention) to reflect the updated RPV position.

speed, direction, etc), that has accumulating error, and that must be corrected before generating any image. As such, the Lyons paper discusses techniques for correcting or updating the dead reckoned positions. In particular, Lyons states "The objective is to make use of equipment normally carried for RPV operation to supplement a simple dead reckoning navigation system." (abstract).

In particular, Lyons describes transmitting laser measurements for updating the dead reckoned position. The pilot station determines error associated with dead reckoning; identifies a search area in the digital ELEVATION database based on the dead reckoned position - where the current dead reckoned position is the center of the search area ("expected RPV position" in Figure 12) and the search area represents the locations the RPV could be due to the accumulating error in the current dead reckoned position; compares the transmitted laser measurements for various positions in the search area in an effort to locate a corrected dead reckoned position of the RPV.[3]

In fact, Lyons states the following:

> This paper discusses methods by which the navigation function for a Remotely Piloted Vehicles (RPVs) can be achieved without the need for complex specialized navigation equipment. The objective is to make use of equipment normally carried for RPV operation to supplement a simple dead reckoning navigation system. In this way significant improvements in navigation capability can be achieved with little or no added complexity in the vehicle itself. The additional processing is carried out at the control centre where restrictions on equipment size and cost are not so prohibitive. (Abstract)

Thus, the digital database of Lyons (conceptually illustrated in Figure 10) is used to update the two-dimensional moving map in an effort to correct for the error in the dead reckoned positions.

[3] In addition, the office action cites pages 5-4, third paragraph, and Figure 8 as disclosing a single system that accesses a database based on the remotely piloted aircraft's transmitted position and orientation and transforms the terrain data into a projected image. However, Figure 8 is for a first system in which the RPV uses a "forward looking sensor" to transmit a video image and the pilot station uses anamorphic projection to overlay that image on a 2D moving map, which is not generated by transforming a database of polygons (see page 5-3, paragraph 6), while pages 5-4, third paragraph describe a second system in which the RPV transmits laser measurements in lieu of a video stream - Lyons describes the advantages of using one over the other.

Again, none of the data transmitted by the RPV (whether it be flight data for dead reckoning, the dead reckoned position, nor the laser measurements) is the position of the aircraft; everything transmitted by Lyon's RPV is data used by the pilot station to determine a corrected dead reckoned position of the aircraft through complicated processing, which corrected dead reckoned position is used for display.

Now that Applicant has put forth a more correct reading of Lyons, Applicant will address what results from combining Lyons with Wysoki or Fant or Beckwith.

3) The combination of Lyons and Wysoki or Fant or Beckwith, in further view of Kanaly

Lyons describes that the remote pilot station displays to the remote pilot a two-dimensional moving map (which is not based at all on the digital elevation database) on which the position of the remote aircraft is indicated. In particular, Lyons uses the digital elevation database in the remote pilot station in conjunction with the laser measurements for automatically updating the dead reckoned position indicated on the two-dimensional moving map.

The Office Action asserts that the combination of Lyons and Wysoki or Fant or Beckwith would result in a system that produces "a three dimensional image data from the digital database and the navigation information." First, the claims are not that the image is generated from the digital database and some vague notion of "navigation information," but require that the **transmitted** position and orientation **be used to generate the three dimension image** (as stated above, Lyons describes a very different system in which the transmitted data is not used for image generation, but that the transmitted data goes through complicated processing to generate a corrected dead reckoned position and that it is the corrected dead reckoned position that is used for image generation). Thus, the Office Action's language is improperly disregarding limitations in the claims.

Second, the combination of Lyons Kanaly and Wysoki or Fant or Beckwith would result in a system according to the following table, where the addition of Kanaly for the purposes asserted by the Office Action would merely result in making a determination of the time delay of the entire system to illustrate that the combination is better than the prior art and/or fast enough not to be perceptible by the human eye.

Lyons in view of Wysoki or Fant or Beckwith, and further in view of Kanaly	Applicant's Invention
Aircraft transmits dead reckoning information	Aircraft determines its own position and orientation, and then transmits its own position and orientation
Aircraft transmits laser measurements for automatic dead reckoned position update	
Pilot station determines error associated with dead reckoning; identifies a search area in the digital database based on the dead reckoned position - where the current dead reckoned position is the center of the search area ("expected RPV position" in Figure 12) and the search area represents the locations the RPV could be due to the accumulating error in the current dead reckoned position; compares the transmitted laser measurements for various position in the search area in an effort to locate a corrected position of the RPV.	

As modified by Wysoki, Fant or Beckwith, the pilot station would then also transform the digital database relative to the corrected dead reckoned position to generate a three dimensional image.	The pilot station transforms the digital database relative to the position and orientation transmitted from the aircraft to generate a three dimensional image.
Knowing the time delay and that it is imperceptible to the human eye	The pilot station computer measuring the time delay to communicate with the aircraft (see claims 1 & 14)
	The pilot station computer adjusting the sensitivity of the controls based on the measured time delay (see claims 1 & 14)

Thus, the asserted combination would result in forgoing Lyon's two-dimensional map, and instead using Lyons digital database to generate a three-dimensional image (through some technique in Wysoki, Fant or Beckwith) relative to a corrected dead reckoned position. The above table is a fair read of the combination of Lyons and Wysoki or Fant or Beckwith because none of Wysoki or Fant or Beckwith describe a manner of piloting of a remotely piloted aircraft; in contrast Wysoki and Fant and Beckwith describe how to generate three dimensional images from various databases (none of which store the terrain as a set of polygons).

4) The Claimed Invention is Not Obvious in view of the combination of Lyons and Wysoki or Fant or Beckwith, and further in view of Kanaly

Clearly, the above table illustrates that the combination of Lyons and Wysoki, Fant or Beckwith does not describe Applicant's claimed invention. In particular, the combination of Lyons, Kanaly, and Wysoki or Fant or Beckwith results in a system that uses transmission of dead reckoning information by the aircraft, some mechanism in the pilot station to correct the dead reckoned positions, and some scheme to generate images based on the corrected dead reckoned position.[4]

The laser measurement system of Lyons[5] relied on by the Office Action requires the use of "terrain-referenced navigation" - that is, Lyons describes searching an elevation database in a search area (based on the estimated error in the dead reckoned position) for a match to a set of elevation based laser measurements. Terrain-referenced navigation suffers from a number of disadvantages, including an inability to function over non-unique terrain (e.g., flat terrain such as deserts, water, etc.). For example, assume that Lyons RPV is flying over water. The three or more laser measurements taken by the RPV will all indicate that the terrain over which the RPV is flying is a relatively constant elevation. According to Lyons, the three or more laser measurements would be compared to locations in an estimated error region that is a relatively constant elevation because it maps a body of water. As such, the laser measurements can no longer be used to correct the dead reckoned position. In fact, Lyons states:

> Apart from the errors involved in the actual laser measurements the accuracy of terrain representation has a considerable influence on the feasibility of the method. In addition, the technique is ineffective over the sea or over flat, featureless terrain. (section 4). (emphasis added).

---

[4] Lyons states the following:

> This paper discusses methods by which the navigation function for a Remotely Piloted Vehicles (RPVs) can be achieved without the need for complex specialized navigation equipment. The objective is to make use of equipment normally carried for RPV operation to supplement a simple dead reckoning navigation system. In this way significant improvements in navigation capability can be achieved with little or no added complexity in the vehicle itself. The additional processing is carried out at the control centre where restrictions on equipment size and cost are not so prohibitive. ... Use can also be made of an on-board laser to provide range-to-terrain measurements which, when correlated with a computer stored map, enables the RPV position to be continuously updated. (Abstract)

[5] Lyons describes basically two systems: 1) a higher bandwidth system that uses dead reckoning and transmits images from the RPV to the pilot station for updating the dead reckoned positions; and 2) a lower bandwidth system that also uses dead reckoning, but uses laser measurements for updating the dead reckoned positions. Unlike the former, Applicant's claimed system does not require the transmission of images to fly the aircraft and to correct dead reckoned positions, but has the remotely piloted aircraft determine and transmit its position and generates three-dimensional images from the database in the pilot station from that transmitted position. As described in the text, unlike the later, Applicant's claimed system does not use terrain-referenced navigation.

> Where the data link is limited in bandwidth the laser/terrain correlation technique should give good accuracy and the process could be completely automated to provide a continuous indication of RPV position. Disadvantages of the system are the large amount of data storage and computation necessary at the control centre, the development work required to produce an operational system and the unsuitability of the system over featureless terrain. (section 5). (emphasis added)

Applicant's claimed invention does not use Lyons dead reckoned positions that must be corrected in the pilot station using terrain-referenced navigation, but rather Applicant's claimed invention requires the remotely piloted aircraft determines and transmits its own position to the pilot station and that it is this transmitted position and orientation that is used to generate the three dimensional images (not an untransmitted corrected dead reckoned position). Again, the asserted combination results in a system in which the digital database in the pilot station is accessed based on the error associated with the dead reckoned position, and then the digital database is accessed using the correct dead reckoned position to generate the three dimensional image (in other words, the asserted combination does not generate the three-dimensional image using the position and orientation transmitted from the RPV; in contrast the asserted combination uses a corrected dead reckoned position that was not transmitted by the RPV). Thus, none of the data transmitted by the RPV (whether it be flight data for dead reckoning, the dead reckoned position, image data, or the laser measurements) is the position of the aircraft; rather, everything transmitted by Lyon's RPV is data used by the pilot station to determine a corrected dead reckoned position of the aircraft through complicated processing, which corrected dead reckoned position is used for display. Thus, Lyons teaches away from Applicant's claimed invention in that Lyon's "objective" is to put the onus of determining the position of the RPV on the pilot station to "supplement a simple dead reckoning navigation system," whereas Applicant's claimed invention puts the onus of determining position on the remotely piloted vehicle and uses the transmitted position to generate the three dimensional image.

In particular, Applicant's claim 32 requires "determining the current position of said remotely piloted aircraft in three dimensions; ... communicating said current position .. from said remotely piloted aircraft to a pilot station; transforming said terrain data into image data representing a simulated three dimensional view according to the current position; displaying said simulated three dimensional view using said image data." Thus, Applicant's claim 32 requires that the three-dimensional image be produced from the TRANSMITTED position, not one that is corrected or updated using some laser measurement dead reckoning scheme. Since Applicant's claimed invention requires the remotely piloted aircraft to determine and transmit its own position to the pilot station and that it is this transmitted position and orientation that is used to generate the three dimensional images, Applicant's system provides an advantage over Lyons in that Applicant's system does not have difficulty over featureless terrain.

Furthermore, Claims 1 and 14 have additional limitations that the Office Action improperly asserts are found in Kanaly. The determination by Kanaly that the delay time for his overall system is imperceptible by the human eye does not even come close to teaching or suggesting the claimed limitation of having the computer in the pilot station measure the time delay, much less doing anything about it (e.g., adjusting the sensitivity of the controls). In fact, Kanaly indicates that the delay is imperceptible (0.2 is "substantially less" than 0.5 seconds), and thereby indicates no need to do anything about the delay. Thus, Kanaly teaches away from the claimed invention by teaching that the delay is not perceptible to the human eye. In contrast, the language of claims 1 and 14 requires that the computer in the pilot station determine the delay and adjust the sensitivity of the controls. If there was a static time delay in transmission and/or the delay was imperceptible, the sensitivity of the flight controls of Applicant's system could be permanently set. However, Applicant claim language requires that the computer in the pilot station determine the time delay of the communication and adjust the sensitivity of the controls, thereby requiring at least one real time measurement of the delay and some adjustment.

Furthermore, Applicant's claims 24 and 32 require that the database store the terrain data as polygons. As previously described, none of art used in the rejection make use of a database that stores the terrain data as a set of polygons. In particular, Lyons describes the use of an Elevation Database in which each point represents an elevation. Although Figure 10 from Lyons shows (for illustrative purposes only because Lyons does not display an image from the database) lines connecting the elevation points, the points in an elevation database are not stored as polygons. While the images generated by Wysoki or Beckwith of Fant may look like one or more polygons, the terrain is not stored in their databases as polygons.[6] In contrast, Applicant's claim 24 requires the transmitted "position and orientation" be transformed "into a three dimensional projected image of said remotely piloted aircraft's environment according to a database representing real terrestrial terrain using polygons." Similarly, Applicant's claim 32 requires "accessing a database comprising terrain data that represents real terrestrial terrain as a set of polygons." Thus, claims 24 and 32 require that the database stores the terrain as polygons.

[6] As described above, the data in the database of Lyons is not used to generate an image, but simply to update the dead reckoned position.

With respect to Beckwith, the digital elevation data in the database is points with a constant north up position, not polygons (see col. 6, lines 52-61; col. 7, lines 30-36).

Fant describes the use of two databases: 1) the object library database which contains real-world images; and 2) the gaming area database which provides the information necessary for the placement of the contents of the object library, surfaces, and special effect on a grid or gaming area (see col. 6, line 38 - col. 7, line 10). In particular, the Fant patent is for a high performance computer graphics system that combines Computer Generated Imagery (CGI) with Computer Synthesized Imagers (CSI) to form Computer Generated Synthesized Imagery (CGSI) (see col. 2, line 53 - col. 3, line 12).

Wysoki describes a database of digital orthophotographs (see col. 4, lines 43-51). Digital orthophotographs are computerized images generated by making geometric corrections to scanned aerial photographs. In particular, an aerial photograph contains some degree of distortion. In contrast, maps maintain a constant scale, but lack the detail of an aerial photograph. Orthophotography combines the features of maps and aerial photographs. The aerial photographs are unwrapped (to remove the distortion) and fitted to a particular map projection to create an image map that has uniform scale and known accuracy.

The remaining rejected claims are each dependent on one of the allowable base claims. For at least these reasons, Applicant respectfully request this rejection be withdrawn.

35 U.S.C. §103 rejection, over Lyons in view of Wysoki or Fant or Beckwith, and further in view of Thornberg

The Examiner has rejected Claims 12-13 and 21-22 under 35 U.S.C. §103 as being obvious over Lyons in view of Wysoki or Fant or Beckwith, and further in view of Thornberg.

Claims 12-13 and 21-22 are each dependent on one of the allowable base claims 1 and 14. For at least this reason, Applicant respectfully submits that claims 12-13 and 21-22 are allowable.

Conclusion

Applicant respectfully submits that the rejections have been overcome by the amendments and remarks, and that the Claims are now in condition for allowance. Accordingly, Applicant respectfully requests the rejections be withdrawn and the Claims as amended be allowed.

Drawing Corrections

The drawings have been objected to by the draftsman. The Applicant will file amended drawings at the time of allowance of the present application.

Invitation for a telephone interview

The Examiner is invited to call the undersigned at 408-720-8598 if there remains any issue with allowance of this case.

Charge our Deposit Account

Please charge any shortage to our Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Date: 7/6, 1998

Daniel M. De Vos
Reg. No. 37,813

12400 Wilshire Boulevard
Seventh Floor
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(408) 720-8598

AF/GAU 3611

#12

OIPE JUL 09 1998 JC21 PATENT & TRADEMARK OFFICE

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Attorney's Docket No.: 002055.P004 Patent

In re the Application of: Jed Margolin (inventor(s))

AMENDMENT UNDER 37 C.F.R. § 1.116
EXPEDITED PROCEDURE

Application No.: 08/587,731

Filed: January 19, 1996

EXAMINING GROUP 3614

For: A Method and Apparatus for Remotely Piloting an Aircraft (title)

RECEIVED 98 JUL 13 AM 9:00 TECHNOLOGY CENTER 3600

ASSISTANT COMMISSIONER FOR PATENTS
Washington, D.C. 20231
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SIR: Transmitted herewith is an **Amendment After Final Action** for the above application.

____ Small entity status of this application under 37 C.F.R. §§ 1.9 and 1.27 has been established by a verified statement previously submitted.

____ A verified statement to establish small entity status under 37 C.F.R. §§ 1.9 and 1.27 is enclosed.

_X_ No additional fee is required.

____ **A Notice of Appeal is enclosed.**

The fee has been calculated as shown below:

	(Col. 1) Claims Remaining After Amd.		(Col. 2) Highest No. Previously Paid For	(Col. 3) Present Extra	SMALL ENTITY Rate	SMALL ENTITY Additional Fee	OTHER THAN A SMALL ENTITY Rate	OTHER THAN A SMALL ENTITY Additional Fee
Total Claims	* 38	Minus	** 49	0	x11	$ 0	x22	$
Indep. Claims	* 3	Minus	*** 5	0	x41	$ 0	x82	$
First Presentation of Multiple Dependent Claim(s)					+135	$ 0	+270	$
					Total Add. Fee	$ 0	Total Add. Fee	$

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Conny Van Dalen
Name of Person Mailing Correspondence

Conny VanDalen — 7-6-98
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(LJV/cak 10/25/96)

_______ A check in the amount of $___________ is attached for presentation of additional claim(s).
_______ Applicant(s) hereby Petition(s) for an Extension of Time of _______ month(s) pursuant to 37 C.F.R. § 1.136(a).
_______ A check for $___________ is attached for processing fees under 37 C.F.R. § 1.17.
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A duplicate copy of this sheet is enclosed.
__X__ The Commissioner of Patents and Trademarks is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. 02-2666 **(a duplicate copy of this sheet is enclosed)**:

__X__ Any additional filing fees required under 37 C.F.R. § 1.16 for presentation of extra claims.

__X__ Any extension or petition fees under 37 C.F.R. § 1.17.

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP

Date: 7/6, 1998

Daniel M. De Vos

Reg. No. 37,813

12400 Wilshire Boulevard
Seventh Floor
Los Angeles, California 90025
(408) 720-8598

(LJV/cak 10/25/96)

08/587,731

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/587,731	01/19/96	MARGOLIN J	002055.P004

PM21/0724

BLAKELY SOKOLOFF TAYLOR AND ZAFMAN
12400 WILSHIRE BOULEVARD
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LOS ANGELES CA 90025

EXAMINER	
NGUYEN, T	
ART UNIT	**PAPER NUMBER**
3614	13

DATE MAILED: 07/24/98

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Tan Nguyen
TAN Q. NGUYEN
PATENT EXAMINER

PTO-90C (Rev. 2/95) ☆U.S. GOVERNMENT PRINTING OFFICE 1996-411-619/40275 1- File Copy

Advisory Action

Application No.	Applicant(s)	
08/587,731	MARGOLIN	
Examiner	**Group Art Unit**	
TAN Q. NGUYEN	3614	

THE PERIOD FOR RESPONSE: [check only a) or b)]

a) ☒ expires THREE months from the mailing date of the final rejection.

b) ☐ expires either three months from the mailing date of the final rejection, or on the mailing date of this Advisory Action, whichever is later. In no event, however, will the statutory period for the response expire later than six months from the date of the final rejection.

Any extension of time must be obtained by filing a petition under 37 CFR 1.136(a), the proposed response and the appropriate fee. The date on which the response, the petition, and the fee have been filed is the date of the response and also the date for the purposes of determining the period of extension and the corresponding amount of the fee. Any extension fee pursuant to 37 CFR 1.17 will be calculated from the date of the originally set shortened statutory period for response or as set forth in b) above.

☐ Appellant's Brief is due two months from the date of the Notice of Appeal filed on ______________ (or within any period for response set forth above, whichever is later). See 37 CFR 1.191(d) and 37 CFR 1.192(a).

Applicant's response to the final rejection, filed on 7/9/98 has been considered with the following effect, but is NOT deemed to place the application in condition for allowance:

☐ The proposed amendment(s):

☐ will be entered upon filing of a Notice of Appeal and an Appeal Brief.

☐ will not be entered because:

☐ they raise new issues that would require further consideration and/or search. (See note below).

☐ they raise the issue of new matter. (See note below).

☐ they are not deemed to place the application in better form for appeal by materially reducing or simplifying the issues for appeal.

☐ they present additional claims without cancelling a corresponding number of finally rejected claims.

NOTE: ______________________________

☐ Applicant's response has overcome the following rejection(s):

____

☒ Newly proposed or amended claims *1-9, 12-18, 21-23, and 50* would be allowable if submitted in a separate, timely filed amendment cancelling the non-allowable claims.

☒ The affidavit, exhibit or request for reconsideration has been considered but does NOT place the application in condition for allowance because:
Upon the response filed on July 19, 1998, the arguments are partial deemed to be persuasive. Therefore, claims 1-9, 12-18, 21-23, and 50 . However, the references cited do read on claims 24-38, and 51-52 .

☐ The affidavit or exhibit will NOT be considered because it is not directed SOLELY to issues which were newly raised by the Examiner in the final rejection.

☒ For purposes of Appeal, the status of the claims is as follows (see attached written explanation, if any):

Claims allowed: *1-9, 12-18, 21-23, and 50*

Claims objected to: *NONE*

Claims rejected: *24-38, 51, and 52*

☐ The proposed drawing correction filed on ______________ ☐has ☐has not been approved by the Examiner.

☐ Note the attached Information Disclosure Statement(s), PTO-1449, Paper No(s). ________.

☐ Other

Tan Nguyen

TAN Q. NGUYEN
PRIMARY EXAMINER
ART UNIT 3614

002055.P004

Patent

M. Ems 8-12-98 14/C

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

OIPE JC25 AUG 07 1998 PATENT & TRADEMARK OFFICE

In re Application of:
Jed Margolin

Serial No. 08/587,731

Filed: January 19, 1996

For: A Method and Apparatus for Remotely Piloting an Aircraft

Examiner: T. Nguyen

Art Unit: 3614

PLEASE ENTER 08/20/98 TN

RESPONSE UNDER 37 C.F.R. § 1.116 -- EXPEDITED PROCEDURE - EXAMINING GROUP 3614

Assistant Commissioner for Patents
Washington, D.C. 20231

RESPONSE UNDER 37 C.F.R. § 1.116
EXPEDITED PROCEDURE -- EXAMINING GROUP 3614

Sir:

Responsive to the Advisory Action mailed on July 24, 1998, the Applicant respectfully requests the Examiner to enter the following amendment and to consider the following remark:

RECEIVED TECHNOLOGY CENTER 3600 98 AUG 11 PM 2:41

AMENDMENT

In the Claims:

TN 08/20/98

Please cancel Claims 24-38, 51 and 52 and 53 *without prejudice.*

REMARK

The Advisory Action has indicated that claims 1-9, 12-18, 21-23, and 50 are allowable and that claims 24-38, 51 and 52 remain rejected. Although Applicant disagrees

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Conny VanDalen
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8-4-98
Date

with the rejection, Applicant has canceled claims 24-38, 51 and 52 to place the application in condition for allowance. Applicant currently plans on filing a continuation to further pursue the rejected claims.

Invitation for a telephone interview

The Examiner is invited to call the undersigned at 408-720-8598 if there remains any issue with allowance of this case.

Charge our Deposit Account

Please charge any shortage to our Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Date: 8/4, 1998

Daniel M. De Vos
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Attorney's Docket No.: 002055.P004

Patent

In re the Application of: Jed Margolin (inventor(s))

Application No.: 08/587,731

Filed: January 19, 1996

For: A Method and Apparatus for Remotely Piloting an Aircraft (title)

AMENDMENT UNDER 37 C.F.R. § 1.116
EXPEDITED PROCEDURE
EXAMINING GROUP 3614

ASSISTANT COMMISSIONER FOR PATENTS
Washington, D.C. 20231
Box AF

SIR: Transmitted herewith is an **Amendment After Final Action** for the above application.

_____ Small entity status of this application under 37 C.F.R. §§ 1.9 and 1.27 has been established by a verified statement previously submitted.
_____ A verified statement to establish small entity status under 37 C.F.R. §§ 1.9 and 1.27 is enclosed.
__X__ No additional fee is required.
_____ **A Notice of Appeal is enclosed.**

The fee has been calculated as shown below:

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Total Claims	* 21	Minus	** 49	0	x11	$ 0	x22	$
Indep. Claims	* 2	Minus	*** 5	0	x41	$ 0	x82	$
First Presentation of Multiple Dependent Claim(s)					+135	$ 0	+270	$
					Total Add. Fee	$ 0	Total Add. Fee	$

* If the entry in Col. 1 is less than the entry in Col. 2, write "0" in Col. 3.

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Conny VanDalen
Signature

8-4-98
Date

(LJV/cak 10/25/96)

_______ A check in the amount of $____________ is attached for presentation of additional claim(s).

_______ Applicant(s) hereby Petition(s) for an Extension of Time of ________ month(s) pursuant to 37 C.F.R. § 1.136(a).

_______ A check for $____________ is attached for processing fees under 37 C.F.R. § 1.17.

_______ Please charge my Deposit Account No. 02-2666 the amount of $______________. **A duplicate copy of this sheet is enclosed.**

__X__ The Commissioner of Patents and Trademarks is hereby authorized to charge payment of the following fees associated with this communication or credit any overpayment to Deposit Account No. 02-2666 **(a duplicate copy of this sheet is enclosed)**:

__X__ Any additional filing fees required under 37 C.F.R. § 1.16 for presentation of extra claims.

__X__ Any extension or petition fees under 37 C.F.R. § 1.17.

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP

Date: 8/4, 1998

Daniel M. De Vos

Reg. No. 37,813

12400 Wilshire Boulevard
Seventh Floor
Los Angeles, California 90025
(408) 720-8598

#15

ACCESS ACKNOWLEDGMENT
and
SECRECY ORDER RECOMMENDATION BY DEFENSE AGENCY

Application Serial No.: 08/587,731 Defense Agency: Navy

Filing Date: 01/19/96 Date Referred: 03/18/96

I hereby acknowledge as indicated by my signature on this form that I have inspected this application in administration of 35 USC 181 on behalf of the Agency/Command specified below. I promise not to divulge any information from this application for any purpose other than administration of 35 USC 181.

Recommendation (e.g., 'Secrecy Not Recommended (SNR)')	**Reviewer(s) Signature/Date/Command**
SNR	[signature] 5/23/96 NAVY

Instructions to Reviewers:

1. All individuals reviewing this application are required under 35 USC 181 to sign and date this form regardless of whether they are making a secrecy order recommendation.

2. The attached copy of the application, any copies made therefrom and this form must be returned to the PTO once a recommendation not to impose secrecy has been made or a secrecy order has been rescinded.

Time for Completion of Review:

Pursuant to 35 U.S.C. 184, the subject matter of this application may be filed in a foreign country for the purpose of filing a patent application without a license any time after the expiration of 6 months from filing date unless the application becomes the subject of a secrecy order.

5/30/96

ACCESS ACKNOWLEDGMENT
and
SECRECY ORDER RECOMMENDATION BY DEFENSE AGENCY

Application Serial No.: 08/587,731 — Defense Agency: AirForce

Filing Date: 01/19/96 — Date Referred: 03/18/96

I hereby acknowledge as indicated by my signature on this form that I have inspected this application in administration of 35 USC 181 on behalf of the Agency/Command specified below. I promise not to divulge any information from this application for any purpose other than administration of 35 USC 181.

Recommendation (e.g., 'Secrecy Not Recommended (SNR)')	**Reviewer(s) Signature/Date/Command**
No Secrecy Recommended	M Jordan, AFISA/TRNP, 26 march 96

Instructions to Reviewers:

1. All individuals reviewing this application are required under 35 USC 181 to sign and date this form regardless of whether they are making a secrecy order recommendation.

2. The attached copy of the application, any copies made therefrom and this form must be returned to the PTO once a recommendation not to impose secrecy has been made or a secrecy order has been rescinded.

Time for Completion of Review:

Pursuant to 35 U.S.C. 184, the subject matter of this application may be filed in a foreign country for the purpose of filing a patent application without a license any time after the expiration of 6 months from filing date unless the application becomes the subject of a secrecy order.

4/3/96 [illegible]

08/587,731

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/587,731	01/19/96	MARGOLIN	J 002055.P004

PM21/0824
BLAKELY SOKOLOFF TAYLOR AND ZAFMAN
12400 WILSHIRE BOULEVARD
7TH FLOOR
LOS ANGELES CA 90025

EXAMINER	
NGUYEN, T	
ART UNIT	PAPER NUMBER
3614	16

DATE MAILED: 08/24/98

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Tan Nguyen
TAN Q. NGUYEN
PATENT EXAMINER

PTO-90C (Rev. 2/95)

☆U.S.GOVERNMENT PRINTING OFFICE 1996-411-516/40275

1- File Copy

Notice of Allowability	Application No. 08/587,731	Applicant(s) MARGOLIN
	Examiner TAN Q. NGUYEN	Group Art Unit 3614

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance and Issue Fee Due or other appropriate communication will be mailed in due course.

[X] This communication is responsive to _08/07/98 and 08/20/98_

[X] The allowed claim(s) is/are _1-9, 10-17, 21-23, and 50 (now renumbered as 1-20)_

[ ] The drawings filed on ____________ are acceptable.

[ ] Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

[ ] All [ ] Some* [ ] None of the CERTIFIED copies of the priority documents have been

[ ] received.

[ ] received in Application No. (Series Code/Serial Number) ____________.

[ ] received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: ____________

[ ] Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

A SHORTENED STATUTORY PERIOD FOR RESPONSE to comply with the requirements noted below is set to EXPIRE THREE MONTHSFROM THE "DATE MAILED" of this Office action. Failure to timely comply will result in ABANDONMENT of this application. Extensions of time may be obtained under the provisions of 37 CFR 1.136(a)

[ ] Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL APPLICATION, PTO-152, which discloses that the oath or declaration is deficient. A SUBSTITUTE OATH OR DECLARATION IS REQUIRED.

[X] Applicant MUST submit NEW FORMAL DRAWINGS

[ ] because the originally filed drawings were declared by applicant to be informal.

[X] including changes required by the Notice of Draftsperson's Patent Drawing Review, PTO-948, attached hereto or to Paper No. _3_.

[ ] including changes required by the proposed drawing correction filed on ____________, which has been approved by the examiner.

[ ] including changes required by the attached Examiner's Amendment/Comment.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the reverse side of the drawings. The drawings should be filed as a separate paper with a transmittal lettter addressed to the Official Draftsperson.

[ ] Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Any response to this letter should include, in the upper right hand corner, the APPLICATION NUMBER (SERIES CODE/SERIAL NUMBER). If applicant has received a Notice of Allowance and Issue Fee Due, the ISSUE BATCH NUMBER and DATE of the NOTICE OF ALLOWANCE should also be included.

Attachment(s)

[ ] Notice of References Cited, PTO-892

[ ] Information Disclosure Statement(s), PTO-1449, Paper No(s). ________

[ ] Notice of Draftsperson's Patent Drawing Review, PTO-948

[ ] Notice of Informal Patent Application, PTO-152

[X] Interview Summary, PTO-413

[ ] Examiner's Amendment/Comment

[ ] Examiner's Comment Regarding Requirement for Deposit of Biological Material

[ ] Examiner's Statement of Reasons for Allowance

Tan Nguyen

TAN Q. NGUYEN
PRIMARY EXAMINER
ART UNIT 3614

Interview Summary

Application No.	Applicant(s)	Examiner	Group Art Unit
08/587,731	MARGOLIN	TAN Q. NGUYEN	3614

All participants (applicant, applicant's representative, PTO personnel):

(1) *TAN Q. NGUYEN* (3) ______

(2) *DANIEL M DE VOS* (4) ______

Date of Interview *8/20/98*

Type: [X] Telephonic [ ] Personal (copy is given to [ ] applicant [ ] applicant's representative).

Exhibit shown or demonstration conducted: [ ] Yes [X] No. If yes, brief description:

Agreement [X] was reached. [ ] was not reached.

Claim(s) discussed: *53*

Identification of prior art discussed:
NONE

Description of the general nature of what was agreed to if an agreement was reached, or any other comments
CLAIM 53 IS REQUESTED TO BE CANCELED SINCE IT DEPENDS ON CLAIM 34 WHICH WAS CANCELED. THE AGREEMENT WAS REACHED.

(A fuller description, if necessary, and a copy of the amendments, if available, which the examiner agreed would render the claims allowable must be attached. Also, where no copy of the amendents which would render the claims allowable is available, a summary thereof must be attached.)

1. [X] It is not necessary for applicant to provide a separate record of the substance of the interview.

Unless the paragraph above has been checked to indicate to the contrary, A FORMAL WRITTEN RESPONSE TO THE LAST OFFICE ACTION IS NOT WAIVED AND MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a response to the last Office action has already been filed, APPLICANT IS GIVEN ONE MONTH FROM THIS INTERVIEW DATE TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW.

2. [X] Since the Examiner's Interview summary above (including any attachments) reflects a complete response to each of the objections, rejections and requirements that may be present in the last Office action, and since the claims are now allowable, this completed form is considered to fulfill the response requirements of the last Office action. Applicant is not relieved from providing a separate record of the interview unless box 1 above is also checked.

Examiner Note: You must sign and stamp this form unless it is an attachment to a signed Office action.

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office

NOTICE OF ALLOWANCE AND ISSUE FEE DUE

PM21/0824
BLAKELY SOKOLOFF TAYLOR AND ZAFMAN
12400 WILSHIRE BOULEVARD
7TH FLOOR
LOS ANGELES CA 90025

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT		DATE MAILED
08/587,731	01/19/96	020	NGUYEN, T	3614	08/24/98

First Named Applicant: MARGOLIN, JED

TITLE OF INVENTION: METHOD AND APPARATUS FOR REMOTELY PILOTING AN AIRCRAFT

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
2 002055.P004	701-120.000	I16	UTILITY	YES	$660.00	11/24/98

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED.

THE ISSUE FEE MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED.

HOW TO RESPOND TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.
If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is changed, pay twice the amount of the FEE DUE shown above and notify the Patent and Trademark Office of the change in status, or
B. If the status is the same, pay the FEE DUE shown above.

If the SMALL ENTITY is shown as NO:

A. Pay FEE DUE shown above, or

B. File verified statement of Small Entity Status before, or with, payment of 1/2 the FEE DUE shown above.

II. Part B-Issue Fee Transmittal should be completed and returned to the Patent and Trademark Office (PTO) with your ISSUE FEE. Even if the ISSUE FEE has already been paid by charge to deposit account, Part B Issue Fee Transmittal should be completed and returned. If you are charging the ISSUE FEE to your deposit account, section "4b" of Part B-Issue Fee Transmittal should be completed and an extra copy of the form should be submitted.

III. All communications regarding this application must give application number and batch number.
Please direct all communications prior to issuance to Box ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PATENT AND TRADEMARK OFFICE COPY

PART B—ISSUE FEE TRANSMITTAL 242 - 605 901 - 38

Complete and mail this form, together with applicable fees, to: **Box ISSUE FEE**
Assistant Commissioner for Patents
Washington, D.C. 20231

MAILING INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE. Blocks 1 through 4 should be completed where appropriate. All further correspondence including the Issue Fee Receipt, the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Legibly mark-up with any corrections or use Block 1)

PM21/0824
BLAKELY SOKOLOFF TAYLOR AND ZAFMAN
12400 WILSHIRE BOULEVARD
7TH FLOOR
LOS ANGELES CA 90025

Note: The certificate of mailing below can only be used for domestic mailings of the Issue Fee Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing.

Certificate of Mailing

I hereby certify that this Issue Fee Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Box Issue Fee address above on the date indicated below.

Conny Van Dalen (Depositor's name)
Conny VanDalen (Signature)
11-24-98 (Date)

RECEIVED Publishing Division DEC 3 - 1998

APPLICATION NO.	FILING DATE	TOTAL CLAIMS	EXAMINER AND GROUP ART UNIT		DATE MAILED
~~08/587,731~~	~~01/19/96~~	~~020~~ 16	~~NGUYEN, T~~	~~3614~~	~~08/24/98~~

First Named Applicant ~~MARGOLIN,~~ ~~JED~~

TITLE OF INVENTION METHOD AND APPARATUS FOR REMOTELY PILOTING AN AIRCRAFT

ATTY'S DOCKET NO.	CLASS-SUBCLASS	BATCH NO.	APPLN. TYPE	SMALL ENTITY	FEE DUE	DATE DUE
~~2 003055.P004~~	~~701-120.000~~	~~I16~~	~~UTILITY~~	~~YES~~	~~$660.00~~	~~11/24/98~~

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363). Use of PTO form(s) and Customer Number are recommended, but not required.

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47) attached.

2. For printing on the patent front page, list (1) the names of up to 3 registered patent attorneys or agents OR, alternatively, (2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Blakely, Sokoloff,
2 Taylor and Zafman LLP
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)
PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. Inclusion of assignee data is only appropriate when an assignment has been previously submitted to the PTO or is being submitted under separate cover. Completion of this form is NOT a substitute for filing an assignment.
(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY & STATE OR COUNTRY)

Please check the appropriate assignee category indicated below (will not be printed on the patent)
☐ individual ☐ corporation or other private group entity ☐ government

4a. The following fees are enclosed (make check payable to Commissioner of Patents and Trademarks):
☒ Issue Fee
☒ Advance Order - # of Copies ten (10)

4b. The following fees or deficiency in these fees should be charged to:
DEPOSIT ACCOUNT NUMBER 02-2666
(ENCLOSE AN EXTRA COPY OF THIS FORM)
☒ Issue Fee
☒ Advance Order - # of Copies ten (10)

The COMMISSIONER OF PATENTS AND TRADEMARKS is requested to apply the Issue Fee to the application identified above.

(Authorized Signature) Edwin H. Taylor, Reg. #25,129 (Date) 11/24/98

12/02/1998 00000130 08587731
01 FC:242 605.00 OP
02 FC:561 30.00 OP

NOTE: The Issue Fee will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the Patent and Trademark Office.

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending on the needs of the individual case. Any comments on the amount of time required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, D.C. 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND FEES AND THIS FORM TO: Box Issue Fee, Assistant Commissioner for Patents, Washington D.C. 20231

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMIT THIS FORM WITH FEE

002055.P004 4100 9.28.98 Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Jed Margolin

Application No. 08/587,731

Filed: January 19, 1996

For: A Method and Apparatus for Remotely Piloting an Aircraft

Examiner: T. Nguyen

Art Unit: 3614

Issue Batch No.: I16

Notice of Allowance: 8/24/98

RECEIVED Publishing Division SEP 03 1998 07

SUBMISSION OF FORMAL DRAWINGS

Official Draftsman
Washington, DC 20231

Dear Sir:

Applicant respectfully requests that the objection to the shading in Figure 7 be withdrawn because: 1) the shading aids in understanding the invention; and 2) the inventor has no other way of generating the figures. According to 37 C.F.R. 1.84(m) "the use of shading in views is encouraged if it aids in the understanding of the invention... Flat parts may also be lightly shaded. Such shading is preferred in the case of parts shown in perspective..." Figure 7 illustrates the projections that can be produced from the database in accordance with the invention. The shading is used for depth cueing, and therefore aids in the understanding of the invention by augmenting the perspective views provided.

Respectfully submitted,
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Date: 8/31 1998

Daniel M. De Vos
Registration No. 37,813

12400 Wilshire Blvd.
Seventh Floor
Los Angeles, CA 90025-1026
(408) 720-8598

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail with sufficient postage in an envelope addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231

On August 31, 1998
Date of Deposit

Conny Van Dalen
Name of Person Mailing Correspondence

Conny Van Dalen 8-31-98
Signature Date

APPROVED BY DRAFTSMAN | O.G. FIG. 3,4 | CLASS 701 | SUBCLASS 120

5904724

08/587731

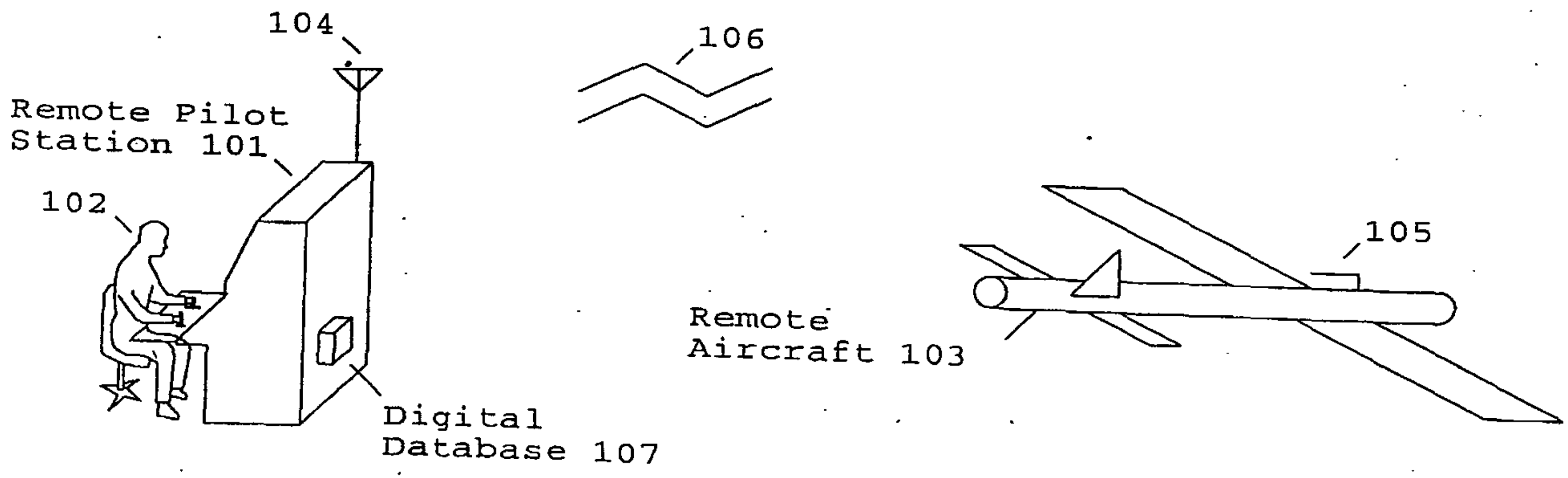

Fig. 1

APPROVED O.G. FIG.
BY CLASS SUBCLASS
DRAFTSMAN

08/587731

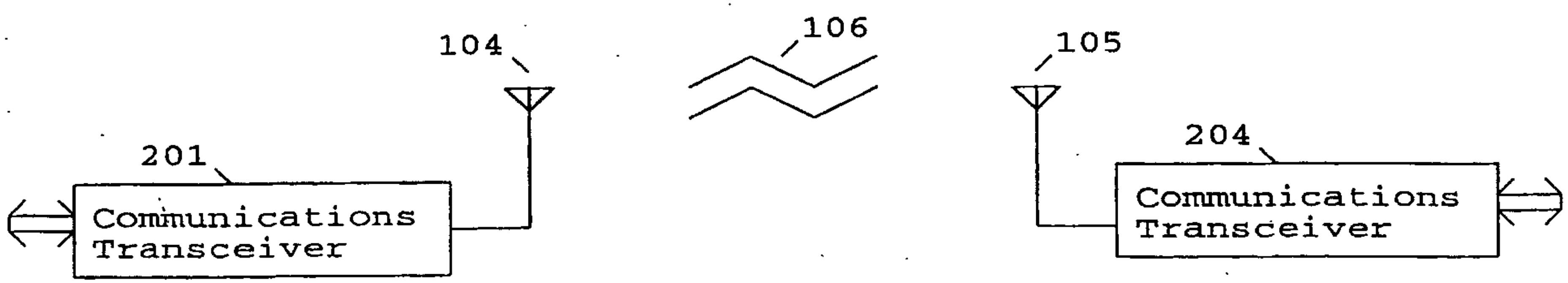

Fig. 2

APPROVED BY DRAFTSMAN | O.G. FIGs. 3,4 | CLASS 701 | SUBCLASS 120

08/587731

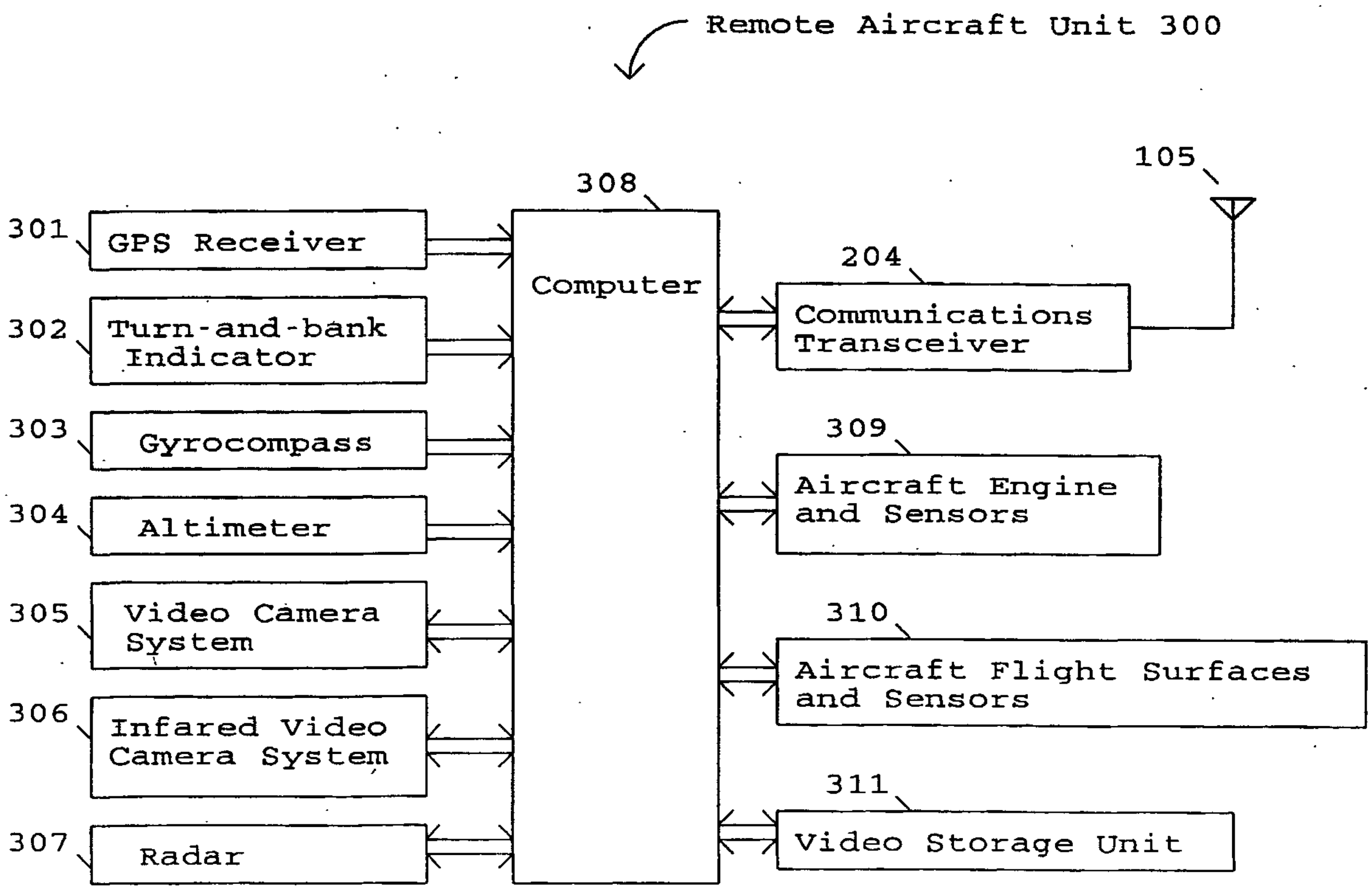

Fig. 3

2

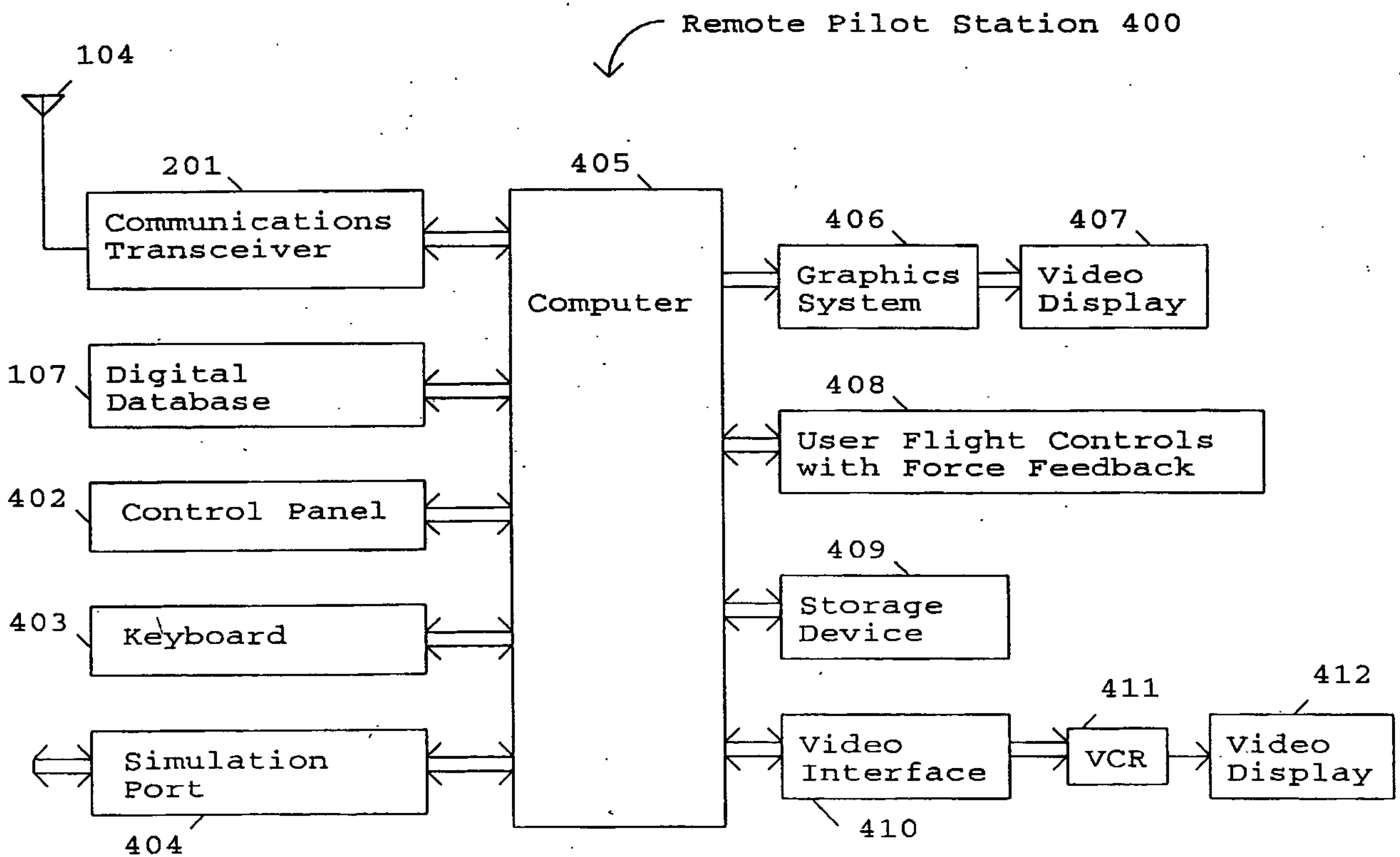

Fig. 4

APPROVED BY DRAFTSMAN | O.G. FIG. 3,4 | CLASS 701 | SUBCLASS 120

08/587731

APPROVED BY DRAFTSMAN | O.G. FIG. | CLASS | SUBCLASS

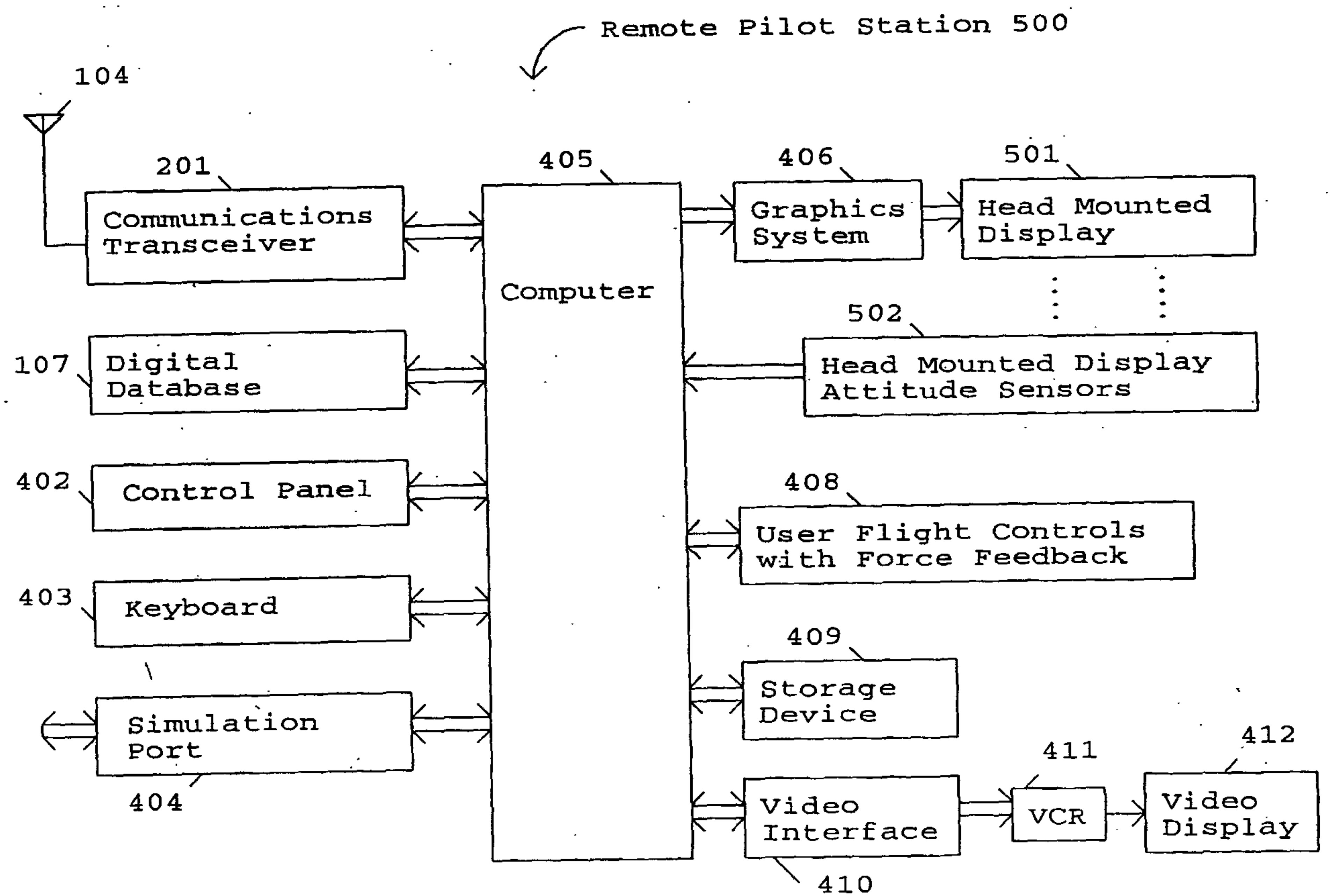

Fig. 5

08/587731

APPROVED BY DRAFTSMAN | O.G. FIG. | CLASS | SUBCLASS

08/587731

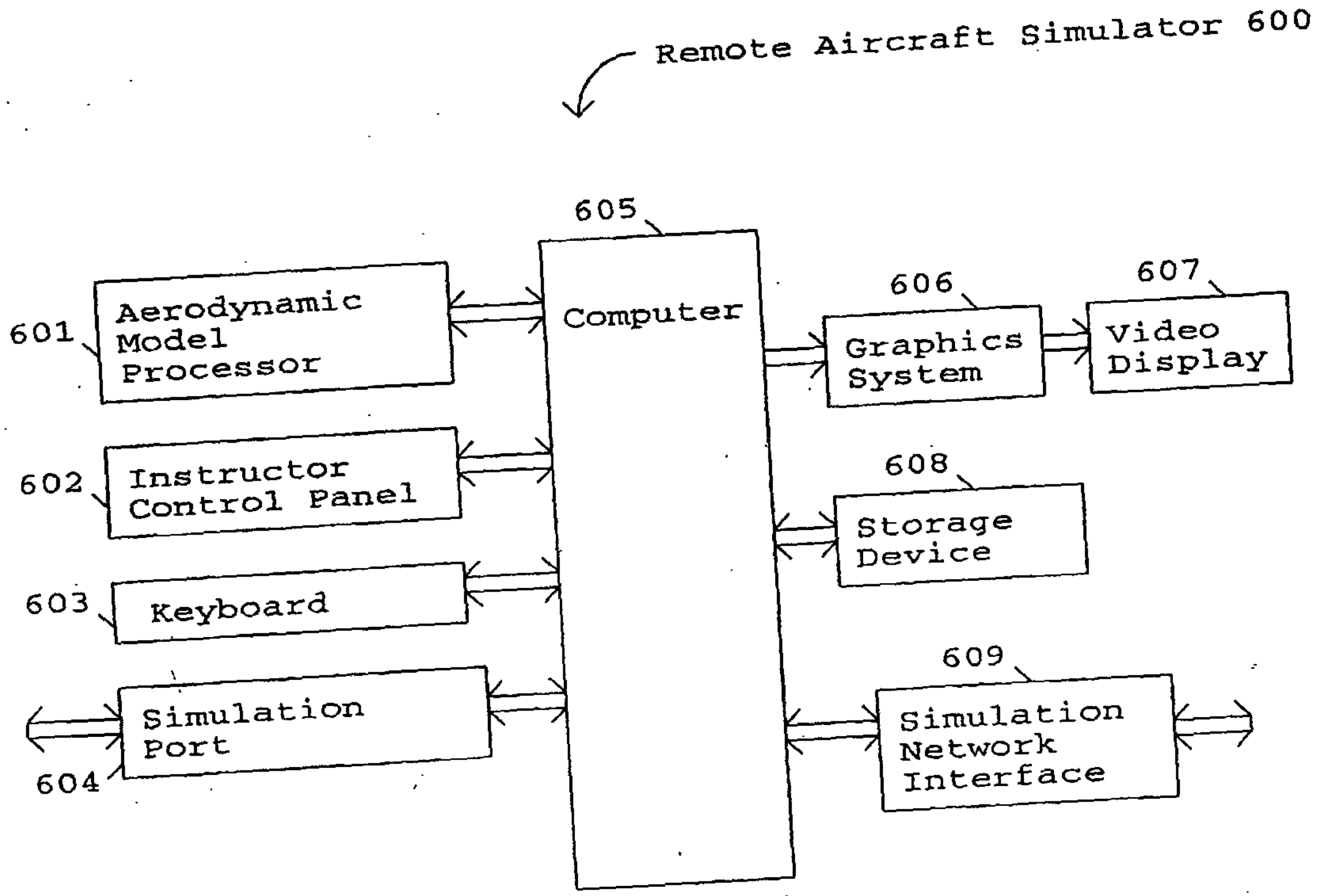

Fig. 6

APPROVED BY DRAFTSMAN	O.G. FIG.	
	CLASS	SUBCLASS

09/587731

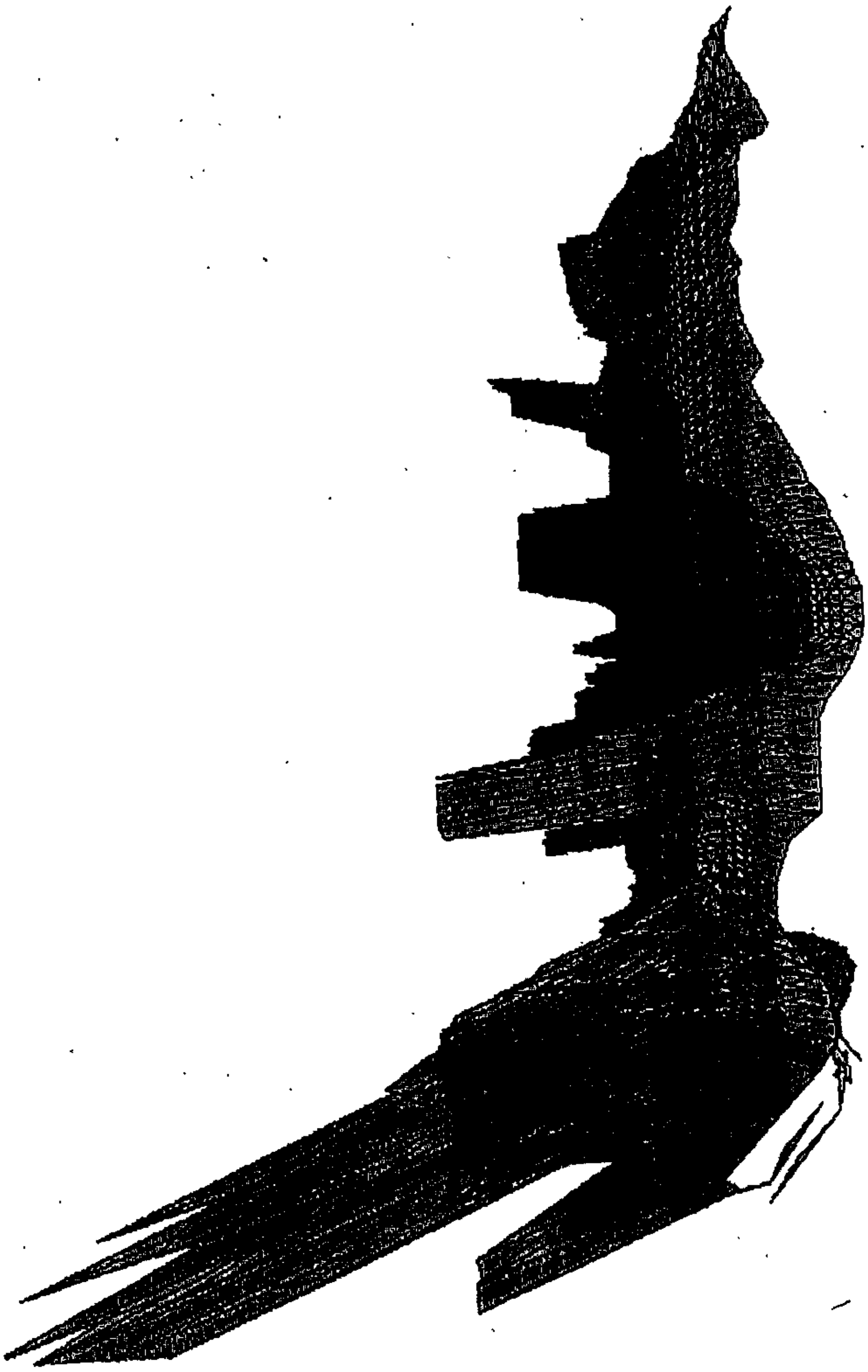

Figure 7

08/587,731

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/587,731	01/19/96	MARGOLIN	J 002055.P004

PM52/1201

BLAKELY SOKOLOFF TAYLOR AND ZAFMAN
12400 WILSHIRE BOULEVARD
7TH FLOOR
LOS ANGELES CA 90025

EXAMINER	
NGUYEN, T	

ART UNIT	PAPER NUMBER
3614	

DATE MAILED: 12/07/98

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Tan Nguyen

TAN Q. NGUYEN
PATENT EXAMINER

PTO-90C (Rev. 2/95)

1- File Copy

Supplemental Notice of Allowability	Application No. 08/587,731	Applicant(s) MARGOLIN
	Examiner TAN Q. NGUYEN	Group Art Unit 3661

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance and Issue Fee Due or other appropriate communication will be mailed in due course.

☒ This communication is responsive to *09/03/98*.

☒ The allowed claim(s) is/are *1-9, 10-17, 21-23, and 50 (now renumbered as 1-20)*.

☒ The drawings filed on *1/19/96* are acceptable.

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) ________ .

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: ________ .

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

A SHORTENED STATUTORY PERIOD FOR RESPONSE to comply with the requirements noted below is set to EXPIRE THREE MONTHS FROM THE "DATE MAILED" of this Office action. Failure to timely comply will result in ABANDONMENT of this application. Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

☐ Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL APPLICATION, PTO-152, which discloses that the oath or declaration is deficient. A SUBSTITUTE OATH OR DECLARATION IS REQUIRED.

☐ Applicant MUST submit NEW FORMAL DRAWINGS

☐ because the originally filed drawings were declared by applicant to be informal.

☐ including changes required by the Notice of Draftsperson's Patent Drawing Review, PTO-948, attached hereto or to Paper No. ____ .

☐ including changes required by the proposed drawing correction filed on ________ , which has been approved by the examiner.

☐ including changes required by the attached Examiner's Amendment/Comment.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the reverse side of the drawings. The drawings should be filed as a separate paper with a transmittal lettter addressed to the Official Draftsperson.

☐ Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Any response to this letter should include, in the upper right hand corner, the APPLICATION NUMBER (SERIES CODE/SERIAL NUMBER). If applicant has received a Notice of Allowance and Issue Fee Due, the ISSUE BATCH NUMBER and DATE of the NOTICE OF ALLOWANCE should also be included.

Attachment(s)

☐ Notice of References Cited, PTO-892

☐ Information Disclosure Statement(s), PTO-1449, Paper No(s). ________

☒ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

☐ Interview Summary, PTO-413

☐ Examiner's Amendment/Comment

☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material

☐ Examiner's Statement of Reasons for Allowance

Tan Nguyen

TAN Q. NGUYEN
PRIMARY EXAMINER
ART UNIT 3661

Form PTO 948 (Rev. 8-98) U.S. DEPARTMENT OF COMMERCE - Patent and Trademark Office Application No. 08/587731

NOTICE OF DRAFTSPERSON'S PATENT DRAWING REVIEW

The drawing(s) filed (insert date) 1/19/96 are:

A. ☒ approved by the Draftsperson under 37 CFR 1.84 or 1.152.

B. ☐ objected to by the Draftsperson under 37 CFR 1.84 or 1.152 for the reasons indicated below. The Examiner will require submission of new, corrected drawings when necessary. Corrected drawing must be sumitted according to the instructions on the back of this notice.

1. DRAWINGS. 37 CFR 1.84(a): Acceptable categories of drawings:
   Black ink. Color.
   ____ Color drawings are not acceptable until petiton is granted.
   Fig(s) ____
   ____ Pencil and non black ink not permitted. Fig(s) ____
2. PHOTOGRAPHS. 37 CFR 1.84 (b)
   ____ 1 full-tone set is required. Fig(s) ____
   ____ Photographs not properly mounted (must use brystol board or photographic double-weight paper). Fig(s) ____
   ____ Poor quality (half-tone). Fig(s) ____
3. TYPE OF PAPER. 37 CFR 1.84(e)
   ____ Paper not flexible, strong, white, and durable.
   Fig(s) ____
   ____ Erasures, alterations, overwritings, interlineations, folds, copy machine marks not accepted. Fig(s) ____
   ____ Mylar, velum paper is not acceptable (too thin).
   Fig(s) ____
4. SIZE OF PAPER. 37 CFR 1.84(f): Acceptable sizes:
   ____ 21.0 cm by 29.7 cm (DIN size A4)
   ____ 21.6 cm by 27.9 cm (8 1/2 x 11 inches)
   ____ All drawing sheets not the same size.
   Sheet(s) ____
   ____ Drawings sheets not an acceptable size. Fig(s) ____
5. MARGINS. 37 CFR 1.84(g): Acceptable margins:
   Top 2.5 cm Left 2.5cm Right 1.5 cm Bottom 1.0 cm
   SIZE: A4 Size
   Top 2.5 cm Left 2.5 cm Right 1.5 cm Bottom 1.0 cm
   SIZE: 8 1/2 x 11
   Margins not acceptable. Fig(s) ____
   ____ Top (T) ____ Left (L)
   ____ Right (R) ____ Bottom (B)
6. VIEWS. 37 CFR 1.84(h)
   REMINDER: Specification may require revision to correspond to drawing changes.
   Partial views. 37 CFR 1.84(h)(2)
   ____ Brackets needed to show figure as one entity.
   Fig(s) ____
   ____ Views not labeled separately or properly.
   Fig(s) ____
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   ____ Hatching not indicated for sectional portions of an object.
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9. SCALE. 37 CFR 1.84(k)
   ____ Scale not large enough to show mechanism without crowding when drawing is reduced in size to two-thirds in reproduction.
   Fig(s) ____
10. CHARACTER OF LINES, NUMBERS, & LETTERS. 37 CFR 1.84(l)
   ____ Lines, numbers & letters not uniformly thick and well defined, clean, durable, and black (poor line quality).
   Fig(s) ____
11. SHADING. 37 CFR 1.84(m)
   ____ Solid black areas pale. Fig(s) ____
   ____ Solid black shading not permitted. Fig(s) ____
   ____ Shade lines, pale, rough and blurred. Fig(s) ____
12. NUMBERS, LETTERS, & REFERENCE CHARACTERS. 37 CFR 1.84(p)
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   Fig(s) ____
   ____ Figure legends are poor. Fig(s) ____
   ____ Numbers and reference characters not oriented in the same direction as the view. 37 CFR 1.84(p)(1)
   Fig(s) ____
   ____ English alphabet not used. 37 CFR 1.84(p)(2)
   Figs ____
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   Fig(s) ____
13. LEAD LINES. 37 CFR 1.84(q)
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   ____ Lead lines missing. Fig(s) ____
14. NUMBERING OF SHEETS OF DRAWINGS. 37 CFR 1.84(t)
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15. NUMBERING OF VIEWS. 37 CFR 1.84(u)
   ____ Views not numbered consecutively, and in Arabic numerals, beginning with number 1. Fig(s) ____
16. CORRECTIONS. 37 CFR 1.84(w)
   ____ Corrections not made from prior PTO-948 dated ____
17. DESIGN DRAWINGS. 37 CFR 1.152
   ____ Surface shading shown not appropriate. Fig(s) ____
   ____ Solid black shading not used for color contrast.
   Fig(s) ____

COMMENTS

REVIEWER A D. DATE 11/23/98 TELEPHONE NO. ____

ATTACHMENT TO PAPER NO. 17

[redacted]

PTO UTILITY GRANT

Paper Number 18

The United States of America

The Commissioner of Patents and Trademarks

Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this

United States Patent

Grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America for the term set forth below, subject to the payment of maintenance fees as provided by law.

If this application was filed prior to June 8, 1995, the term of this patent is the longer of seventeen years from the date of grant of this patent or twenty years from the earliest effective U.S. filing date of the application, subject to any statutory extension.

If this application was filed on or after June 8, 1995, the term of this patent is twenty years from the U.S. filing date, subject to an statutory extension. If the application contains a specific reference to an earlier filed application or applications under 35 U.S.C. 120, 121 or 365(c), the term of the patent is twenty years from the date on which the earliest application was filed, subject to any statutory extension.

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REVOCATION OF POWER OF ATTORNEY OR AUTHORIZATION OF AGENT

Application Number	08/587,731
Filing Date	01-19-1996
First Named Inventor	Jed Margolin
Group Art Unit	3614
Examiner Name	NGUYEN, TAN QUAN
Attorney Docket Number	

I hereby revoke all previous powers of attorney or authorizations of agent given in the above-identified application:

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APPLICATION NUMBER	FILING DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
08/587,731	01/19/1996	JED MARGOLIN	002055.P004

23497
JED MARGOLIN
3570 PLEASANT ECHO DRIVE
SAN JOSE, CA 951481916

5904724

Date Mailed: 08/03/2000

NOTICE REGARDING POWER OF ATTORNEY

This is in response to the Power of Attorney filed 07/02/2000.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

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(1) Lyon —

00596186 E.I. Monthly No: EI7701002230 E.I. Yearly No: EI77029141
Title: REPORT ON THE BOEING FLEET LOCATION AND INFORMATION REPORTING SYSTEM (FLAIR).
Author: Lewis, R. W.; Lezniak, T. W.
Corporate Source: Boeing Co, Wichita, Kans
Source: Kentucky University, Office of Research and Engineering Services, Bulletin n 110 May 1976 Carnahan Conf on Crime Countermeas, Proc, Univ of Ky, Lexington, May 5-7 1976 p 73-85
Publication Year: 1976
CODEN: KUOBAJ ISSN: 0454-8566
Language: ENGLISH

620 A072KE

00619089 E.I. Monthly No: EI7704021861 E.I. Yearly No: EI77003363
Title: SOME NAVIGATIONAL CONCEPTS FOR REMOTELY PILOTED VEHICLES.
Author: Lyons, J. W.; Bannister, J. D.; Brown, J. G.
Corporate Source: Hawker Siddeley Aviat Ltd, Brough, North Humberside, Engl
Source: AGARD Conference Proceedings n 176 Aug 1976 Medium Accuracy Low Cost Navig at Avionics Panel Tech Meet, Sandfjord, Norw, Sep 8-12 1975 Pap 15 p
Publication Year: 1976
CODEN: AGCPAV ISSN: 0549-7191
Language: ENGLISH

629.13 A063AY

00619112 E.I. Monthly No: EI7704021735 E.I. Yearly No: EI77001918
Title: OPTIMALLY INTEGRATED PROJECTED MAP NAVIGATION SYSTEM.
Author: Reid, D. B.; Harman, R. K.; Frame, D. J.
Corporate Source: Comput Devices Co, Ottawa, Ont
Source: AGARD Conference Proceedings n 176 Aug 1976 Medium Accuracy Low Cost Navig at Avionics Panel Tech Meet, Sandfjord, Norw, Sep 8-12 1975 Pap 28, 31 p
Publication Year: 1976
CODEN: AGCPAV ISSN: 0549-7191
Language: ENGLISH

629.13 A063AY

(1) 6 *7

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Application or Docket Number: 587731

PATENT APPLICATION FEE DETERMINATION RECORD

Effective October 1, 1995

CLAIMS AS FILED - PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	SMALL ENTITY RATE	SMALL ENTITY FEE	OR	OTHER THAN SMALL ENTITY RATE	OTHER THAN SMALL ENTITY FEE
BASIC FEE				375.00	OR		750.00
TOTAL CLAIMS	49 minus 20 =	* 29	x$11=	319	OR	x$22=	
INDEPENDENT CLAIMS	5 minus 3 =	* 2	x39=	78	OR	x78=	
MULTIPLE DEPENDENT CLAIM PRESENT			+125=		OR	+250=	
			TOTAL	792	OR	TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2

CLAIMS AS AMENDED - PART II

AMENDMENT A

		CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
Total		* 38	Minus	** 49	= —	x$11=		OR	x$22=	
Independent		* 4	Minus	*** 5	= —	x39=		OR	x78=	
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM						+125=		OR	+250=	
						TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

		CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE	ADDITIONAL FEE	OR	OTHER THAN SMALL ENTITY RATE	ADDITIONAL FEE
Total		* 38	Minus	** 49	=	x$11=		OR	x$22=	
Independent		*	Minus	*** 5	=	x39=		OR	x78=	
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM						+125=		OR	+250=	
						TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

		CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	ADDI-		OR	RATE	ADDITIONAL FEE
Total		* 12	Minus	** 20	= —	x$11=	—	OR	x$22=	—
Independent		* 2	Minus	*** 3	= —	x39=	—	OR	x78=	—
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM						+125=		OR	+250=	
						TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3."
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

FORM PTO-875
(Rev. 10/95)

Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

Form PTO 1130
(REV 2/94)

U.S. DEPARTMENT OF COMMERCE
Patent and Trademark Office

PACE DATA ENTRY CODING SHEET

1ST EXAMINER	N. Ruy	DATE	2/28/96
2ND EXAMINER		DATE	

APPLICATION NUMBER	TYPE APPL	FILING DATE (MONTH DAY YEAR)	SPECIAL HANDLING	GROUP ART UNIT	CLASS	SHEETS OF DRAWING
08/587731	1	011996	0	2304	364	007

TOTAL CLAIMS	INDEPENDENT CLAIMS	SMALL ENTITY?	FILING FEE	FOREIGN LICENSE	ATTORNEY DOCKET NUMBER
049	005		-772	N	002055.P004

CONTINUITY DATA

CONT CODE	STATUS CODE	PARENT APPLICATION SERIAL NUMBER	PCT APPLICATION SERIAL NUMBER	PARENT PATENT NUMBER	PARENT FILING DATE (MONTH DAY YEAR)
			PCT/ /		
			PCT/ /		
			PCT/ /		
			PCT/ /		
			PCT/ /		

PCT/FOREIGN APPLICATION DATA

FOREIGN PRIORITY CLAIMED	COUNTRY CODE	PCT/FOREIGN APPLICATION SERIAL NUMBER	FOREIGN FILING DATE (MONTH DAY YEAR)

SOME NAVIGATIONAL CONCEPTS FOR REMOTELY PILOTED VEHICLES

J. W. Lyons, J. D. Bannister, J. G. Brown.
Hawker Siddeley Aviation Ltd.
Brough.
North Humberside.
United Kingdom.

ABSTRACT

This paper discusses methods by which the navigation function for Remotely Piloted Vehicles (RPVs) can be achieved without the need for complex specialised navigation equipment. The objective is to make use of equipment normally carried for RPV operation to supplement a simple dead reckoning navigation system. In this way significant improvements in navigation capability can be achieved with little or no added complexity in the vehicle itself. The additional processing is carried out at the control centre where restrictions on equipment size and cost are not so prohibitive. Both a two-way data link and a forward looking electro-optical sensor are highly desirable RPV facilities and these are on-board equipments that can be adapted to provide additional information at the ground-based or airborne control station for vehicle position updating.

The paper discusses techniques varying from the use of the data link to provide range-bearing navigation to map matching using reconnaissance sensors or a forward looking sensor picture. Use can also be made of an on-board laser to provide range-to-terrain measurements which, when correlated with a computer stored map, enables the RPV position to be continuously updated. Results of simulation studies which have been carried out to validate the tecnniques and provide an estimate of the accuracies that may be achieved are presented.

NOMENCLATURE

σ_{RPV}	=	Position error of RPV
σ_R	=	Range error of DME system
σ_ψ	=	Bearing error of Data Link
R	=	Range of RPV from relay aircraft
σ_A	=	Navigation error of control or relay vehicle
R_n	=	Range of RPV at the nth sample
ψ_n	=	Azimuth angle of RPV at the nth sample
Δt	=	Time between data samples
V_R	=	Velocity of relay vehicle
θ	=	Heading of RPV
R_c	=	Range of RPV from the bisector of the relay station base line
ψ_c	=	Bearing of RPV from the bisector of the relay station base line
D	=	Distance between the relay stations forming the base line
R_{IP}	=	Range from RPV to Identification Point
h	=	Height of RPV above Identification Point
θ_{IP}	=	Downlook angle from RPV to Identification Point
θ_L	=	Laser depression angle
ϕ_i	=	Laser azimuth angle
RH_i	=	Horizontal range from RPV to laser/terrain intersection point
ΔH_i	=	Height difference between terrain at RPV and at laser/terrain intersection point
ε_i	=	Error in actual/predicted terrain height

1. INTRODUCTION

In recent years the ever increasing cost and complexity of manned aircraft for operation in a battlefield environment has led to a re-appraisal of the use of Remotely Piloted Vehicles (RPVs) for certain types of missions. For high attrition situations in which aircrew are at risk the use of expendable or limited life vehicles is attractive. Provided the vehicle controllers are [illegible] with the necessary guidance and control information, the RPV can possess an operational flexibility comparable with that of a manned aircraft. The roles most suited to a battlefield RPV are :

i) Target Marking
ii) Reconnaissance
iii) ECM

The penetration of the RPV beyond the Forward Edge of the Battle Area (FEBA) necessitates the use of a relay station located such that its altitude is adequate to maintain radio contact with the RPV while its position is such as to be out of range of SAMs. The relay may be either a stationary platform or a patrolling aircraft. In the latter case, the controller can be located in the aircraft. More usual is the use of a ground control station.

The RPV should be as small as possible compatible with the above mission tasks and this means restricting the complexity of the onboard avionics. Although equipment such as forward looking and reconnaissance sensors, a data link and possibly a laser are of necessity located on the vehicle, the navigation and guidance equipment can be largely accommodated on the relay vehicle or at the ground station. The sensors already on board the RPV can be used to provide a navigational facility which can supplement a simple modest accuracy system such as a compass/air data unit. The basic airborne system would provide sufficient information for general flying of the RPV, i.e. heading, velocity and a rough measure of position, while the additional sensors can be used to provide an accurate measure of present RPV position. This philosophy is adopted here and the paper presents a number of alternative techniques whereby, depending on the particular situation, one or more of the above items form part of the overall navigation system.

Firstly, the data link is required to maintain a constant or regular periodic contact with the RPV by means of a narrow beam - width microwave link, hence a tracking facility must already exist on the relay vehicle providing RPV bearing information. Range information can be provided by means of a responsive transponder similar to an IFF system utilising the same vehicle antennas.

Secondly, update facilities can be provided by means of either a real time forward looking or vertical reconnaissance image used in conjunction with a moving map display.

A third possibility makes use of the ranging laser used for target marking purposes. En route to and from the target area, range-to-terrain measurements can be transmitted over the data link to the control station. This data can then be correlated with a computer stored map to determine the most likely RPV position.

The adoption of one or more of the above techniques leads to a significant improvement in navigational accuracy with little or no additional complexity in the vehicle itself.

2. RADIO NAVIGATION USING A DATA LINK

The data link forms the life line of communication between the RPV and the control station. It is the means by which guidance signals to the RPV are transmitted and video signals received. Because of the need for wideband transmissions of video signals (typically 5 M Hz) and the desirability of narrow beam - width, low side-lobe antennas for good anti-jamming capability, microwave frequencies are generally employed. This limits RPV operation to line of sight communication and hence may necessitate the use of airborne relay stations. A possible operational situation is shown in Fig. 1. In practice there may well be more than one relay station and RPV. It is envisaged that the relay station will stand back from the FEBA, out of direct range of ground-to-air weapons. This does not however prevent the enemy making use of either ground or airborne jammers to illuminate the relay vehicle, thereby reducing the effective signal-to-noise ratio of the signals received from the RPV. Two situations can be distinguished, one in which the relative relay - RPV geometry is such that the jamming signals are received by the relay antenna mainlobe, in which case the signal-to-noise ratio is low. The second situation relates more to large lateral separations of jammers and the RPV in which case jamming signals enter the relay antenna via the side-lobes. In such cases, the signal-to-noise ratio may not be significantly degraded and unimpaired operations can continue.

When the effects of enemy ECM can be neglected, i.e. the relay station remaining in contact with the RPV, angular information is directly available from the data link antenna and range can be derived using conventional DME techniques. Thus the position of the RPV relative to the relay station can be reasonably well defined. For absolute location of the RPV, clearly the position of the relay vehicle needs to be defined. In the case of tethered platforms this is no problem but for patrolling aircraft or hovering vehicles the error of the relay vehicle navigation system has also to be taken into account. An overall error can be estimated from the following equation.

$$\sigma_{RPV} = \left(\sigma_R^2 + \sigma_A^2 + R^2 \sigma_\psi^2 \right)^{\frac{1}{2}} \qquad -(1)$$

Typical results are presented in Fig. 2.

Perhaps of more importance is the dynamic problem of guiding the RPV to a given position. For this case it is desirable to have a good knowledge of the RPV heading and velocity as well as its present position and best results are obtained by using both on-board and remote guidance equipment. For example, estimates of heading and velocity provided by the compass/air data system can be compared with time dependent range and bearing data derived from the data link to obtain improved estimates of RPV position, velocity and heading. Figure 3 shows the geometry relevant to a 3 point moving window tracking technique. The heading of the RPV can be written in functional form as

$$\theta = f \left(R_{n-1,n,n+1}, \psi_{n-1,n,n-1} / \Delta\tau, V_R \right) \qquad -(2)$$

This generally requires more processing effort than the determination of range or velocity. For tethered or hovering relay vehicles V_R is clearly zero in the above equation. Since the on-board and remote systems use independent data the results are best combined using a statistical filter. The simplest approach is to use a least squares technique (see Reference 1). Alternatively, an integrated filtering method as described in Reference 2 may be employed. This latter paper suggests a significant improvement in navigational accuracies by employing filtering techniques.

In ECM environments, range information to the RPV cannot be guaranteed though it is likely that bearing information can still be derived. To estimate the RPV position in such circumstances, use can be made of the possible multiplicity of relay stations. From known locations of the relay vehicles, cross bearing fixes on the RPV of interest can be achieved. This is a well known location technique, both for air and marine applications. A detailed analysis of the method is given in Reference 3. For the present analysis a more useful expression for position accuracy is

$$\sigma_{RPV} = \sigma_{\psi}\sqrt{2}\,\frac{(R_c^2 + D^2/4)^{\frac{1}{2}}}{RD\cos\psi_c}\left((R_c^2 + D^2/4)^2 - (R_c D \sin\psi_c)^2\right)^{\frac{1}{2}} \qquad -(3)$$

Results derived from equation 3 are plotted in Fig. 4. It can be shown from the above expression that the best accuracy is achieved when $\psi_c = 0$ and $R_c/D = 0.3536$. Thus for good accuracy using this technique, the separation between the relay stations should be large compared with the penetration of the RPV beyond the FEBA. To determine the overall RPV position, the additional effect of relay station position accuracy must also be taken into account.

3. MAP MATCHING

So far we have considered on-board dead reckoning and remote radio navigation techniques. The main problem with these techniques is that the position accuracy is either time or range dependent and so additional methods of updating vehicle positions are necessary. A number of techniques are available for an RPV. For reconnaissance vehicles having real time sensors, the problem is relatively straight-forward. The use of either Side Looking Radar (SLR) or Infra Red Line Scan (IRLS) systems means that effectively a map is generated while the sensor is operating. The resulting video signal transmitted to the control station thus provides a method whereby the RPV position can be readily located.

One system widely employed for displaying aircraft navigational information is the projected moving map display and a similar technique can be employed by the RPV control station. Current map systems have the additional facility of being able to combine an electronic display with the moving map and Reference 4 discusses some of the latest developments in this field. Making use of this principle, it may be possible to project the sensor image onto the map and determine the RPV position by matching the two images. Fig. 5 shows the principles of the combined map/sensor display projection system.

In practice it is envisaged that the RPV reconnaissance sensor image will be monitored on a TV display. The use of digital scan converters allows a number of alternative display presentations (see Reference 5). Perhaps the most convenient display mode for the present application is the rolling map or "passing scene" technique where a new line is added to the top of the display and the scene is shifted slowly downwards.

When likely update features are seen (e.g. rivers, crossroads, distinctive man made objects) the frame is frozen, a transfer button is initiated and the digitally stored frame is projected via the map system. The map is then moved laterally to align with the projected image. When the alignment is judged adequate an accept button is pressed and the present position co-ordinates of the RPV updated, taking into account the elapsed time for updating actions. A possible arrangement of operator console is shown in Fig. 6. Control of the image pictures and map matching facility is achieved through the use of a joystick control. Some simulated results of this update technique are shown in Fig. 7. These results make use of SLR imagery.

When the RPV has only real time forward-looking sensors, use can still be made of the transmitted image to provide a navigational update facility. However, in order to create the correct perspective map-like projection, appropriate transformation of the image is necessary. In photogrammetrical language this is termed rectification though the appropriate term in perspective art is anamorphic projection. The principle involved is shown in Fig. 8. The received forward looking image may be co-ordinate transformed either by optical techniques utilising anamorphic lens systems or electronically by means of the scan converter or projection CRT sweep circuitry. Since the image already exists in electrical form, the electronic transformation techniques are probably most suitable. The map type image projected onto the display is now trapezoidal in shape because of the transformation. Major features on the map can again be aligned as described above. In practice several factors combine to make the task more difficult than for the vertical sensor case :-

i) varying resolution, contrast and intensity across the display.
ii) distortion due to undulation of the terrain.
iii) the wildly exaggerated size of trees, hedges, buildings etc.

Hence an alternative simpler update technique is proposed for this situation.

With a forward looking sensor display it is possible to mark objects electronically with a joystick controlled marker symbol; this is standard HUD technology. The electronics can be arranged such that having frozen a suitable image and marked an identifiable point on it, a marker symbol appears on the projected map. Also the field-of-view of the sensor, as projected in the horizontal plane, is superimposed on the map as a "bright up" presentation so that the orientation of the sensor view is clearly seen. The same joystick is now used to align the map with the marker. To ensure correct alignment at least two identification points (IPs) are required on any given image, preferably three or four. In a conventional airborne situation the task of marking a target on a display is not easy and may take several seconds. For the situation described above, however, the problem is one of marking chosen objects on a frozen image in a shirt sleeve environment and hence this aspect of the navigation problem is not considered too difficult.

Fig. 9 shows some simulated results of the above update technique. The effect of the bright area is clearly seen in relati[illegible] marked targets.

4. TERRAIN MAP CORRELATION

correction of 2-D map

Reconnaissance or forward looking sensors provide a convenient method of updating the navigation system. However, these sensors require a large data link bandwidth to transmit the video pictures to the control centre and hence are vulnerable to ECM. Reduction of the video bandwidth reduces the effect of ECM but with a consequent degradation of picture resolution. Hence an alternative method of updating the navigation system is desirable. The method to be described uses ranging measurements made by the laser and compares these with corresponding ranges obtained from a representation of the terrain stored in a computer at the control centre. The data link bandwidth required to transmit the laser ranges is very small and hence is correspondingly less susceptible to interference by ECM.

Basically the technique depends on an adequate representation of the terrain over which it is intended to fly the RPV. The terrain is stored as a series of height ordinates obtained from a map of the relevant area and these are used to construct a computer model of the terrain (Fig. 10). The initial effort in producing this data base from the map is considerable but for a given area it is a 'once-only' task. A simulation of the RPV flight path at the control centre then allows laser range to be calculated for each RPV position and a comparison made with actual ranging measurements. A series of positions and headings around the expected values (and limited in deviation from these expected values by estimated navigation errors) are also tested against the actual measurements and the best position and heading for the RPV found.

For a 2-D simulation, where it is only necessary to determine the alongtrack position of the RPV, it has been found that a minimum of three measurements (2 laser - altimeter) are necessary to give a reliable indication of position, while for a 3-D simulation at least four measurements (3 laser - altimeter) are required. These conclusions are based on error-free simulations. However, when errors are taken into account it has been found necessary to considerably increase the number of measurements to effectively smooth out the errors. Apart from the errors involved in the actual laser measurements the accuracy of terrain representation has a considerable influence on the feasibility of the method. In addition, the technique is ineffective over the sea or over flat, featureless terrain. Nevertheless, by combining this method with those described previously, an effective navigation system is offered without the necessity for specialised navigation equipment.

The method has been demonstrated using a computer simulation of both the laser range measurement and range matching processes, bearing in mind that the latter should not simply be a reversal of the former as this would neglect the "real world" errors caused by imperfect representation of the terrain. The simulation of the matching process is precisely the process that is required to be carried out at the control centre, while the simulation of the laser measurement is an attempt to predict the results of actual measurements made from the vehicle during flight. Hence careful representation of the terrain has been used for measurement simulation with terrain data points spaced 100m apart on a rectangular grid.

The range as seen by the laser is calculated by taking a section through the terrain in the direction in which the laser is pointing. Assuming a knowledge of the RPV height above the terrain h (from a radio altimeter) and the laser beam depression angle θ_L, the horizontal range RH and incremental height ΔH of the laser/terrain intersection point Y, relative to the RPV position X, can be calculated (Fig. 11). The following data is then transmitted from the RPV to the control centre :-

i)	height differences	$\Delta H_1 \ldots\ldots \Delta H_i \ldots\ldots \Delta H_n$
ii)	horizontal ranges	$RH_1 \ldots\ldots RH_i \ldots\ldots RH_n$
iii)	laser azimuth angles	$\phi_1 \ldots\ldots \phi_i \ldots\ldots \phi_n$

From a knowledge of RPV velocity and heading and an estimate of likely navigation errors, the current RPV position can be predicted together with a circle of possible error (Fig. 12). A search can therefore be made within this circle to determine the most likely RPV position. For each position considered, the terrain height H is known from the model and at range RH_i and bearing ϕ_i from that position the expected terrain height is given by $H + \Delta H_i$. This is compared with the actual terrain height at that point (as stored by the model) to give an error ε_i. By considering each RH_i and ϕ_i ($i = 1$ to n) an RMS error is obtained for each position, and the position with minimum error gives the most likely RPV position.

5. NAVIGATION ACCURACIES

In this section of the paper an attempt will be made to compare the navigation accuracies attainable from the various techniques previously discussed.

For the basic on-board system comprising a magnetic compass and air data unit, the following accuracies are predicted based on currently available equipment :-

heading	1° standard deviation
velocity	2% standard deviation

This gives a position accuracy of approximately 2% distance gone. However, a major source of error will be due to wind; although a correction can be applied, an uncertainty in wind speed of the order of 5 m/s is not unreasonable. Assuming an RPV velocity 200 m/s this represents 2½% giving a resultant position accuracy of the order of 3½% distance gone.

Range-bearing techniques have been used for many years as exemplified by TACAN/DME navigation. When using ground beacons a major source of error is multipath propagation which gives rise to large errors in estimating the bearing to a station. However the modern systems which use airborne beacons overcome this pro[illegible] .. this is the situation which exists when considering RPVs.

Clearly target bearing estimation from the relay vehicle is a major contributor to RPV location accuracy. Since microwave frequencies, perhaps at X-band, coupled with monopulse determination techniques are employed in the relay vehicle, good angular estimates of the RPV bearing are available. Final figures are dependent on antenna size, frequency of operation and signal-to-noise ratio. It is considered that at least 1° standard deviation should be readily attainable in a practical system. From Fig. 2 it is seen that this gives a typical RPV position error better than 2 km standard deviation at 100 km range. The ultimate short range accuracy is clearly dependent on the accuracy of the relay vehicle navigation system.

When jamming environments are such that perhaps only bearing information is available to the relay vehicles, the cross bearing fix principle utilising multiple relay vehicles remains a possibility for RPV position fixing. Fig. 4 shows the accuracy function on a relative scale and clearly indicates the position dependent accuracy effect. To utilise this technique successfully in a practical situation, it is necessary to carefully select the patrol station positions for the relay vehicles relative to the battlefield.

Taking the 50% accuracy contour as a guide to the area of utility of the technique, this corresponds to a distance from the baseline bi-sector roughly equal to the relay station separation. If we therefore envisage RPV operations out to 100 km from the relay, the relay stations should be located 100 km from each other. At this separation, with a bearing accuracy estimation of 1° standard deviation the RPV can be located to a maximum accuracy of 1.6 km standard deviation. Combining this with a typical relay vehicle position accuracy of 0.5 km raises this figure by less than 0.1 km.

Navigation updating using a real time picture from a vertical reconnaissance sensor provides a very accurate means of position fixing. Fig. 7 shows some simulated results based on SLR imagery. The picture quality of these radars is seen to be more than adequate to identify the main geographical terrain and man made features. In the example shown, the river bank provides a good map matching feature. Fig. 7a shows some degree of misalignment of the map and radar image. In Fig. 7b the two are aligned. Some errors are present due to the scale compression effect at ranges close to the RPV and this is reflected in map projection distortion. Even without further video processing to correct this effect, it is considered that a location accuracy of 0.2 km is attainable.

When using a forward looking sensor for map matching the useful range of the sensor is limited to ∿ 3 km, hence the matching will be done over a small area and a larger scale map can be used (cf Figs. 7 and 9). This, together with the fact that considerable detail will be visible in the foreground of the display, makes the matching task easier allowing a match to within say 100 m. Unfortunately various system errors can produce incorrect transformation of the display and result in significant position errors. The sources of error and their effects are the same irrespective of whether a full display transformation technique is being used or only marked identification points.

Across track errors should be small since the only error is that due to marking the display in azimuth. Display marking should be possible to within ± 2% full scale, allowing for both operator and marker system errors. For a 30° FOV sensor this corresponds to an angular error of 10 m rads. Display points of interest are expected to be at ranges between 1 and 2 km and for accurate across track matching a near and a far point should be chosen. This will give sensor heading to within 30 m rads and across track errors < 40 m, i.e. the matching is the biggest source of error.

Along track errors can be much greater. The range to an identification point is given by

$$R_{IP} = \frac{h}{\tan(\theta_{IP})}$$

where h is the height of the RPV above the IP
θ_{IP} is the downlook angle from RPV to the IP

The most significant sources of error in determining R_{IP}, with typical values for standard deviation, are

i) Uncertainty in RPV altitude ∿ 3 m in 150 m i.e. 2% h
ii) Undulating terrain. The effect of undulating terrain is exactly the same as variations in RPV altitude. Variations ∿ ± 20 m are expected, i.e. 13% h.
iii) Display marking. Errors in marking the display in elevation are again estimated at ± 2% full scale. For a 20° vertical FOV this is 8 m rad.
iv) Uncertainty in sensor attitude. The accuracy with which the sensor attitude is known in elevation is dependent on the equipment fit in the RPV. A value of 2 m rad is assumed. If the attitude is not known to this accuracy an estimate can probably be made from the position of the horizon.

For identification points at a nominal range of 1.5 km the above factors give the following independent errors

i) 30 m ii) 200 m iii) 100 m iv) 25 m

The combined effects of these errors and the basic matching error is 230 m.

As yet it has not been possible to quantify the navigation accuracy that could be achieved by the laser/terrain correlation system. It is a function of the terrain used and the accuracy of terrain representation. Preliminary results of the simulation described previously are available with the effects of errors in

- laser beam depression angle (2 m rad, 1 σ)
- laser range measurement (6 m, 1 σ)
- radio height measurement (3 m, 1 σ)
- terrain height representation (∿ 3 m, 1 σ)

represented. These results suggest that the technique is viable. Nevertheless the search technique used to obtain these results was very much simplified; for each navigation attempt the true vehicle position was presented to the system along with numerous points in the search area. In practice, the true position would not be available and some degradation in results would then be expected.

Further work is required to ascertain the relation between navigation accuracy and errors in terrain representation. However, since it appears that terrain representation is an important part of the concept terrain data taken directly from stereoscopic photographs should yield considerable improvement over data taken from maps. Also careful consideration is required of the optimum search technique which should be used in practice.

6. CONCLUSIONS

A navigation concept has been presented whereby a good navigation accuracy (down to ½ km) can be realised for an RPV with the minimum of on-board equipment. Table 1 summarises the accuracies of the various techniques available. It is proposed that several of these be incorporated into the overall RPV control and guidance system so that the controller can select the one most suitable for a given situation.

When a wide bandwidth data link can be maintained the map matching technique using SLR or IRLS offers the simplest and most accurate solution with the forward looking sensor as a good alternative. It does however, impose a large workload on the controller since, depending on the accuracy of the basic on-board system, the updating needs to be performed every few minutes. A separate navigator is therefore envisaged, keeping track of several RPVs. Electronic devices which are currently being developed to perform area correlation for automatic electro-optical tracking may lead to automation of the matching task in the future.

Where the data link is limited in bandwidth the laser/terrain correlation technique should give good accuracy and the process could be completely automated to provide a continuous indication of RPV position. Disadvantages of the system are the large amount of data storage and computation necessary at the control centre, the development work required to produce an operational system and the unsuitability of the system over featureless terrain.

Alternatively recourse can be made to a system based on measurements made from the relay stations. These are well established techniques offering good accuracy at short ranges and modest accuracy at long ranges. Again a completely automatic system is possible.

In the event of a total failure of the RPV control/guidance link, the on-board system would be adequate to allow the RPV to navigate itself back to a pre-defined recovery area.

7. ACKNOWLEDGEMENTS

The authors acknowledge the help given by H. G. Loftus and his colleagues during the preparation of the photographic material for this paper. Permission to publish the paper is by courtesy of Hawker Siddeley Aviation Limited. The opinions however are entirely those of the authors.

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TABLE 1

Comparison of RPV Navigation Techniques

Technique	Accuracy-km (1 σ)	Comment	
Compass/Air Data Basic On-Board System	3.5 after 100 km	3½% Distance gone Depends on wind estimates	Continuous Navigation
Range-Bearing from Relay Station	1.8 at 100 km range	1° Bearing accuracy	Continuous Navigation
Cross Bearing Fix from Relay Stations	1.6 at 100 km range	1° Bearing accuracy 100 km baseline	Continuous Navigation
Laser Ranger-Terrain Map Correlation	0.5	Depends on the accuracy of the terrain representation	Continuous Navigation
Map Matching with Recce Sensor	0.2	Accuracy limited by display system	Update Techniques
Map Matching with Forward Looking Sensor	0.25	As above. Additional errors due to display marking etc. Altitude 150 m.	Update Techniques

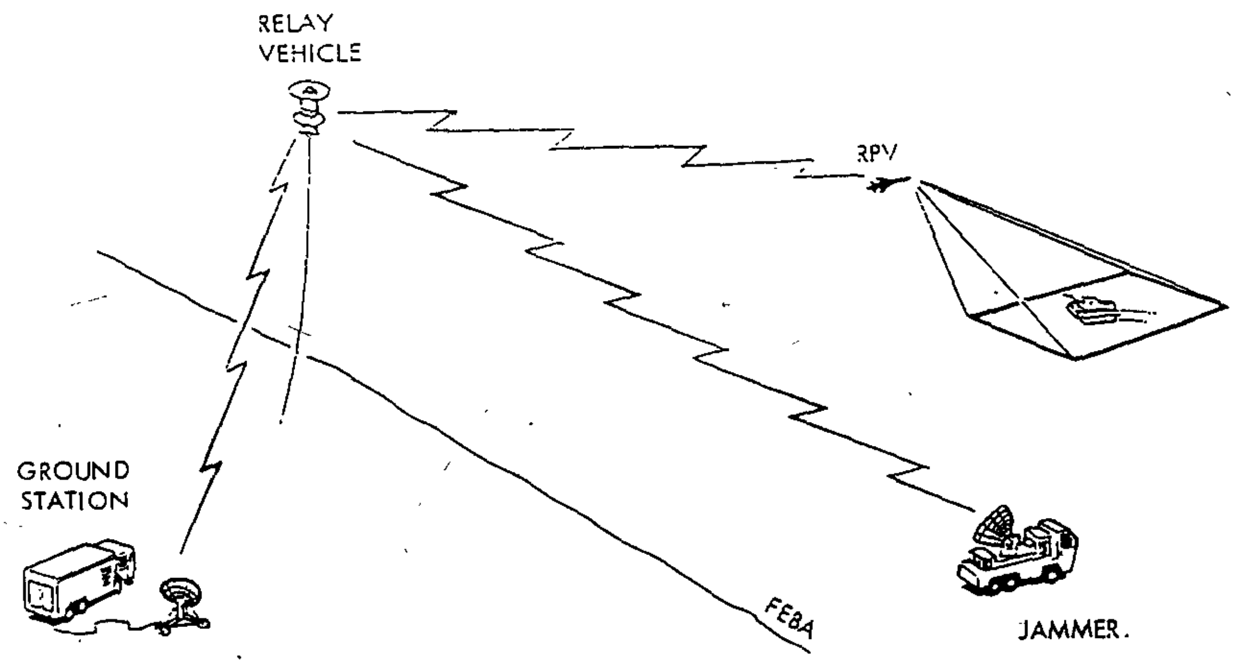


Fig. 1 RPV Operational Situation.

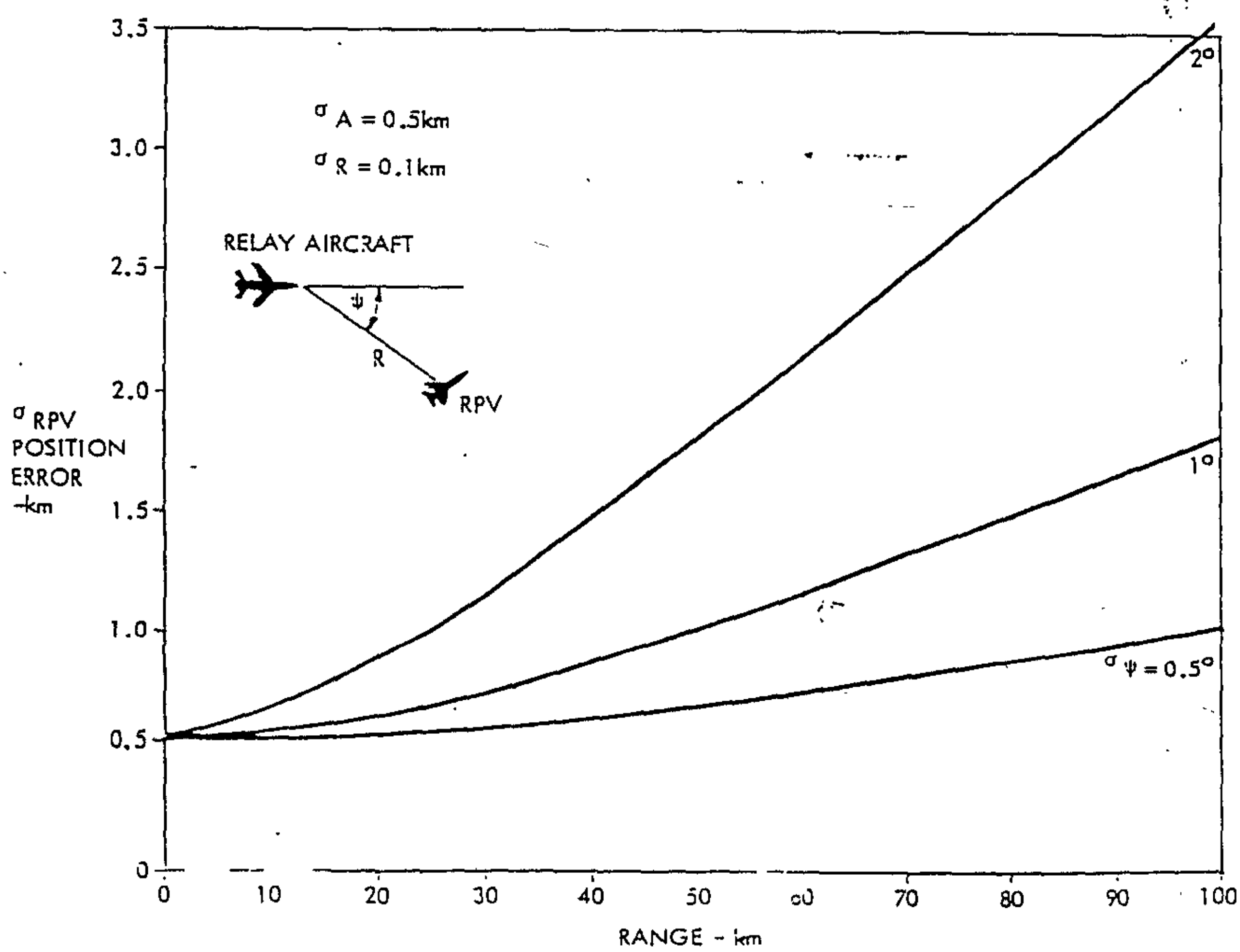


Fig. 2 Accuracy of DME System.

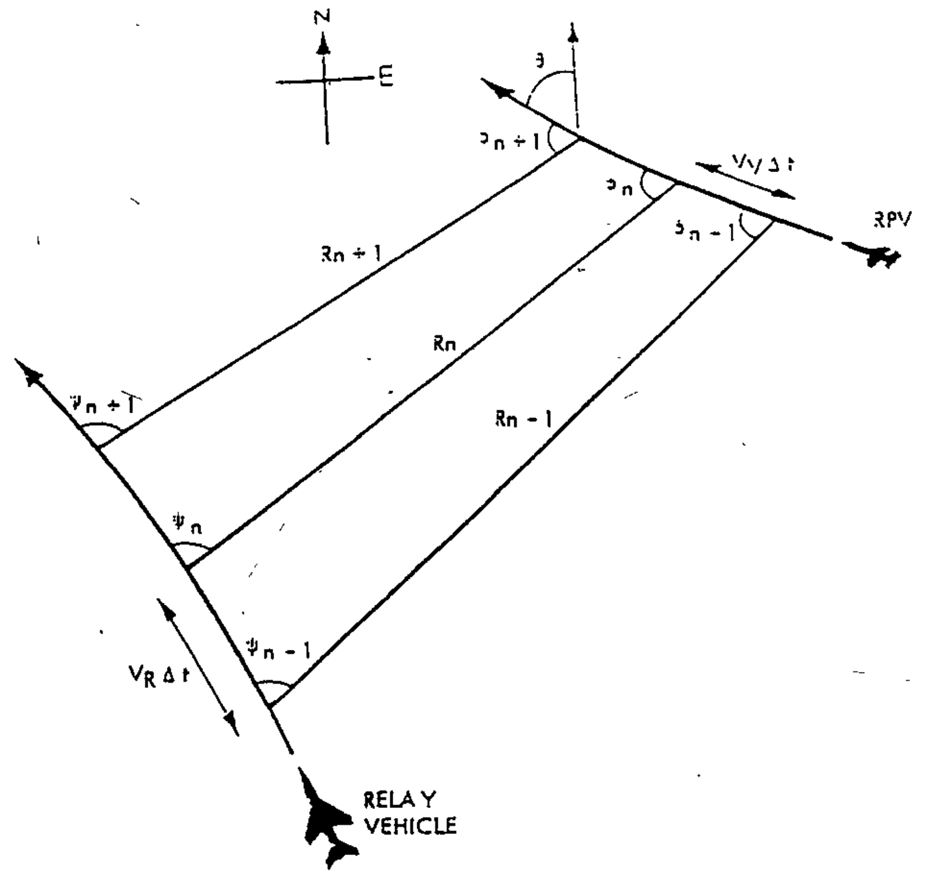
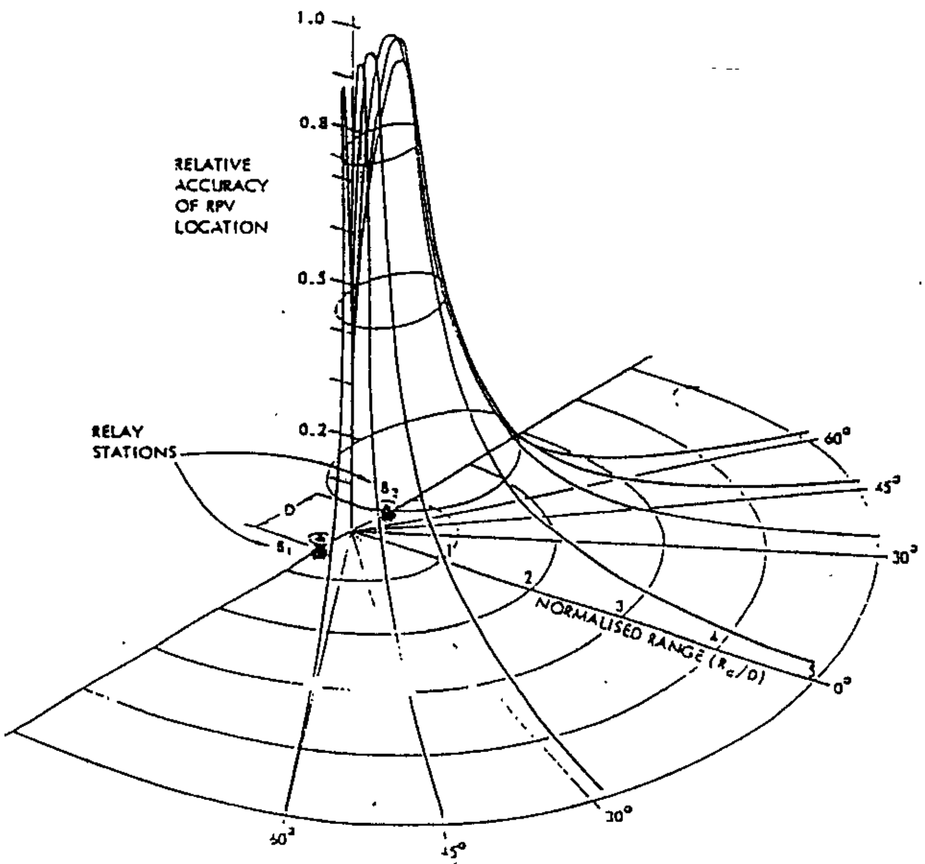


Fig. 3 Moving Window Tracking Technique



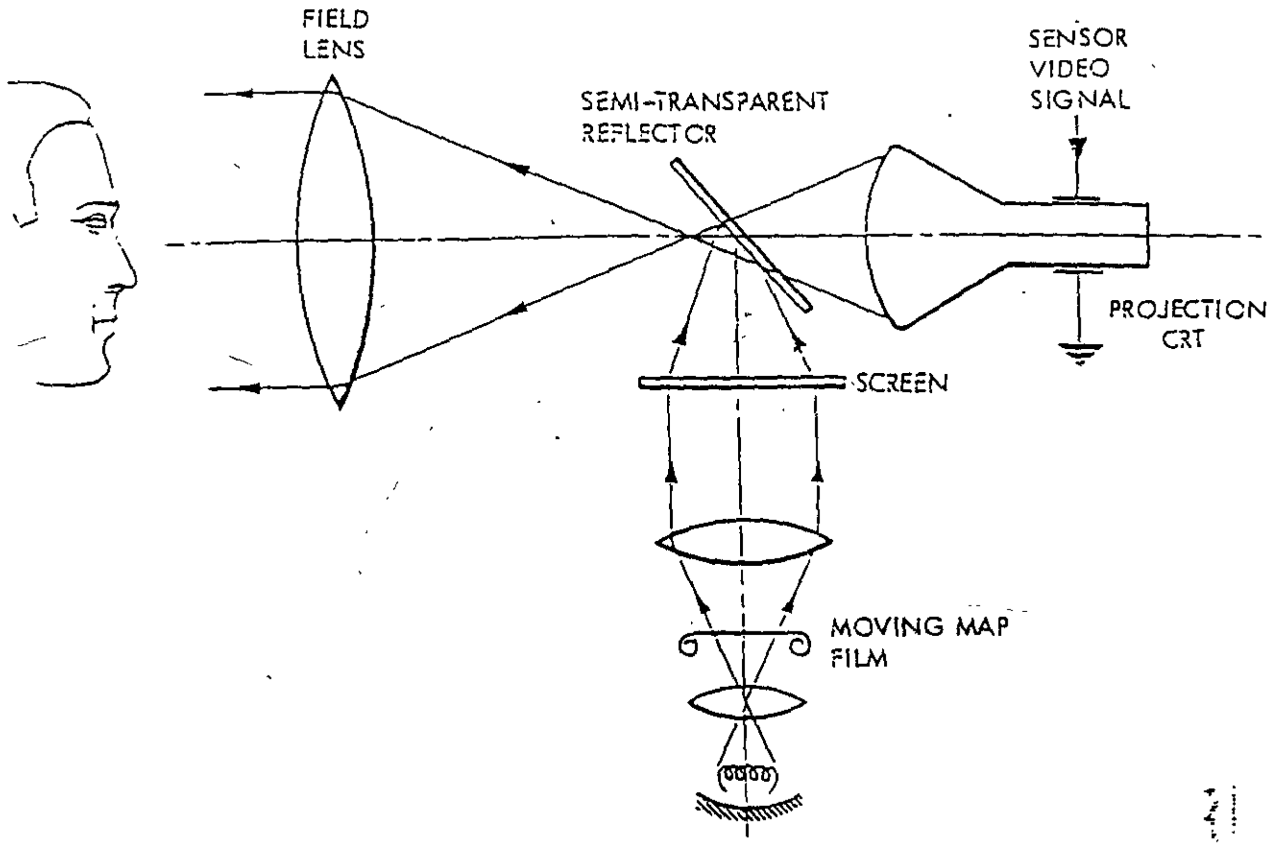


Fig. 5 Combined Moving Map/CRT Display.

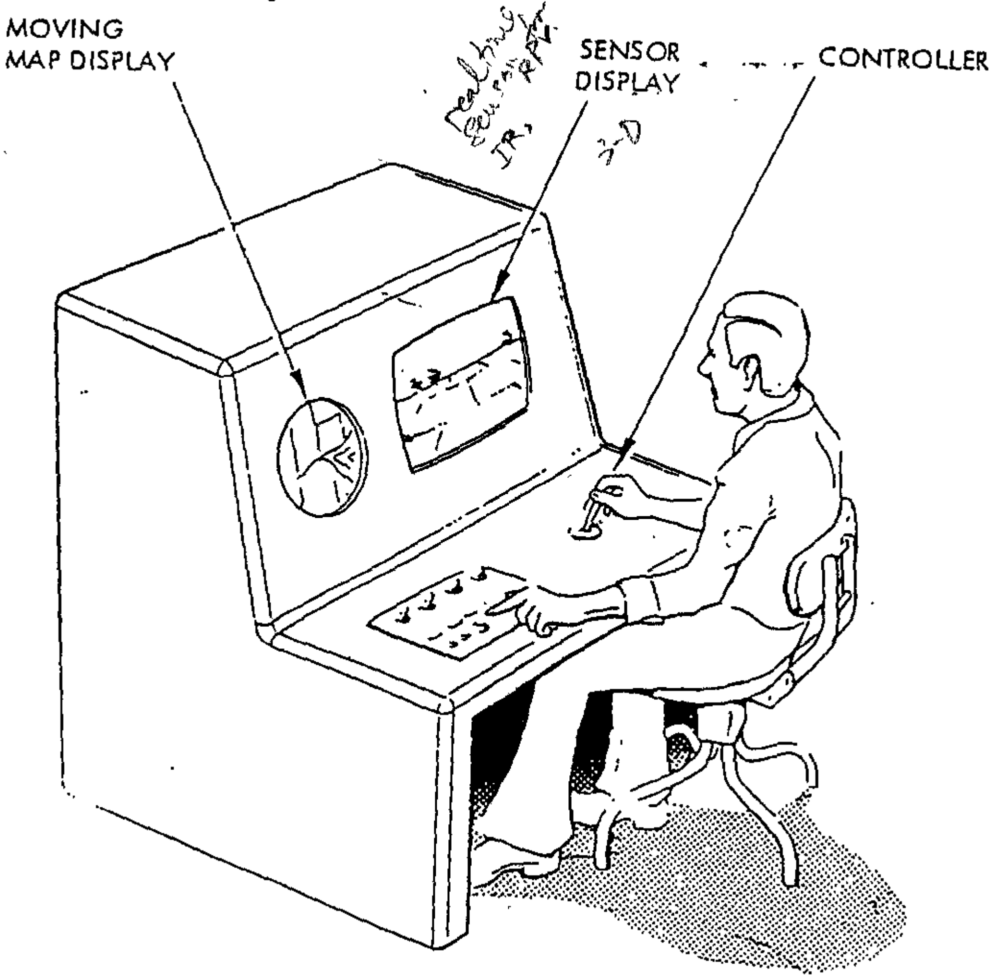


Fig. 6 RPV Controllers Console.

from aircraft
RPV.

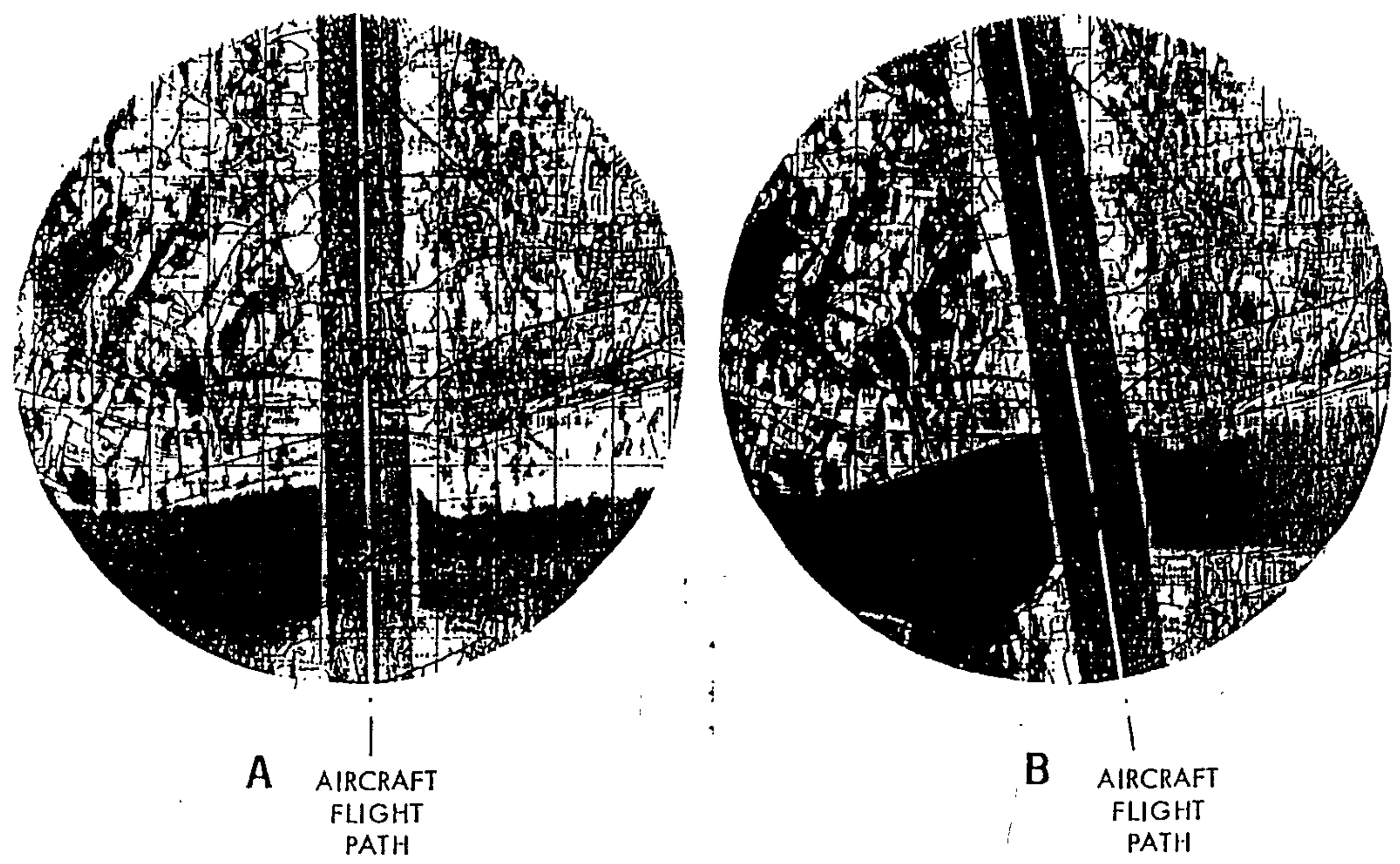


Fig. 7 Simulated SLR/MAP Update System.

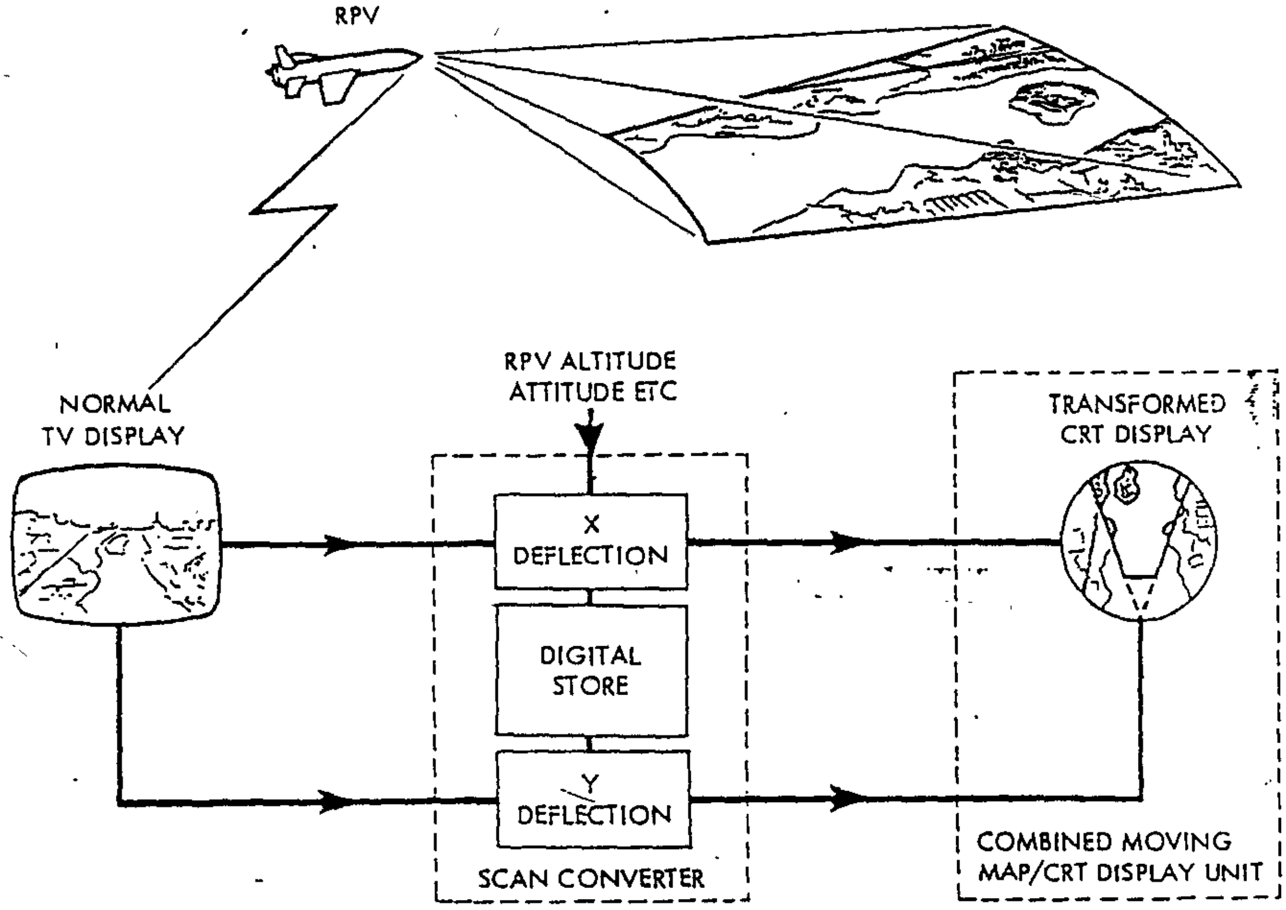


Fig. 8 Forward Looking Sensor Co-ordinate Transformation.

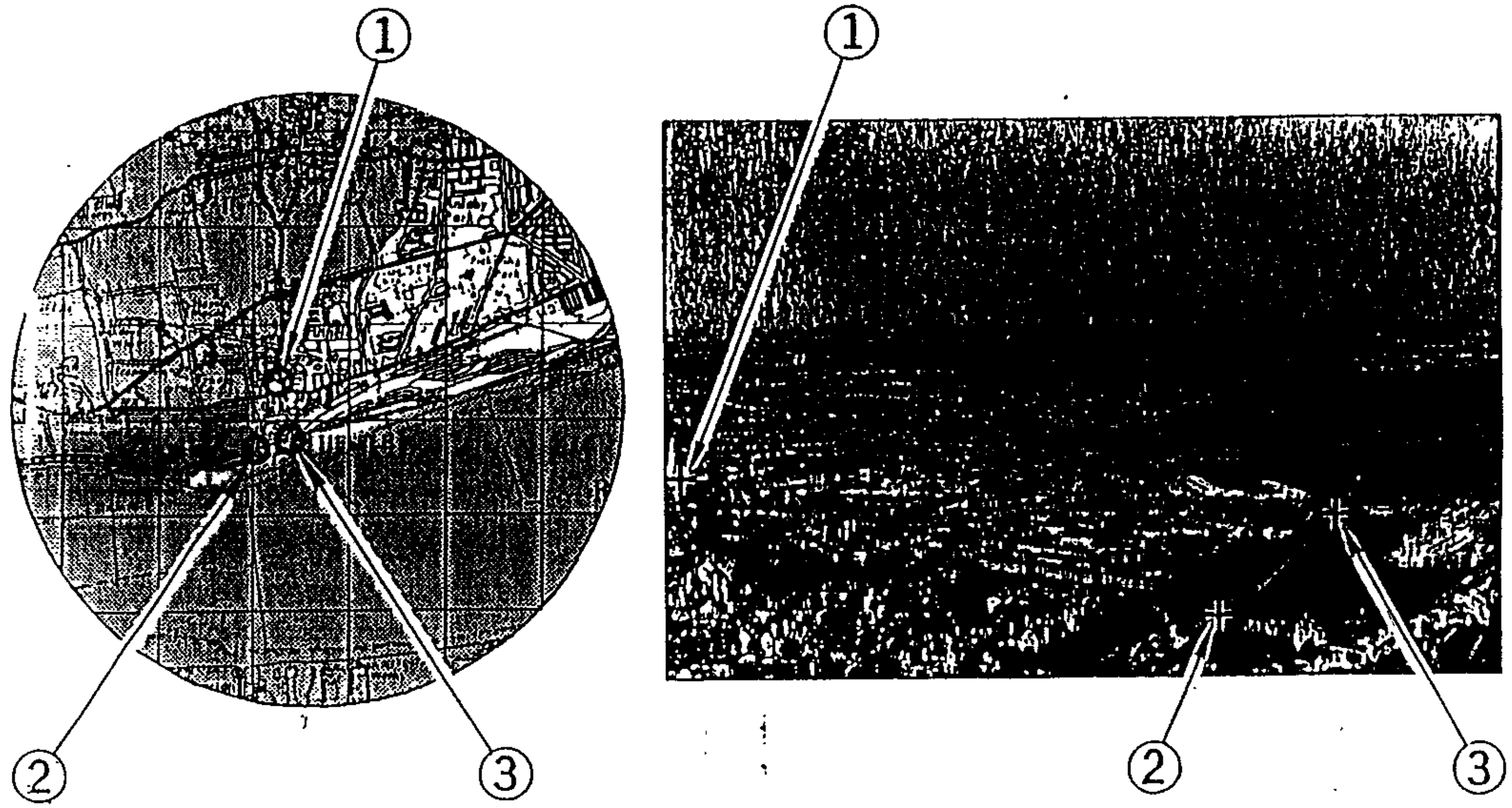


Fig. 9 Simulation of Marked Forward Looking Display/Map Update System.

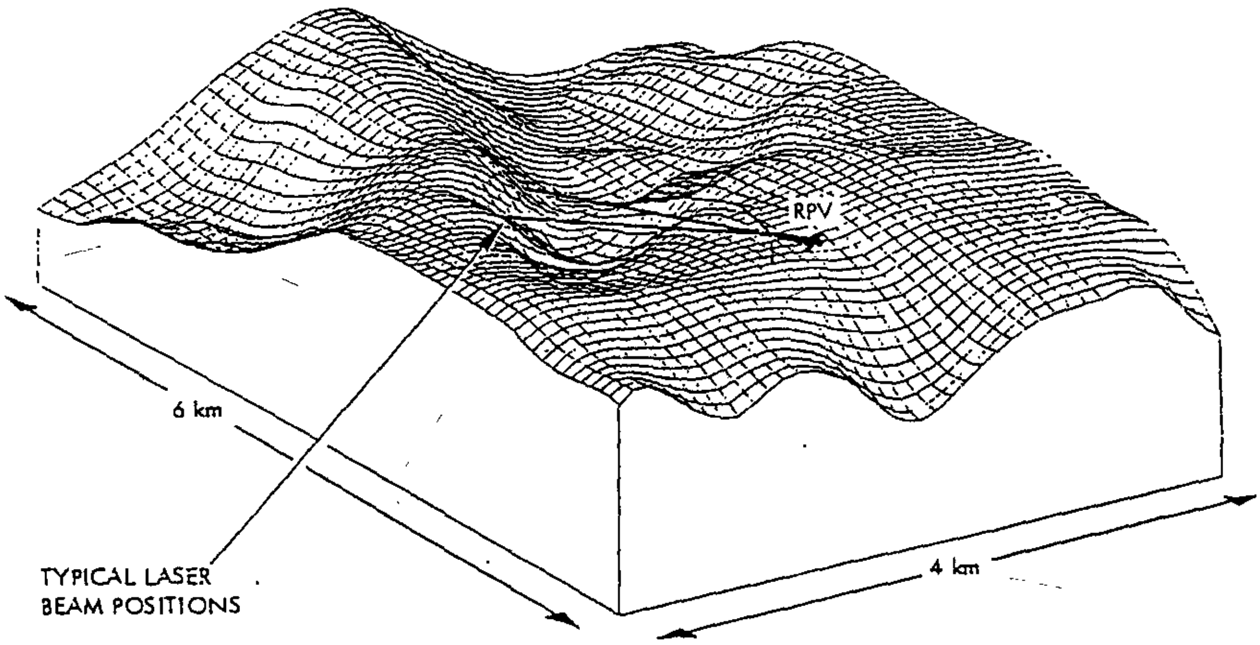


Fig. 10 Terrain Model.

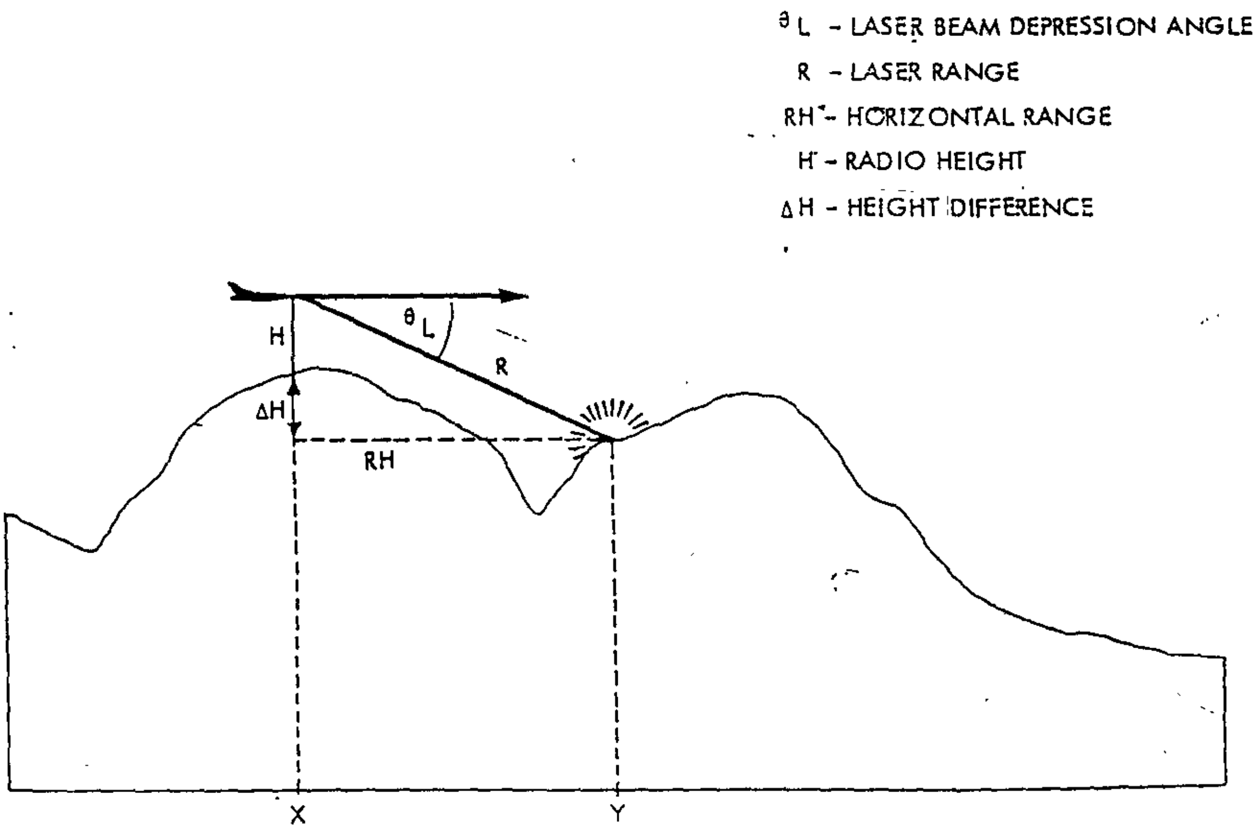


Fig. 11 Terrain Section.

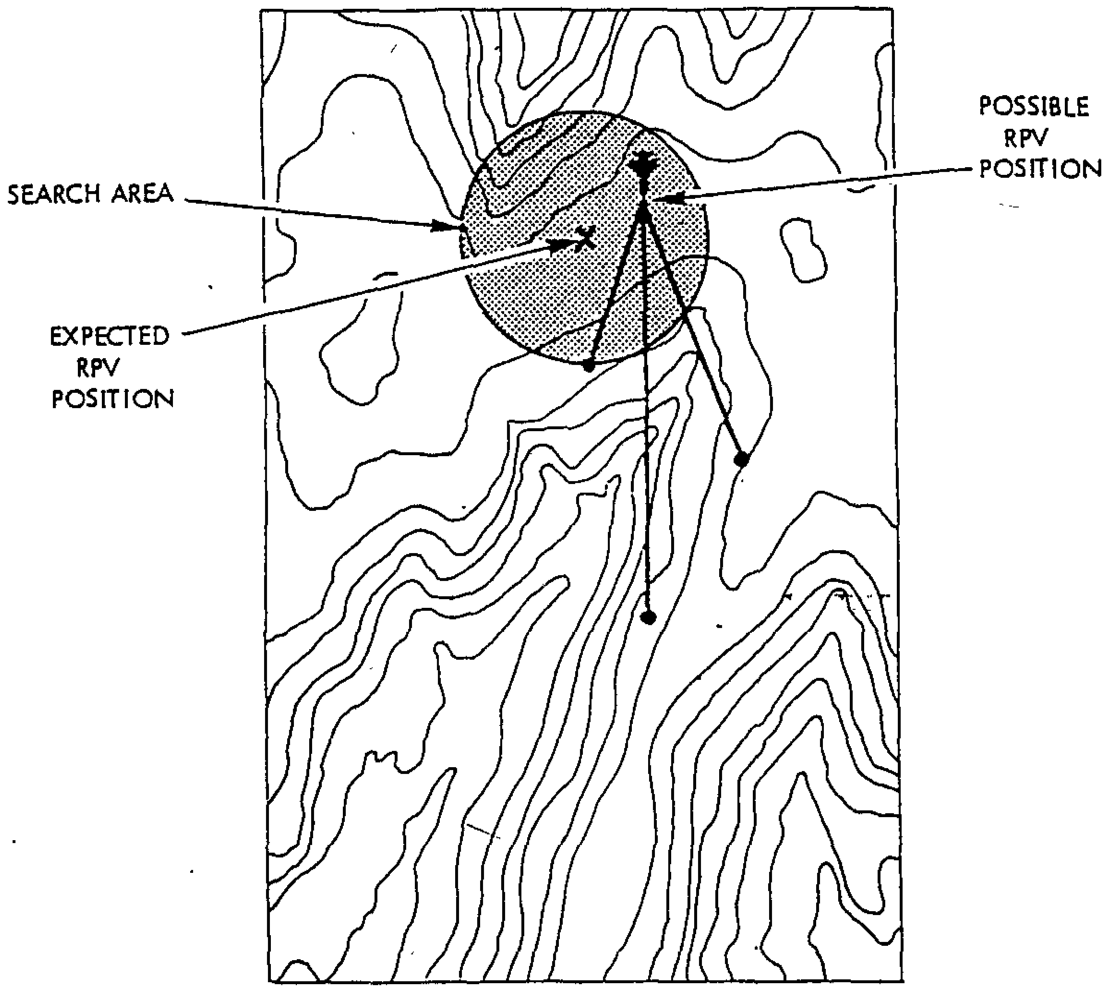


Fig. 12 Terrain Correlation Search.

DISCUSSION

D Halliwell, Decca Systems Study and Management Division, UK

Using the terrain map correlation method, are three ranges really able to give an unique position? There are probably many solutions in each case, only one of which is correct. After a false reset the true position may be outside the area of uncertainty for the next fix. Have your simulations shown any tendency to this effect?

J W Lyons, HSA, UK

For an error-free system three range measurements and radio height will in general be adequate to give an unique position within a limited area, though it is possible to conceive terrain configurations where this would not hold. The method will not work over flat featureless terrain. Also, in a real-world system, errors will be present and further range measurements will be necessary to smooth the effects of these. For convenience and to avoid a cluttered presentation only three measurements were illustrated in Fig. 12.

The area of uncertainty for the next fix depends on errors associated with the estimation of present position. However, when an update is attempted, a confidence level can be estimated based on how well the range measurements fit the stored terrain model. Only when a high confidence level is achieved is an update accepted.

C T J Jessop, Sperry Gyroscope Company, UK

To achieve the fix accuracies quoted what horizontal datum accuracy, in pitch and roll, is assumed for forward and sideways looking laser and radar sensors; and could these in fact approach inertial navigation system accuracy levels?

J D Bannister, HSA, UK

For the small laser beam depression angles assumed, the system is relatively insensitive to small changes in pitch and roll angles. The paper illustrates, in Fig. 11, that it is the horizontal range, RH, which is used for the correlation process. The error in RH will be small. However the question then arises as to the change in terrain height over the distance associated with the error in RH. This will depend very much on the nature of the terrain being overflown. The accuracy of the pitch and roll information thus determines the type of terrain over which the method provides a useful update facility. Also it should be borne in mind that the smoothing effect of taking a number of measurements is very powerful.

U.S. Department of the Interior
U.S. Geological Survey
Earth Science
Information Center (ESIC)

Factsheet

US GeoData
Digital Line Graphs

Digital line graph data

Digital line graph (DLG) data are digital representations of cartographic information. DLG's of map features are converted to digital form from maps and related sources. U.S. Geological Survey (USGS) DLG data are classified as large, intermediate, and small scale.

Data sources

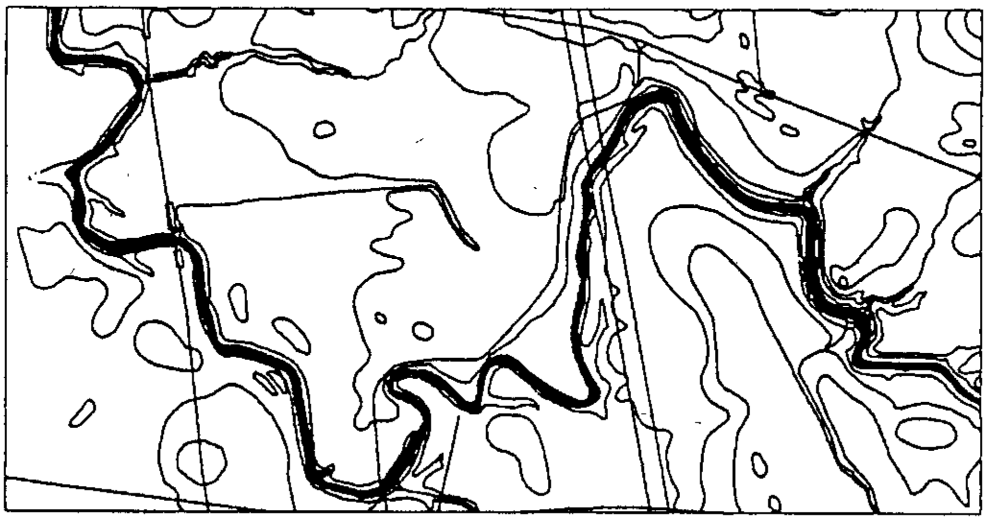
Large-scale DLG data are derived from USGS 1:20,000-, 1:24,000-, and 1:25,000-scale 7.5-minute topographic quadrangle maps. If 7.5-minute maps are not available, sources are used in the following order of preference: (1) advance manuscripts for 7.5-minute maps; (2) published 15-minute quadrangles at 1:62,500 scale (1:63,360 scale for Alaska); and (3) archival compilation materials for 15-minute quadrangles such as 1:48,000-scale compilations.

Intermediate-scale DLG data are derived from USGS 1:100,000-scale 30- by 60-minute quadrangle maps. If these maps are not available, Bureau of Land Management planimetric maps at a scale of 1:100,000 are used, followed by archival compilation materials.

Small-scale DLG data are derived from such maps as the USGS 1:2,000,000-scale sectional maps of the National Atlas of the United States of America. Alaska hydrography data were collected at 1:1,000,000 scale from Landsat images from 1979. Other categories of data were revised from 1979-80 sources.

Unit size and file extent

Large-scale DLG data are produced in 7.5-minute units that correspond to USGS 1:20,000-, 1:24,000-, and 1:25,000-scale topographic quadrangle maps. However, some older units in the western United States cover 15-minute areas and correspond to maps at 1:62,500 scale. The unit sizes in Alaska vary depending on latitude. Units south of 59° N. cover



Plot of DLG data—northwest corner of Bombay, New York-Quebec Quadrangle, 1:24,000-scale showing hydrography, roads and trails, railroads, miscellaneous transportation, and hypsography.

15- by 20-minute areas; between 59° and 62° N., 15- by 22.5-minute areas; between 62° and 68° N., 15- by 30-minute areas; and north of 68° N., 15- by 36-minute areas (all values are latitude and longitude, respectively).

Intermediate-scale DLG data are sold in 30-minute units that correspond to the east or west half of USGS 30- by 60-minute 1:100,000-scale topographic quadrangle maps. Each 30-minute unit is produced and distributed as four 15- by 15-minute cells, except in high-density areas, where the 15-minute cells may be divided into four 7.5-minute cells.

Intermediate-scale hydrography and transportation DLG data are sold on compact disc-read only memory (CD-ROM). Each disc contains all the 15- by 15-minute cells within the 1:100,000-scale quadrangles that cover a State or States. Currently 3 areas within 14 planned sectional regions in the United States are available: Area 3—southeastern States of NC, SC, and GA; Area 4—FL; and Area 13—northwestern States of WA, OR, and ID.

Small-scale DLG data that correspond to USGS 1 :2,000,000-scale sectional maps of the National Atlas are sold in 21 units. Fifteen sections cover the continental United States, five cover Alaska, and one covers Hawaii. These sectional DLG's are usually sold in multi-State units. Some, however, may cover only one State or a portion of a State. All 21 units are available on a single CD-ROM.

All nonstandard quadrangles with neatlines that extend beyond the standard unit size to accommodate overedge boundaries are collected as multiples of the standard unit size. Data covering a 7.5- by 8.5-minute quadrangle area would, therefore, be sold as two 7.5-minute units.

Data content

Large-scale DLG data are available in nine categories: (1) hypsography, including contours and supplementary spot elevations; (2) hydrography, including flowing water, standing water, and wetlands; (3) vegetative surface cover, including woods, scrub, orchards, vineyards, and vegetative features associated with wetlands; (4) nonvegetative features, including lava, sand, and gravel; (5) boundaries, including State, county, city, and other national and State lands such as forests and parks; (6) survey control and markers, including horizontal and vertical positions (third order or better); (7) transportation, including roads and trails, railroads, pipelines, and transmission lines; (8) manmade features, including cultural features not collected in other major data categories such as buildings; and (9) the Public Land Survey System, including township, range, and section line information.

Presently, intermediate-scale DLG's are sold in five categories: (1) Public Land Survey System; (2) boundaries; (3) transportation; (4) hydrography; and (5) hypsography.

Small-scale DLG data are sold in three categories: (1) boundaries, including political and administrative boundaries; (2) transportation, including roads and trails, railroads, and cultural features (airports and the Alaska pipeline); and (3) hydrography, including streams and water bodies, and hypsography (Continental Divide only). All of these categories are also included in the 1:2,000,000-scale CD-ROM.

Data structure

All DLG data distributed by the USGS are DLG - Level 3 (DLG-3), which means the data contain a full range of attribute codes, have full topological structuring, and have passed certain quality-control checks. The DLG-3 concept is based on graph theory in which a two-dimensional diagram is expressed as a direct graph composed of a set of nodes, lines, and areas that express logical relationships with minimal redundancy. Nodes define the end points of lines. A line is an ordered set of points that describe the position and shape of a linear feature of the map. An area is a continuous, unbroken region of the map bounded by lines. Applied to a map, this concept expresses spatial relationships between map elements that are obvious when the map is examined. The spatial relationships between features on a map include concepts such as location, adjacency, and connections. Data that maintain the spatial relationships inherent in the map are topologically structured.

Attribute codes

Attribute codes are used to describe the physical and cultural characteristics of DLG node, line, and area elements. Attribute codes are used to reduce redundant information, provide enough reference information to support integration with larger data base, and describe the relationships between cartographic elements. Each DLG element has one or more attribute codes composed of a three-digit major code and a four-digit minor code. For example, with the 1:2,000,000-scale DLG data, the line attribute code 290 5001 has a major code (290), meaning road, with a minor code (5001) identifying the road as an interstate.

Data formats

Large- and intermediate-scale DLG's are available in standard and optional formats. The standard format has reduced storage requirements, 144-byte logical record length, an internal file coordinate system (thousandths of a map inch), and topological linkages contained only in the line elements. The optional format is easy to use with an 80-byte logical record length, a ground planimetric coordinate system (Universal Transverse Mercator), and topological linkages contained in node, line, and area elements.

Small-scale DLG's are available in standard, optional, and graphic formats. The standard format is the same as the large- and intermediate-scale DLG's. The optional format is also the same as the large and intermediate scales, except that it uses the ground planimetric coordinate system of the Albers Equal-Area Conic projection. The graphic format is compatible with Geological Survey Cartographic Automatic Mapping (GS-CAM) plotting software, with a 20-byte logical record length; a geographic (latitude-longitude) coordinate system expressed in degrees, minutes, and seconds; and no topological linkages. All three formats are available on the 1:2,000,000-scale CD-ROM.

Data records

The standard format data are organized into 9 record types and the optional format data into 11 record types. For descriptions of these record types, refer to Data Users Guide 1—Digital Line Graphs from 1:24,000-Scale Maps, Data Users Guide 2—Digital Line Graphs from 1:100,000-Scale Maps, and Data Users Guide 3—Digital Line Graphs from 1:2,000,000-Scale Maps.

The graphic format data are DLG line records organized by feature type and reformatted into two record types: one line identifier record and multiple latitude-longitude records.

Data accuracy validation

DLG data do not carry quantified accuracy statements. However, the data files are checked and validated before they are released for distribution for file fidelity and completeness, attribute accuracy, and topological fidelity. For large- and intermediate-scale DLG's, additional data validation such as edge matching and quality control flagging is performed.

US GeoData Sampler

The US GeoData Sampler is available for a nominal charge. Data contents include the 7.5-minute digital elevation model (DEM) and the 1:24,000-scale DLG for Tumwater, Washington; the 1:100,000-scale DLG for Tacoma, Washington; the 1:2,000,000-scale DLG for the northwestern States (WA, OR, and ID); the 1- by 2-degree land use and land cover data for Seattle, Washington; the 1- by 1-degree DEM for Seattle, Washington East; and the Geographic Names Information System data for the State of Washington.

Ordering instructions

DLG data are written as ANSI-standard ASCII characters in fixed-block format on unlabeled or ANSI labeled nine-track magnetic tape at a 1,600-bpi or 6,250-bpi density. DLG's may be ordered by specifying the scale, format, maximum block size, tape density, tape label, and either the topographic quadrangle name or section, or the southeast latitude and longitude corner coordinates of the sales unit.

The US GeoData Sampler can be ordered by name and is offered in standard or optional ASCII DLG formats, on either one 6,250-bpi or three 1,600-bpi tapes.

To assist you in ordering, the Earth Science Information Center (ESIC) can furnish indexes, price lists, and order forms. Data Users Guides are included with each order.

For further information, contact the USGS, Earth Science Information Center, 507 National Center, Reston, VA 22092, or call 1-800-USA-MAPS.

DIGITAL LINE GRAPHS FROM 1:24,000-SCALE MAPS

This document describes the Digital Line Graphs (DLG's) prepared primarily from the 1:24,000 materials associated with the USGS Topographic Map Series. The series will eventually provide complete national coverage.

DATA CONTENT

The DLG data files derived from the 1:24,000-scale and other large-scale maps contain selected base categories of cartographic data in digital form; these data categories do not necessarily correspond to the traditional feature separates associated with the maps. The attribute coding scheme for these data has undergone several revisions since the start of the digital program. A major revision of these codes has been printed as Standards for Digital Line Graphs - Part 3, Attribute Coding, which is available for purchase from a USGS ESIC office (see the ordering information inside the front cover). Currently, DLG data entered in the National Digital Cartographic Data Base (NDCDB) are coded in accordance with the Standards for Digital Line Graphs. The implementation of the new coding standards will require the updating of existing files in the NDCDB in order to have a consistent product available for users. Software and procedures are being developed to convert existing data files to these codes during the next several years. Priority will be given to converting files retrieved in response to sales requests. In the meantime, a data base query will provide identification of the coding scheme used for any file in the NDCDB. This information will be supplied to customers when orders are submitted, and upon transmittal of data files. The following categories are included in current large-scale DLG files:

- Boundaries -- This category of data consists of (1) political boundaries that identify States, counties, cities, and other municipalities, and (2) administrative boundaries that identify areas such as National and State forests. Political and administrative boundaries are always collected as a single data set.

- Hydrography -- This category of data is currently being collected as combined hydrography consisting of all flowing water, standing water, and wetlands.

  Prior to 1983, hydrographic data were differentiated into two components: streams and water bodies. Streams represent flowing water and were digitized as a network intended for hydrologic flow modeling. Streams included the banks of double-line rivers and centerline connectors placed through double-line rivers and lakes. Water bodies include standing water such as lakes and ponds. Wetlands and coastal hydrographic data were not collected.

- Public Land Survey System (PLSS) -- This category of data describes the rectangular system of land surveys that is administered by the U.S. Bureau of Land Management. PLSS data are only collected for areas falling solely, or in part, within the States that were formed from the public domain. The PLSS subdivides the public domain and represents property boundaries or references to property boundaries. These DLG data are not intended to be official or authoritative. They are presented as cartographic reference information. The only legal basis for determining land boundaries remains the original survey.

continued

- Transportation -- This category of data includes major transportation systems collected in three séparate overlays labeled: (1) Roads and Trails, (2) Railroads, and (3) Pipelines, Transmission Lines, and Miscellaneous Transportation Features.

  In the last quarter of 1985, new transportation attribute codes were implemented. The principal difference between the old and new coding schemes is that under the old transportation subcategory, certain miscellaneous transportation features were not collected and descriptive attribute codes were not used.

- Other Significant Manmade Structures -- This category of data includes miscellaneous cultural features not included in the other major data categories.

  New attribute codes for Other Significant Manmade Structures were implemented in the last quarter of 1985. Very little data from this category currently reside in the NDCDB.

The attribute codes for the following base categories were newly defined in late 1985. Currently, there are very little data available in these categories.

- Hypsography -- This category of data consists of information on topographic relief (primarily contour data).

- Surface Cover -- This category of data consists of information about vegetative surface cover such as woods, scrub, orchards, and vineyards. Vegetative features associated with wetlands, such as marshes and swamps, are collected under Hydrography.

- Non-Vegetative Surface Features -- This category of data consists of information about the natural surface of the Earth as symbolized on the map such as lava, sand, and gravel features. This category is not all-inclusive, as other non-vegetative surface features are found in the category of Hydrography.

- Survey Control and Markers -- This category of data consists of information about the points of established position and third-order or better elevations that are used as fixed references in positioning and correlating map features.

DATA CONTENT

The DLG data files derived from the 1:100,000-scale maps contain selected base categories of cartographic data in digital form; these data categories do not necessarily correspond to the traditional feature separates associated with the maps. The following categories are included in current 1:100,000 DLG files:

- Hydrography -- This category of data describes combined hydrography consisting of all flowing water, standing water, and wetlands.

- Transportation -- This category of data includes major transportation systems collected in three separate subcategories labeled: (1) roads and trails, (2) railroads, and (3) pipelines, transmission lines, and miscellaneous transportation.

- Hypsography -- This category of data consists of information on topographic relief (primarily contour data), and supplementary spot elevations.

- Boundaries -- This category of data consists of (1) political boundaries that identify States, counties, cities, and other municipalities, and (2) administrative boundaries that identify areas such as National and State forests. Political and administrative boundaries are always collected as a single data set.

- Public Land Survey System (PLSS) -- This category of data describes the rectangular system of land surveys that is administered by the U.S. Bureau of Land Management. PLSS data are only collected for areas falling solely, or in part, within the States that were formed from the public domain. The PLSS subdivides the public domain and represents property boundaries or references to property boundaries. These DLG data are not intended to be official or authoritative. They are presented as cartographic reference information. The only legal basis for determining land boundaries remains the original survey.

The hypsography, boundary, and PLSS categories were authorized for production in late 1987. Currently there is very little data available in these categories.

The remaining categories: manmade features, survey control, vegetative surface cover, and nonvegetative features are projected to enter the production phase in 1990.

DIGITAL LINE GRAPHS FROM 1:2,000,000-SCALE MAPS

DATA CONTENT

The DLG data files derived from the 1:2,000,000-scale maps contain selected base categories of cartographic data in digital form. The data files are derived from the sectional maps of the 1970 National Atlas of the United States of America. The following categories are included in current 1:2,000,000-scale DLG files:

- Boundaries -- This category of data includes boundary information collected in two separate subcategories: (1) Political Boundaries and (2) Administrative Boundaries.
- Hydrography -- This category of data includes features collected in three separate subcategories: (1) Streams, (2) Water Bodies, and (3) Hypsography (Continental Divide only).
- Transportation -- This category of data includes major transportation systems collected in three separate subcategories: (1) Roads and Trails, (2) Railroads, and (3) Cultural Features (airports and Alaska pipeline).

DISTRIBUTION FORMATS

The 1:2,000,000-scale DLG data are available in three distribution formats: (1) standard, (2) optional, and (3) graphic.

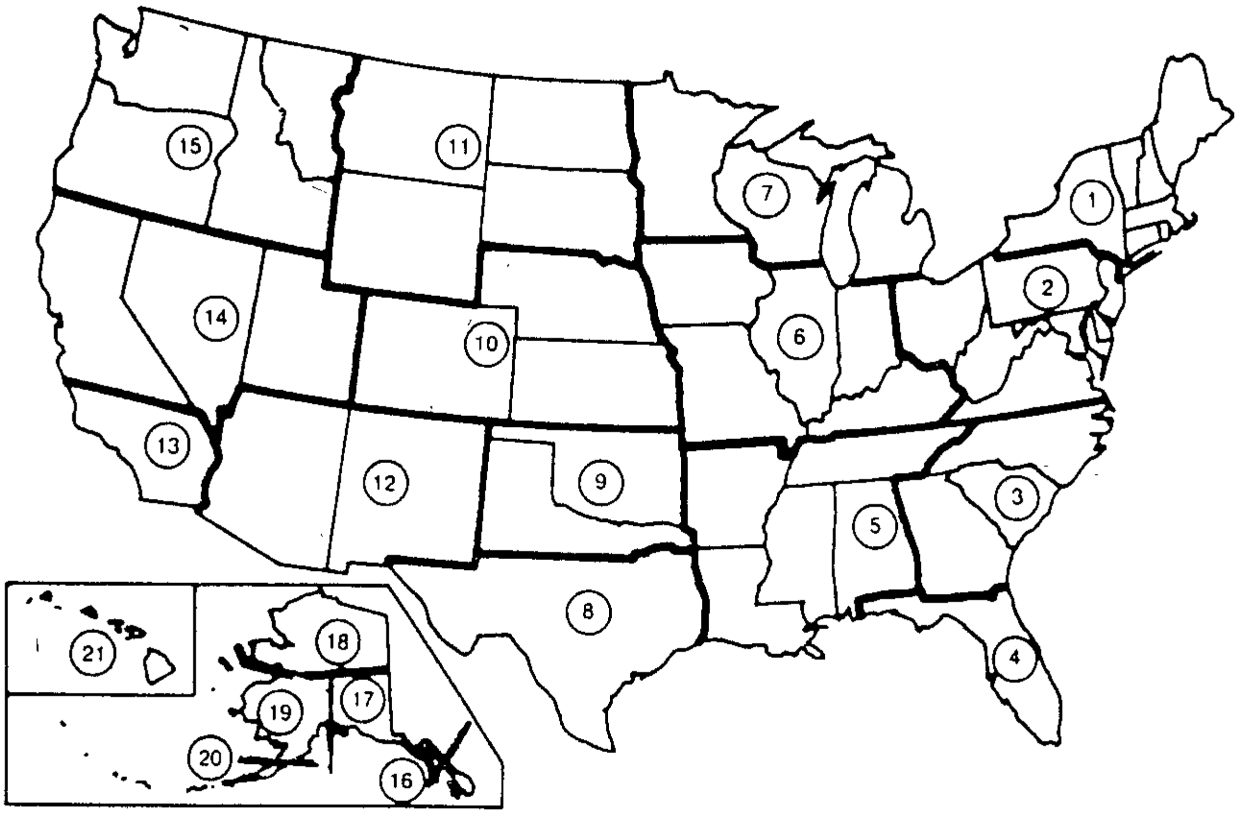
The **Standard** distribution format was designed to minimize storage requirements. Explicit topological linkages are contained only in the line elements.

The **Optional** distribution format was designed for data interchange. These files are typically larger than those in the standard format but, for certain applications, can simplify processing requirements. Topological linkages are explicitly encoded between all line and node elements, and all line and area elements. This structure allows a polygon data structure to be easily created.

The **Graphic** distribution format was designed to be compatible with the GS-CAM (Geological Survey - Cartographic Automatic Mapping) software. This software provides for plotting line and point information using a variety of map projections, scales, and graphic symbologies.

The files in the graphic distribution format are derived from the topologically structured DLG data described above, and contain a subset of the line and attribute code information in the DLG files. No node or area information is stored in these files. These files are not topologically structured.

The small-scale (1:2,000,000-scale) DLG sectional U.S. coverage data is available on a CD-ROM for $32.



Multistate cells used for Digital Line Graphs from 1:2,000,000-scale maps.

INDEX MAP

1 NORTHEASTERN STATES
2 MIDDLE ATLANTIC STATES
3 SOUTHEASTERN STATES
4 FLORIDA
5 SOUTHERN MISSISSIPPI VALLEY STATES
6 CENTRAL MISSISSIPPI VALLEY STATES
7 NORTHERN GREAT LAKES STATES
8 SOUTHERN TEXAS
9 SOUTHERN PLAINS STATES
10 CENTRAL PLAINS STATES
11 NORTHERN PLAINS STATES
12 ARIZONA AND NEW MEXICO
13 SOUTHERN CALIFORNIA
14 CENTRAL PACIFIC STATES
15 NORTHWESTERN STATES
16 SOUTHEASTERN ALASKA
17 CENTRAL ALASKA
18 NORTHERN ALASKA
19 SOUTHWESTERN ALASKA
20 ALEUTIAN ISLANDS
21 HAWAIIAN ISLANDS

DIGITAL LINE GRAPHS

DISTRIBUTION FORMATS

The 1:24,000-scale and other large-scale DLG data are available in two distribution formats: (1) standard and (2) optional.

The **Standard** distribution format is intended to minimize storage requirements. Explicit topological linkages are contained only in the line elements (starting node, ending node, area to the left of direction of travel, area to the right of direction of travel).

The **Optional** distribution format was designed to facilitate data usage. The topological relationships explicitly encoded include starting node, ending node, area to the left of direction of travel and area to the right of direction of travel for line elements, bounding lines for area elements, and bounding lines for node elements. These files are typically larger than those in the standard format but, for certain applications, can simplify processing requirements. For example, topological linkages are explicitly encoded for all line, node, and area elements, allowing a polygon data structure to be easily created. These linkages facilitate GIS applications of DLG data as well as generation of graphic products.

The characteristics of the standard and optional DLG formats are

Standard and optional DLG format

	Standard	**Optional**
Character set	8-bit ASCII	8-bit ASCII
Logical record length	144 bytes	80 bytes
Physical record length (blocksize)	Variable in multiples of 144 bytes.	Variable in multiples of 80 bytes.
Coordinate system	Internal file (thousandths of a map inch).	Ground planimetric (UTM).
Topological linkages	Contained only in line elements.	Contained in node, area, and line elements.

APPENDIX --Standard DLG Distribution Format (Record Contents)

In the standard DLG distribution format, the topological linkages are contained only in the line elements. The files are physically comprised of standard 8-bit ASCII characters organized into fixed-length logical records of 144 characters. Nine distinct record types are defined.

Logical record type	Content
A	Header record containing DLG identification information.
B	Header record containing projection information and registration points.
C	Header record identifying data categories contained in this DLG and indicating the number of nodes, areas, and lines in each category.
D.1	A node or an area record.
D.2	A line record.
E	Record containing x,y coordinate string.
F	Record containing attribute codes.
G	Record containing text string (not currently used).
H	Accuracy estimate (not currently used).

The actual sequence of records in a standard distribution DLG file is as follows:

1. Header records
   - Type A (one record)
   - Type B (one record)
   - Type C (one record)

2. Data records (Repeated for each data category)
   - Node records (Repeated for each node within a data category)
     - Node description (D.1)
     - Attribute codes (F)
     - Text string (G)
   - Area records (Repeated for each area within a data category)
     - Area description (D.1)
     - Attribute codes (F)
     - Text string (G)
   - Line records (Repeated for each line within a data category)
     - Line description (D.2)
     - x,y coordinates (E)
     - Attribute codes (F)
     - Text string (G)

3. Accuracy estimate
   - Type H (one record) (not currently used)

APPENDIX --Sample DLG Data File (Standard Distribution Format)

(Each 144-character record is shown as two consecutive 72-character lines.)

```
GLEN ELLEN                                              1968     24000

     3      1     10  -0.122033045000000D 09    0.380180450000000D 08    0.0
                       0.0                      0.0
   0.0                      0.0                      0.0
   0.0                      0.0                      0.0
   0.0                      0.0                      0.0
   0.0                      2    0.610000000000000D 00     0     4
  -0.122625000000000D 03    0.382500000000000D 02  -0.122625000000000D 03
   0.383750000000000D 02  -0.122500000000000D 03    0.383750000000000D 02
  -0.122500000000000D 03    0.382500000000000D 02

   0.609594407590000D 00  -0.288178569420000D-02    0.538248793410000D 06
   0.424037445560000D 07      4
SW -8971-11376NW -8955 11375NE  8955 11376SE  8971-11376

     1

BOUNDARIES (24&25)      795     16   795     7   530     20

N       1 -8971-11376     0      0

N       2 -8955 11375     0      0

N       3  8955 11376     0      0

N       4  8971-11376     0      0

N       5 -8966  3203     0      0

N       6  2101 11374     0      0

N       7  5832 11376     0      0

N       8  7513 11376     0      0

N       9  8956  7494     0      0

N      10  8961  2884     0      0

N      11  3469 10371     0      0

N      12  5530  9112     0      0

N      13 -3115-10127     0      0

N      14  7520 11175     1      0

    90      1
```

APPENDIX --Sample DLG Data File (Optional Distribution Format)

(Each 80-character record is shown as a single line.)

```
USGS-NMD  DLG DATA - CHARACTER FORMAT - 09-29-82 VERSION
GLEN ELLEN                                                 1968     24000

     3     1    10     2 0.61000000000D+00     4     0     4     1
  -0.122033045000000D+09    0.380180450000000D+08    0.0
   0.0                      0.0                      0.0
   0.0                      0.0                      0.0
   0.0                      0.0                      0.0
   0.0                      0.0                      0.0
  0.10000000000D+01 0.0                0.0                0.0
SW        38.250000 -122.625000          532812.91  4233413.86
NW        38.375000 -122.625000          532757.10  4247282.79
NE        38.375000 -122.500000          543674.93  4247335.01
SE        38.250000 -122.500000          543750.25  4233465.56
BOUNDARIES (24&25)      0    16    16 010     7     7 010    20    20   1
N     1    532812.91  4233413.86          2           0     0
      1    -10
N     2    532757.10  4247282.79          2           0     0
     -2      3
N     3    543674.93  4247335.01          2           0     0
     -6      7
N     4    543750.25  4233465.56          2           0     0
     -9     10
N     5    532773.94  4242301.15          3           0     0
     -1      2    12
N     6    539496.77  4247314.04          3           0     0
     -3      4    17
N     7    541771.16  4247326.01          3           0     0
     -4      5   -19
N     8    542795.89  4247330.85          3           0     0
     -5      6   -14
N     9    543686.72  4244968.57          3           0     0
     -7      8   -15
N    10    543703.06  4242158.35          3           0     0
     -8      9   -20
N    11    540333.59  4246706.56          3           0     0
    -16    -17    18
N    12    541593.59  4245945.02          3           0     0
    -18     19    20
N    13    536379.09  4234192.12          2           0     0
     11    -11
N    14    542800.74  4247208.34          2           1     0
     14     15
     90      1
N    15    537351.64  4243171.97          2           1     0
    -12     13
     90      1
N    16    538780.02  4243415.25          2           1     0
    -13     16
     90      1
```

APPENDIX --Optional DLG Distribution Format (Record Contents)

In the optional DLG distribution format, topological linkages are explicitly encoded for node and area elements as well as for line elements. The files are physically comprised of 8-bit ASCII characters organized into fixed-length logical records of 80 characters (bytes). Bytes 1-72 of each record may contain DLG data, and bytes 73-80 may contain a record sequence number.

The 11 distinct record types used in the optional DLG distribution format may be categorized as header and data records.

Four types of records are considered header records:

- File identification and description records
- Accuracy records (not currently used)
- Control-point identification records
- Data-category identification records

Seven types of records are considered data records:

- Node and area identification records
- Node-to-line linkage records
- Area-to-line linkage records
- Line identification records (also contains line-to-node and line-to-area linkages)
- Coordinate string records
- Attribute code records
- Text records (not currently used)

The actual sequence of records in an optional distribution format DLG file is as follows:

1. Header records
    - Ten file identification and description records
    - Accuracy records (not currently used)
    - Control point identification records (one per control-point)
    - Data category identification records (one per data category in the file)

2. Data records

Records	Repeated	Repeated
Node identification record Node-to-line linkage record(s) Attribute code record(s) Text record(s)	Repeated for each node within a data category	Repeated for each data category
Area identification record Area-to-line linkage record(s) Attribute code record(s) Text record(s)	Repeated for each area within a data category	
Line identification records Coordinate string record(s) Attribute code record(s) Text record(s)	Repeated for each line within a data category	

U.S. Department of the Interior
U.S. Geological Survey
Earth Science
Information Center (ESIC)

Factsheet

US GeoData
Digital Elevation Models

Digital elevation models

Digital elevation model (DEM) data consist of an array of regularly spaced elevations. U.S. Geological Survey (USGS) DEM data are sold in 7.5-minute, 15-minute (Alaska only), and 1-degree units.

Data production

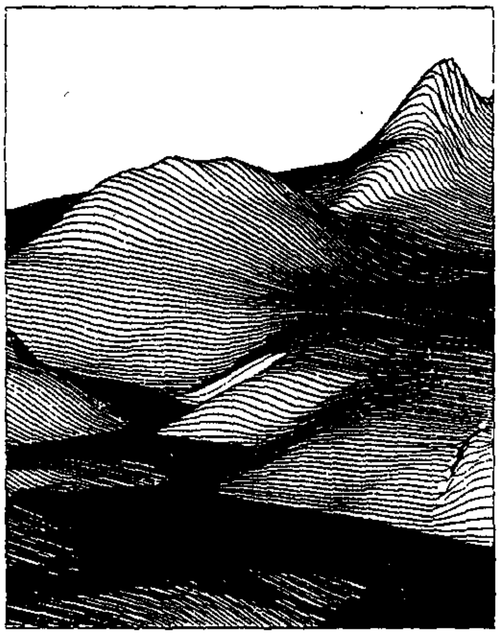
DEM data for 7.5-minute units are collected by four production methods: (1) the Gestalt Photo Mapper II (GPM2), an automated photogrammetric system designed to produce orthophotos, digital terrain data, and contours in subunits called patches; (2) manual profiling from photogrammetric stereomodels using stereoplotters equipped with three-axis electronic digital profile recording modules, by scanning stereomodels along successive terrain profiles; (3) interpolation of the elevations from stereomodel digitized contours, derived from stereoplotters equipped with three-axis digital recording modules used for compilation of 7.5-minute topographic quadrangle maps; and (4) interpolation from digital line graph (DLG) hypsographic and hydrographic data, collected using scanners, manual digitizers, and automated line followers.

DEM data for 15-minute units are derived from DLG hypsographic and hydrographic data.

DEM data for 1-degree units are collected from topographic map sources, ranging from the 7.5-minute map series to the 1- by 2-degree map series, or from photographic sources by using image correlation systems.

Unit size and file extent

DEM data for 7.5-minute units correspond to the USGS 7.5-minute topographic quadrangle map series for all of the United States and its territories except Alaska.



Portion of a 7.5-minute DEM plot of Tumwater, WA

DEM data for 15-minute units correspond to the USGS 15-minute topographic quadrangle map series in Alaska. The unit sizes in Alaska vary depending on the latitude. Units south of 59° N. cover 15- by 20-minute areas, those between 59° and 62° N. cover 15- by 22.5-minute areas, those between 62° and 68° N. cover 15- by 30-minute areas, and those north of 68° N. cover 15- by 36-minute areas. (All values are latitude-longitude, respectively.)

DEM data are produced by the Defense Mapping Agency in 1- by 1-degree units that correspond to the east or west half of USGS 1- by 2-degree topographic quadrangle map series (1:250,000 scale) for all of the United States and its territories. In Alaska these are west, central, and east files.

All nonstandard quadrangles with neatlines that extend beyond the standard unit size to accommodate overedge boundaries are collected as multiples of the standard unit sizes. These data, therefore, are sold as two 7.5- by 7.5-minute units.

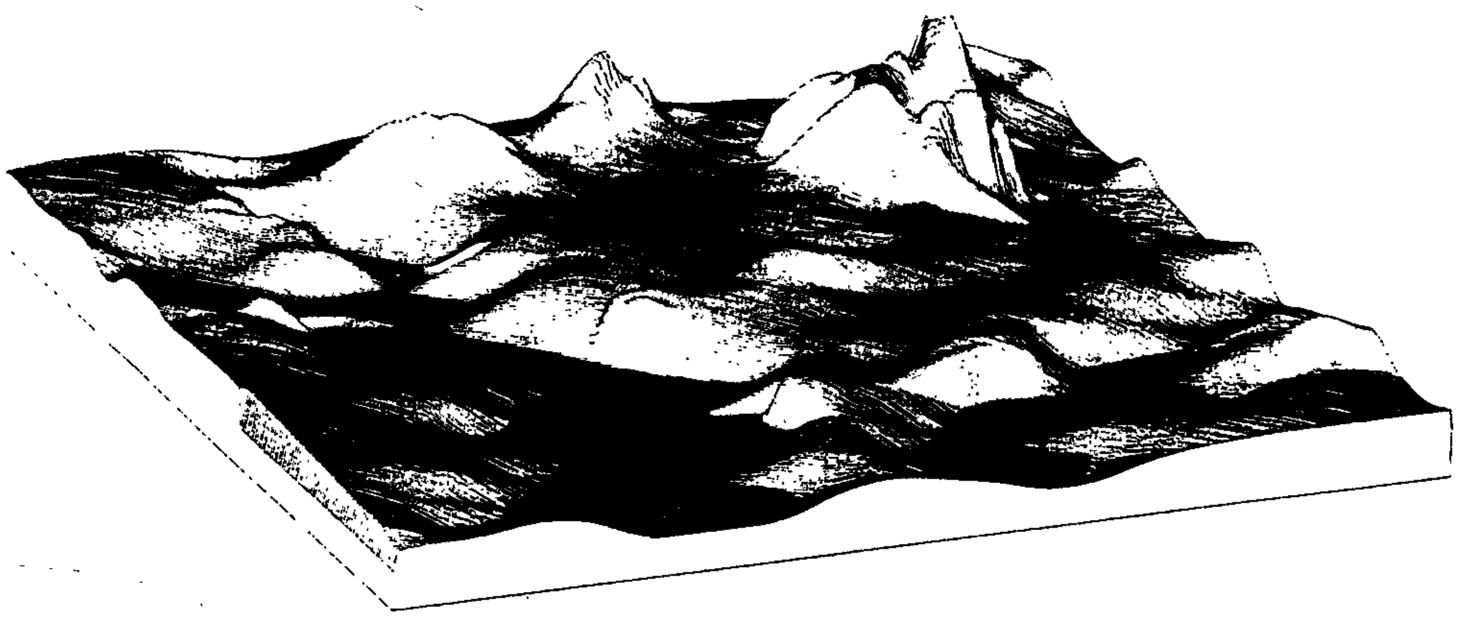
Data characteristics

All DEM data are similar in logical data structure and are ordered from south to north in profiles that are ordered from west to east. However, they differ in geographic reference systems and sampling intervals.

DEM data in 7.5-minute units consist of regular arrays of elevations arranged horizontally on the Universal Transverse Mercator (UTM) coordinate system of the North American Datum of 1927 (NAD 27). These data are stored as profiles with 30-meter spacing along and between each profile. The profiles do not always have the same number of elevations because of the variable angle between true north and grid north in the UTM system.

DEM data in 15-minute units consist of regular arrays of elevations arranged horizontally to the coordinate system of NAD 27. The spacing between elevations along profiles is 2 arc seconds of latitude by 3 arc seconds of longitude. Each profile has 451 elevations.

DEM data in 1-degree units consist of a regular array of elevations arranged horizontally using the coordinate system of the World Geodetic System 1972 Datum. A few units are also available using the World Geodetic System 1984 Datum. Spacing of the elevations along and between each profile is 3 arc seconds with 1,201 elevations per profile. The only exception is DEM data in Alaska, where the spacing and number of elevations per profile varies depending on the latitude. Latitudes between 50° and 70° N. have spacings at 6 arc seconds with 601 elevations per profile, and latitudes greater than 70° N. have spacings at 9 arc seconds with 401 elevations per profile.



7.5 - Minute DEM plot of Tumwater, Washington

Data records

A DEM file is organized into three logical records, types A, B, and C. The type A record contains information defining the general characteristics of the DEM, including its name, boundaries, units of measurement, minimum and maximum elevations, number of type B records, and projection parameters. There is only one type A record per DEM file. The type B record contains profiles of elevation data and associated header information. There is a type B record for each profile. The type C record contains statistics on the accuracy of the data.

Data accuracy

The accuracy of DEM data depends on the source and resolution of the data samples. The accuracy of the 7.5-minute DEM data is derived by comparing linear interpolated elevations in the DEM with corresponding map location elevations and computing the statistical standard deviation or root-mean-square error (RMSE). The RMSE is used to describe the DEM accuracy. The vertical accuracy of 7.5-minute DEM's is 15 meters or better. The 15-minute DEM accuracy is one-half of a contour interval of the 15-minute topographic quadrangle map or better. The 1-degree DEM data have an absolute accuracy of 130 meters horizontally and 30 meters vertically.

US GeoData Sampler

A US GeoData Sampler is available for a nominal charge. The sampler includes the 7.5-minute DEM and the 1:24,000-scale DLG for Tumwater, Washington; the 1:100,000-scale DLG for Tacoma, Washington; the 1:2,000,000-scale DLG for the northwestern States (WA, OR, and ID); 1- by 2-degree land use and land cover data for Seattle, Washington; the 1- by 1-degree DEM for Seattle, Washington East; and the Geographic Names Information System data for the State of Washington.

Ordering instructions

DEM data are written as ANSI-standard ASCII characters in fixed-block format on unlabeled or ANSI labeled 9-track magnetic tapes at a 1,600-bpi or 6,250-bpi density. The logical record length is 1,024 bytes with a physical record size of 4,096 bytes or four logical records. DEM data may be ordered by specifying the unit size, maximum block size, tape density, and tape label and by identifying the sales unit by topographic quadrangle name or by the southeast latitude and longitude corner coordinates.

The US GeoData Sampler can be ordered in standard or optional ASCII DLG formats, on either one 6,250-bpi or three 1,600-bpi tapes.

The Earth Science Information Center can furnish indexes, price lists, and order forms. Data Users Guides are included with each order.

For further information, contact:

U.S. Geological Survey
Earth Science Information Center
507 National Center
Reston, Virginia 22092
1-800-USA-MAPS

7.5-MINUTE DIGITAL ELEVATION MODELS

Characteristics

A 7.5-minute DEM has the following characteristics:

- The data consist of a regular array of elevations referenced horizontally in the UTM coordinate system. The reference datum may be North American Datum of 1927 (NAD 27), North American Datum of 1983 (NAD 83), Old Hawaiian Datum (OHD), or Puerto Rico Datum of 1940 (PRD).
- The unit of coverage is the 7.5-minute quadrangle. Overedge coverage is not provided.
- The data are ordered from south to north in profiles that are ordered from west to east.
- The data are stored as profiles in which the spacing of the elevations along and between each profile is 30 m.
- The profiles do not always have the same number of elevations because of the variable angle between the quadrangle's true north and the grid north of the UTM coordinate system.
- Elevations for the continental U.S. are either meters or feet referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29). Elevations for Hawaii and Puerto Rico are either in meters or feet referenced to local mean sea level. DEM's of low-relief terrain or generated from contour maps with intervals of 10 ft (3 m) or less are generally recorded in feet. DEM's of moderate to high-relief terrain or generated from maps with terrain contour intervals greater than 10 ft are generally recorded in meters.

Profiles for 7.5-minute DEM's are generated by using a UTM cartesian coordinate system as a base. The profiles are clipped to the straight-line intercept between the four geographic corners of the quadrangle--an approximation of the geographic map boundary (neatline).
The resulting area of coverage for the DEM is a quadrilateral, the opposite sides of which are not parallel.

The UTM coordinates of the four corners (bounds) of the DEM's are listed in the type A record, as shown in table 1,* data element 11; the UTM coordinates of the starting points of each profile are listed in the type B record (profiles), table 2,* data element 3. These coordinates describe the shape of the quadrilateral and the variable x, y starting position of each profile. Because of the variable orientation of the quadrilateral in relation to the UTM coordinate system, profiles intersect the east and west neatlines as well as the north and south neatlines.
In addition, DEM's have profile easting values that are continuous from one DEM to the adjoining DEM only if the adjoining DEM is contained within the same UTM zone.

* See Data Users Guide 5 - Digital Elevation Models

Structure of Digital Data

The Earth Science Information Centers (ESIC) distribute digital cartographic/geographic data files produced by the U.S. Geological Survey (USGS) as part of the National Mapping Program. The data files are grouped into four basic types. The first type, called a Digital Line Graph (DLG), is line map information in digital form. These data files include information on planimetric base categories, such as transportation, hydrography, and boundaries. The second type, called a Digital Elevation Model (DEM), consists of a sampled array of elevations for ground positions that are usually at regularly spaced intervals. The third type, Land Use and Land Cover digital data, provide information on nine major classes of land use such as urban, agricultural, or forest as well as associated map data such as political units and Federal land ownership. The fourth type, the Geographic Names Information System, provides primary information for known places, features, and areas in the United States identified by a proper name.

The digital cartographic data files from selected quadrangles currently available from ESIC include the following:

- Digital Elevation Models (DEM's)
  - 7.5-minute
  - 15-minute
  - 30-minute
  - 1-degree

- Digital Line Graphs (DLG's)
  - 1:24,000-scale
  - 1:62,500-scale
  - 1:63,360-scale
  - 1:100,000-scale
  - 1:2,000,000-scale

- Land Use and Land Cover digital data
  - 1:250,000- and 1:100,000-scale Land Use and Land Cover and associated maps
  - 1:250,000-scale Alaska Interim Land Cover

- Geographic Names Information System

The digital data are useful for the production of cartographic products such as plotting base maps and for various kinds of spatial analysis. A major use of these digital cartographic/geographic data is to combine them with other geographically referenced data, enabling scientists to conduct automated analyses in support of various decision making processes.

The information for the following pages on "Structure of Digital Data" was obtained from sections of the DATA USERS GUIDES listed:

DATA USERS GUIDES

1: Digital Line Graphs from 1:24,000-Scale Maps - $2
2: Digital Line Graphs from 1:100,000-Scale Maps - $1.50
3: Digital Line Graphs from 1:2,000,000-Scale Maps - $1.50
4: Land Use and Land Cover from 1:2,000,000-Scale Maps - $1
5: Digital Elevation Models - $1
6: Geographic Names Information System - $1
7: Alaska Interim Land Cover Mapping Program - $1

Data Users Guides 1-7 replace Geological Survey Circular 895 B-G.

ALASKA DIGITAL ELEVATION MODELS

- The product consists of a regular array of elevations referenced horizontally to the geographic (latitude/longitude) coordinate system of NAD 27 or NAD 83.
- Elevation data on the quadrangle neatlines (all four sides) share edge profiles with the surrounding eight quadrangles.
- Elevations are in meters or feet relative to NGVD 29.
- The data are ordered from south to north in profiles that are ordered from west to east.

Characteristics

7.5-MINUTE Alaska DEM's have the following characteristics:

- The unit of coverage corresponds to four basic quadrangle sizes for 1:24,000- and 1:25,000-scale graphics (depending on latitude):

Cell size limits

7.5 x 18 minutes	State of Alaska north of 68° N latitude
7.5 x 15 minutes	Between 62° N and 68° N latitude
7.5 x 11.25 minutes	Between 59° N and 62° N latitude
7.5 x 10 minutes	State of Alaska south of 59° N latitude

- The longitudinal limits of these cells are computed east and west of the -150 degree meridian. The north-south cell limits conform to even multiples of 7.5 minutes of latitude.
- The data are collected with a 1- x 2-arc-second spacing in latitude and longitude, respectively. The first and last data points along a profile are at the integer degrees of latitude. A profile will therefore contain 451 elevations.

Characteristics

15-MINUTE Alaska DEM's have the following characteristics:

- The unit of coverage corresponds to four basic quadrangle sizes for 1:63,360-scale graphics (depending on latitude):

Cell size limits

15 x 36 minutes	State of Alaska north of 68° N latitude
15 x 30 minutes	Between 62° N and 68° N latitude
15 x 22.5 minutes	Between 59° N and 62° N latitude
15 x 20 minutes	State of Alaska south of 59° N latitude

- The longitudinal limits of these cells are computed east and west of the -150 degree meridian. The north-south cell limits conform to even multiples of 15 minutes of latitude.
- The data are collected with a 2- x 3-arc-second spacing in latitude, and longitude, respectively. The first and last data points along a profile are at the integer degrees of latitude. A profile will therefore contain 451 elevations.

1-DEGREE DIGITAL ELEVATION MODELS

1-Degree DEM (3- x 3-arc-second data spacing). Provides coverage in 1- x 1-degree blocks. Two products (three in some regions of Alaska) provide the same coverage as a standard USGS 1- x 2-degree map series quadrangle. The basic elevation model is produced by or for the Defense Mapping Agency (DMA), but is distributed by USGS in the DEM data record format.

Characteristics

A 1-degree DEM has the following characteristics:

- The product consists of a regular array of elevations referenced horizontally on the geographic (latitude/longitude) coordinate system of the World Geodetic System 1972 Datum (WGS 72) or the World Geodetic System of 1984 (WGS 84).

- The unit of coverage is a 1- x 1-degree block. Elevation data on the integer degree lines (all four sides) correspond with the same profiles on the surrounding eight blocks.

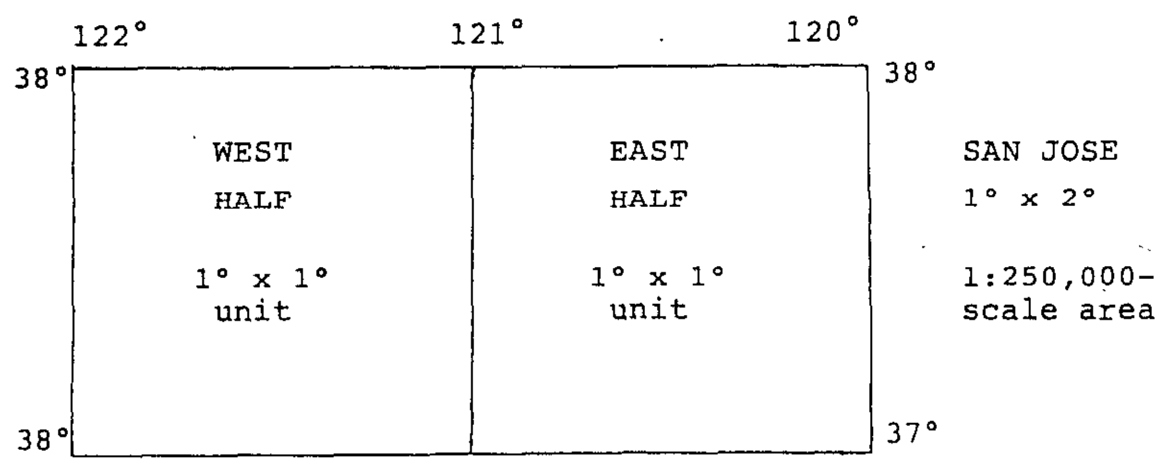
- Elevations are in meters relative to NGVD 29 in the continental U.S. and local mean sea level in Hawaii and Puerto Rico.

- The data are ordered from south to north in profiles that are ordered from west to east.

- Spacing of the elevations along each profile is 3 arc-seconds. The first and last data points are at the integer degrees of latitude. A profile will therefore contain 1,201 elevations.

- Spacing between profiles varies by latitude; however, the first and last data points are at the integer degrees of longitude. North of 50° degrees N and south of 70° N, the spacing is 6 arc-seconds with 601 profiles per product. For the remainder of Alaska north of 70° N the spacing is 9 arc-seconds with 401 profiles per product.

For U.S. 1:250,000-scale 1 degree by 2 degree areas, you need to order TWO 1 degree by 1 degree DEM units: EAST HALF and WEST HALF. They are TWO separate DEM units with TWO separate costs: $7 for each half for a total of $14 for the entire area, if you are ordering six or more units.



For ALASKA 1:250,000-scale DEMs, some areas require THREE units: EAST HALF, CENTRAL HALF and WEST HALF, if you want the entire area.