

### Early Documents for 5,566,073

1. File: *synreal.doc* This is my oldest existing description of what became 5,566,073 that I could find. Created **June 29, 1993**. Note that it does not describe data compression. I wrote it. My name and the date do not appear on it because it was work product. There may have been earlier versions that were not saved.

At that time I started a patent search at the Sunnyvale Patent Library. Searches were done manually using Patentee/Classification books, microfiche, printed patents, and patents on microfilm. Although copies of patents could be made they were of generally poor quality.

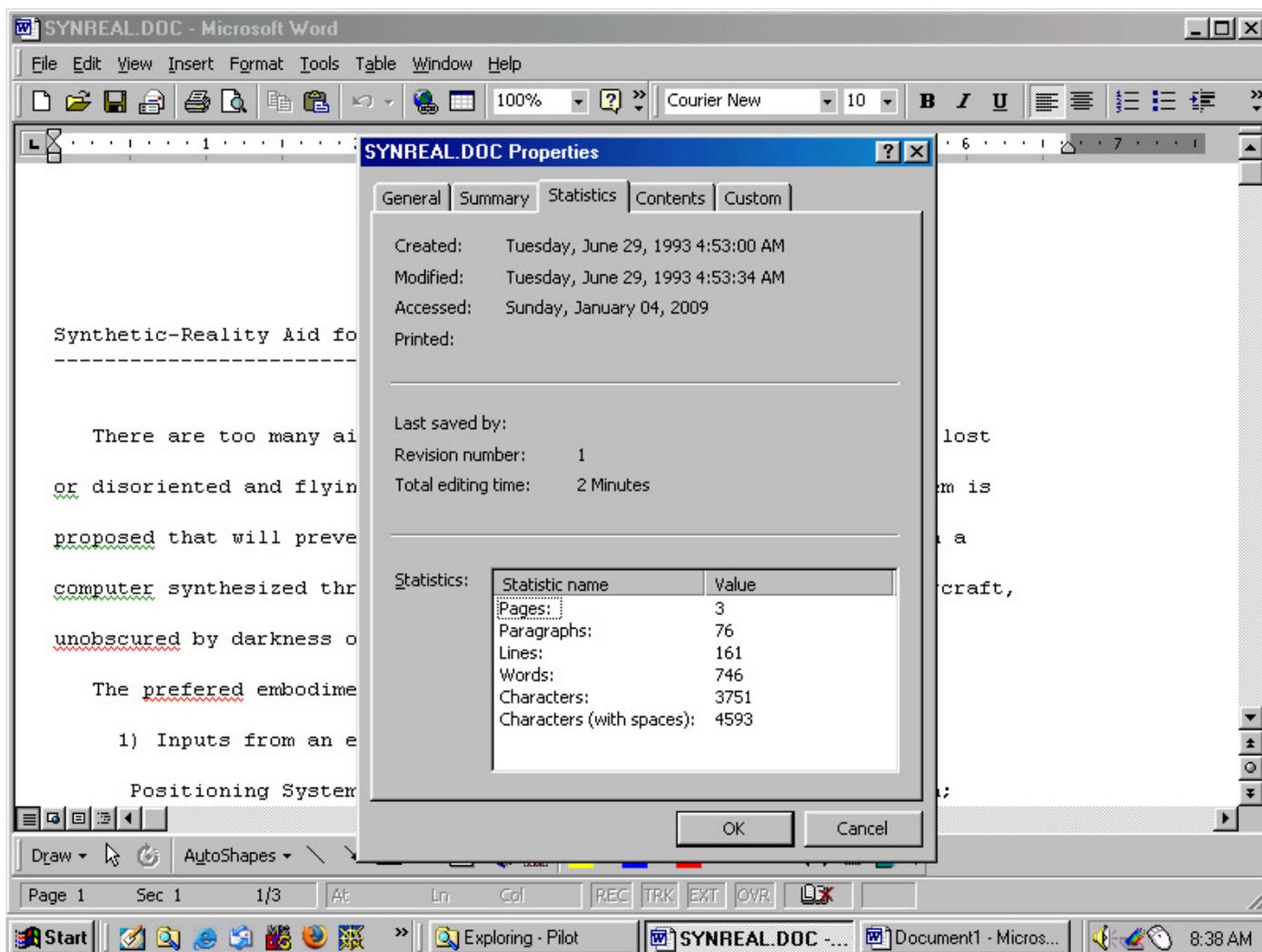
2. Order for patents sent to USPTO, July 18, 1993.

3. Order for patents sent to USPTO, May 31, 1994.

4. By Summer 1994 I discovered that the Stanford Engineering Library had CASSIS CD-ROMS, which made searching easier. CASSIS had classification information and patents abstracts, but not full patents. The search results reproduced here show Dawson and Beckwith. (June 1, 1994). I filed the patent application July 11, 1994.

The following files came from a time before Windows 95 and before I had Microsoft Word. I ran DOS and used only an ASCII text editor. Since it was a text document it was my practice to use a file extension of .doc. I opened the documents with MS Word and used cut-and-paste to bring them into this document. Then I used a screen-capture of the Properties of the original files to show the file creation date for the respective documents.

Jed Margolin  
January 7, 2009



## Synthetic-Reality Aid for Pilots

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There are too many aircraft accidents caused by the pilot becoming lost or disoriented and flying into a mountain or into power lines. A system is proposed that will prevent such accidents by presenting the pilot with a computer synthesized three-dimensional view of what is outside the aircraft, unobscured by darkness or weather.

The preferred embodiment of the system consists of:

- 1) Inputs from an existing navigation system such as the Global Positioning System that precisely locate the aircraft's position;
- 2) Inputs from existing instruments such as the Gyrocompass and Turn-and-

- Bank Indicator that provide the aircraft's heading and orientation;
- 3) A computer accessible data base that contains information on topological features (like mountains) and manmade structures such as highways, antenna towers, power lines, and airports; and
  - 4) A processor that uses the position and orientation information to access the data base and extract the appropriate features from the data base and synthesize from the data base a three-dimensional view of what the pilot should be seeing outside the window.

The pilot would be able to request a display with certain features emphasized. For example, highways. Or runways. When flying at night it can be difficult to determine one's location because one sees mostly lights. And during the day it can be difficult because the desired landmark can be lost in the clutter of everything else.

The system will be able to warn the pilot of potentially dangerous situations well before they occur such as when the aircraft is headed for a mountain and the pilot will need to take action before it is too late, given the aircraft's maneuvering capabilities.

In a basic system, the video can be presented on a cockpit panel display such as a CRT, LCD, Plasma Display, etc.

In a more advanced system, the system can use the type of display used in the field commonly known as Virtual Reality. This consists of a head-mounted display and an orientation sensor. Each eye is presented with its own image thereby producing a stereoscopic image to the brain. The orientation of the user's head is sensed so the correct image is presented according to where the user has turned his/her head. More complicated systems are able to perform eye tracking to determine where the user is actually looking.

With this more advanced system, the pilot would be able to look around in all directions, right through the aircraft. If the pilot finds this confusing, the aircraft can be represented in the display in a way that the

pilot can still see through it, such as a wireframe aircraft.

This has two potent applications:

1. If the aircraft is properly instrumented, including structures such as elevators and rudders, the pilot would be able to "look through" the aircraft's skin to see that the aircraft's structures are operating properly. The pilot would be able to "see" that the flaps are in the desired position instead of just the position of a lever or wheel that can be easily lost in the clutter of a modern cockpit. The pilot would also be able to "look" at the amount of fuel in the various fuel tanks. This would be especially useful in large commercial aircraft that have numerous fuel tanks and require careful fuel management to keep the aircraft balanced.
2. In military aircraft with appropriate sensors, the pilot would be able to engage an enemy aircraft without losing sight of him due to the limits of visibility from the cockpit.

Other sensor inputs:

In order to increase reliability and safety other inputs can include, where available:

- 1) The LORAN Navigation System;
- 2) The OMEGA Navigation System;
- 3) The VOR System;
- 4) Radar Altimeter;
- 5) Weather Radar;
- 6) Airspeed Indicator;
- 7) Barometric Altimeter;
- 8) Air Temperature.

Another capability of the Synthetic Reality System is that the pilot is not limited to a fixed field of view. Since this is a Synthesized Reality, the pilot can request any desired amount of Zoom. With a fully instrumented

aircraft the pilot can also request a different point of view, meaning that the pilot can see what the aircraft looks like from the back, or side, or front, or bottom.

The same data base and method for transforming it into a three-dimensional view can be used in a ground-based simulator so the pilot can preview the trip, or parts of it; especially the difficult parts including flying to a particular destination for the first time.

18 July 1993

Commissioner of Patents & Trademarks  
Box 9  
Washington, D.C. 20231

Dear Sir,

Please send me copies of the following patents:

5,184,250	2/2/93	Lacroix, Michel	Head Display
5,185,610	2/9/93	Ward, Philip W. et al	GPS System and method for deriving pointing or attitude from single GPS receiver
4,999,780	3/12/91	Mitchell, James E.	Automatic Reconfiguration of Electronic Landing Display
5,003,305	3/26/91	Kelly, Brian D. and Pelton, Sam L.	Apparatus and Method for Displaying Aircraft Flight Path Angle on an Attitude Display Indicator 340/974
4,903,216	2/20/90	Huss, Ronald E. and Denlinger Robert M.	Method for Displaying Intervisibility Data
5,181,041	1/19/93	Lind, Harold V.	Accurate Location System Using Transponded and Correlated LORAN Signals
5,210,639	5/11/93	Redwine, Donald J.	Dual-Port Memory with Inhibited Random Access During Transfer Cycles with Serial Access

Enclosed is a check for  $7 * \$3.00 = \$21.00$  .

Thank you.

Sincerely yours,

Jed Margolin

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**JED MARGOLIN**  
3570 PLEASANT ECHO DR.  
SAN JOSE, CA 95148

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AG 93 12

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31 May 1994

Commissioner of Patents & Trademarks  
Box 9  
Washington, D.C. 20231

Dear Sir,

Please send me copies of the following patents:

Patent Number	Issue Date	Inventor(s)
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4,445,118	1984 04 24	Taylor, Ralph E. et al
4,468,793	1984 08 28	Johnson, Charles R., et al
4,485,383	1984 11 27	Maher, Robert A.
4,599,620	1986 07 08	Evans, Alan G.
5,101,356	1992 03 31	Timothy, La Mar K., et al
5,153,836	1992 10 06	Fraughton, Edward J. et al
5,185,610	1993 02 09	Ward, Phillip W. et al
5,140,532	1992	
5,296,854	1994 03 22	Hamilton, Bruce E. et al
5,302,964	1994	
5,275,565	1994 01 04	Moncrief, Rick L.
5,111,192	1992	
4,333,796	1982	

Enclosed is a check for 13 \* \$3.00 = \$39.00 .

Thank you.

Sincerely yours,

Jed Margolin

**JED MARGOLIN**  
3570 PLEASANT ECHO DR.  
SAN JOSE, CA 95148

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90-8078/3211

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*Jed Margolin*

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**FSEARCH.DOC Properties**

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GPS System

Patent Number 4445118  
 Issue Date 1984 04 24  
 Appl. Data 266253 1981 05 22  
 Assignee The United States of America as represented by the  
 Administrator of the  
 National Aeronautics and Space Administration  
 Inventor(s) Taylor, Ralph E.  
 Sennott, James W.  
 State/Country MD

Title Navigation system and method

Abstract In a global positioning system (GPS), such as the NAVSTAR/GPS system, wherein the position coordinates of user terminals (14) are obtained by processing multiple signals transmitted by a constellation of orbiting satellites (16), an acquisition-aiding signal generated by an earth-based control station (12) is relayed to user terminals via a geostationary satellite (10) to simplify user equipment. The

aiding signal is FSK modulated on a reference channel slightly offset from the standard GPS channel. The aiding signal identifies satellites in view having best geometry and includes Doppler prediction data as well as GPS satellite coordinates and identification data associated with user terminals within an area being served by the control station (12) and relay satellite (10). The aiding signal significantly reduces user equipment by simplifying spread spectrum signal demodulation and reducing data processing functions previously carried out at the user terminals (14).

U.S. Class 342/357 342/356  
 IPC H04B 7/185  
 U.S. Refs 3384891 3430234 3471856 3544995 3641433 3763492  
 3789409 3852750 3906204

Other Refs "Spread Spectrum Systems," R. C. Dixon, John Wiley & Sons, New York, 1976, pp. 186-188.

Examiner Blum, Theodore M.  
 Agent Tresansky, John O.  
 Manning, John R.  
 Sandler, Ronald F.

#### Early GPS Receiver

Patent Number 4468793  
 Issue Date 1984 08 28  
 Appl. Data 211499 1980 12 01  
 Assignee Texas Instruments Incorporated  
 Inventor(s) Johnson, Charles R.  
 Ward, Phillip W.  
 Lindley, Joe H.  
 Maher, Robert A.  
 Holmes, Jerry D.  
 Fuchser, Troy D.

State/Country TX

Title Global position system (GPS) multiplexed receiver

Abstract A global positioning system comprises an RF receiver for receiving L.sub.1, L.sub.2 p-code or ca code modulated frequency outputs from one or more space vehicles, a multiplexer operably connected to the receiver multiplexes the L.sub.1 and L.sub.2 signals to the receiver, and code and carrier tracking loops operably connected to the receiver, each loop including a plurality of filters, one for tracking line-of-sight dynamics and another for determining ionosphere effects on the L.sub.1 and/or L.sub.2 signals.

U.S. Class 375/97 342/357 342/418  
 IPC G01S 5/02  
 U.S. Refs 3769585 4286270 4335433

Examiner Griffin, Robert L.  
 Agent Bandy, Alva H.  
 Merrett, N. Rhys

Sharp, Melvin

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Early GPS Receiver

Patent Number 4485383  
 Issue Date 1984 11 27  
 Appl. Data 211500 1980 12 01  
 Assignee Texas Instruments Incorporated  
 Inventor(s) Maher, Robert A.  
 State/Country TX

Title Global position system (GPS) multiplexed receiver

Abstract A global position system (GPS) capable of multiple (two or more space vehicles) space vehicle (SV) multiplexing comprises an RF energy receiver for receiving high and low frequencies (L.sub.1 and L.sub.2) from a plurality of SVs on different codes, a switching means for alternately switching the RF receiver between the coded L.sub.1, L.sub.2 signals for detection, a digital processing means, replica coded L.sub.1, L.sub.2 signal producing hardware, and a coherent time and frequency synthesis means, said digital processing means connected to the RF receiver, coherent time and frequency synthesis means, and replica coded L.sub.1, L.sub.2 signal producing hardware for producing for the RF receiver replica coded L.sub.1, L.sub.2 signals for each SV to be tracked and adjusting with respect to the coherent time and frequency synthesis circuit the states of the hardware replica receiver signals to align them with corresponding signals of each of the SVs at a rate that supports sampled data closed-loop tracking of the SVs without reacquisition of each SV being tracked.

U.S. Class 342/352 370/104.1 375/114  
 IPC H04B 7/185  
 U.S. Refs 3349403 3373424 3430237 3449748 3742498 3747095  
 3836721

Examiner Tubbesing, T. H.  
 Agent Bandy, Alva H.  
 Metrett, N. Rhys  
 Sharp, Melvin

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Method for determining the orientation of a moving platform; Produces Roll, Pitch, and Yaw information.

Patent Number 4599620  
 Issue Date 1986 07 08  
 Appl. Data 678187 1984 12 04  
 Assignee The United States of America as represented by the Secretary of the Navy  
 Inventor(s) Evans, Alan G.  
 State/Country MD

Title Method for determining the orientation of a moving platform

Abstract An improved method for continuously determining the orientation of a moving ser platform at a selected time fix. A Global Positioning System (GPS) is used to carry out the

method and is made up of a plurality of twenty-four (24) earth-orbiting satellites wherein each satellite continuously transmits a pair of distinctively encoded RF signals. The GPS system is also provided with a computerized GPS receiver apparatus for use on a moving platform. The receiver apparatus is generally comprised of a rotatable antenna, a single channel multi-track geodetic receiver, a receiver microprocessor, and an orientation computer with a display. The receiver processor selects an optimum group of four satellites to be tracked. The orientation computer during antenna rotation selects a series of four equidistant points about the antenna periphery for receiving signals from each tracked satellite. The signals are transformed by the computer so as to provide a graphic data display output in near real time of the biased range (Doppler phase measurement) of each optimum-tracked satellite in relation to the moving platform. The biased range data of each graphic display for an optimum-tracked satellite is represented by a series of relatively spaced biased range data lines wherein any point on each line represents the biased range of the satellite in near real time. A common time fix is selected for the graphic data so that the change-in-range of each optimum-tracked satellite is analytically obtained with respect to at least one pair of diametrically opposed points of the series of four equidistant points of the antenna. The change-in-range is a function of predetermined equations so that the orientation of the rotating antenna and thus that of the platform is determined in terms of pitch, roll and yaw. By reason of the improved method for continuously determining orientation of a moving platform in relation to the earth, the method assists in accurately setting, e.g., a platform fire control system whether the platform is on or above the earth's surface.

U.S. Class 342/357 364/434  
 IPC G01S 5/02 H04B 7/185 G06G 7/78  
 U.S. Refs 2861264 3798648 4042929 4060809

Examiner Blum, Theodore M.  
 Agent Beers, R. F.  
 Goshorn, E. E.

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Moving vehicle attitude measuring system

Patent Number 5101356  
 Issue Date 1992 03 31  
 Appl. Data 440001 1989 11 21  
 Assignee Unisys Corporation  
 Inventor(s) Timothy, La Mar K.  
 Ownby, Michael L.  
 Bowen, Douglas G.

State/Country UT

Title Moving vehicle attitude measuring system

Abstract A system for determining attitude of airborne vehicles or surface vehicles is provided with three fixed position antennas separated from each other by a predetermined

calibrated distance. Each antenna is connected to a GPS receiver and the receiver outputs are coupled to a phase comparator which establishes the phase difference between the RF carrier signal of the three possible pairs of receivers. The outputs of the phase comparator are coupled to a preprogrammed dedicated processor that calculates a coordinate frame which fixes the attitude of the plurality of antennas in space. The processor then makes a comparison with a precalibrated reference attitude stored in an associated memory so that a true attitude value of roll, pitch and yaw may be calculated and employed to reposition the gyro of the moving vehicle.

U.S. Class 364/449 342/352 342/357 364/459  
IPC G06F 15/50

U.S. Refs 4613864 4751512 4754280 4812991 4894655 4912475

Examiner Chin, Gary  
Agent Sowell, John B.  
Starr, Mark T.

Images Disc # This patent is on PatentImages disc# 1992\026

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GPS system and method for deriving pointing or attitude from a single GPS receiver; Produces Roll, Pitch, and Yaw information.

Patent Number 5185610  
Issue Date 1993 02 09  
Appl. Data 569890 1990 08 20  
Assignee Texas Instruments Incorporated  
Inventor(s) Ward, Phillip W.  
Scott, H. Logan  
Holmes, Jerry D.  
LaPadula, Leonard J.

State/Country TX

Title GPS system and method for deriving pointing or attitude from a single GPS receiver

Abstract A GPS single-receiver pointing/attitude system derives pointing/attitude measurements by correlating a selected GPS code (either P or C/A), recovered from GPS navigation signals using a single GPS receiver with multiple GPS antennas (a reference antenna and at least two slave antennas for pointing or three for attitude). For a two antenna pointing application, the GPS receiver (FIG. 4) includes, for each receiver channel, the incoming GPS signals are applied to three code correlators (72-75) assigned to the reference antenna, and three code correlators (76-77) assigned to the slave antenna, which provide corresponding reference and slave I and Q correlation outputs. The single-receiver pointing technique involves: (a) using the reference I and Q correlation outputs to establish a conventional reference antenna tracking loop; and (b) processing the reference and slave I and Q correlation outputs (using differential carrier doppler phase or code phase measurements) to determine phase differences from which pointing can be computed.

Exmp. Claim 1

Ex Claim text A GPS pointing and attitude measurement system using a single GPS receiver and multiple antennas to derive pointing and attitude measurement using a selected PRN code recovered from GPS navigation signals, wherein azimuth and elevation are determined in pointing application and roll, pitch, and yaw are determined in attitude application, comprising: a reference and at least one slave antenna mounted to a foundation, such that the separation is significantly less than the correlation interval for the selected PRN code; reference and, for each slave antenna, slave precorrelation electronics for providing respective digital representations of the GPS signals received by said reference and slave antennas; at least one replica carrier generator for generating a replica of the GPS carrier signal; at least one replica code generator for generating a replica of the selected GPS PRN code signal; reference correlation electronics, including a carrier mixer and a selected number of code correlators, responsive to the reference GPS signal, and to replica carrier and replica code signals, for generating reference I and Q correlation outputs; for each slave antenna, slave correlation electronics including a carrier mixer and at least one code correlator responsive to the slave GPS signals, and to replica carrier and replica code signals, for generating slave I and Q correlation outputs; and a GPS processor responsive to the reference I and Q correlation outputs for tracking with the reference antenna, and responsive to the reference and slave I and Q correlation outputs for computing pointing and attitude measurements.

U.S. Class 342/357

IPC H04B 7/185 G01S 5/02

Other Refs Proposal to Design, Fabricate, Test, and Deliver a Navstar Global Positioning System Azimuth Determining System, Texas Instruments Incorporated, Feb. 10, 1989.  
 Bossler and Goad, "Using the Global Positioning System (GPS) for Geodetic Positioning", Bulletin Geodesique, pp. 553-563, 1980.  
 Fell, "Geodetic Positioning Using a Global Positioning System of Satellites", Reports of the Department of Geodetic Science, Report No. 299, Ref. No. DMA PE63701B/3201/240, The Ohio State University Research Foundation, Ohio, Jun. 1980.  
 Remondi, "Using the Global Positioning System (GPS) Phase Observable for Relative Geodesy: Modeling, Processing and Results", Center for Space Research, The University of Texas at Austin, May, 1984.  
 Ashkenazi, Agrotis and Yau, "GPS Interferometric Phase Algorithms", Proceedings of the First International Symposium on Precise Positioning with the Global Positioning System--Positioning with GPS, 1985, vol. 1, pp. 299-313, Apr. 15-19, 1985, Rockville, Md.  
 Henson, Collier and Schneider, "Geodetic Applications of the Texas Instruments TI 4100 GPS Navigator", Proceedings of the First International Symposium on Precise Positioning with the Global Positioning System--vol. 1, pp. 191-200, Apr.

15-19, 1985, Rockville, Md.

Remondi, "Performing Centimeter`Level Survey Results in Seconds with GPS Carrier Phase: Initial Results", Proceedings of the Fourth Geodetic Symposium on Satellite Positioning, vol. 2, pp. 1229-1250, Apr. 28-May 2, 1986, Austin, Texas.

Rath, "Attitude Estimation Using GPS", Texas Instruments Incorporated, paper presented at the National Technical Meeting of the Institute of Navigation, San Mateo, California, Jan. 26, 1989.

Brown, "A GPS Receiver with Built-In Precision Pointing Capability", Texas Instruments Incorporated, paper presented at the IEEE Position Location and Navigation Symposium (Plans '90), Las Vegas, Nevada, Mar. 20, 1990.

Examiner Blum, Theodore M.  
Agent Grossman, Rene E.  
Donaldson, Richard L.

Image Disc # This patent is on PatentImages disc# 1993\012

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Universal dynamic navigation, surveillance, emergency location, and collision avoidance system and method

Patent Number 5153836  
Issue Date 1992 10 06  
Appl. Data 571514 1990 08 22  
Assignee Fraughton, Edward J.  
Inventor(s) Fraughton, Edward J.  
Berger, Philip H.  
State/Country UT

Title Universal dynamic navigation, surveillance, emergency location, and collision avoidance system and method

Abstract A craft tracking and collision avoidance system is disclosed. The system allows the positions of a plurality of craft, either on land, sea, or air, or space, to be monitored. Each craft determines its own position using an existing position determining system such as LORAN or GPS. Each craft then transmits a radio frequency signal into which position information, preferably identifying information, and other messages, have been encoded. Each craft broadcasts its position, identifying information and other messages on a regular basis without the need for any interrogation signal. The broadcast position and identification information can be received by other craft and, since each craft has determined its own position, can be used to determine the proximity and identity of other craft, and if the craft are on a collision course. Preferably, the position of all the craft within a predetermined range of a craft is represented on a display in order to give the craft operator a visual indication of traffic surrounding his craft.

U.S. Class 364/461 340/961 342/30 342/41 342/455 364/452  
IPC G06F 15/50 G01S 3/02  
U.S. Refs 3750166 4197538 4704735 4814711 4835537 4884208  
5043903

Examiner Chin, Gary  
 Agent Workman, Nydegger & Jensen  
 Images Disc # This patent is on PatentImages disc# 1992\086

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Patent Number 5296854  
 Issue Date 1994 03 22  
 Appl. Data 960567 1992 10 13  
 Assignee United Technologies Corporation  
 Inventor(s) Hamilton, Bruce E.  
 Stiles, Lorren  
 Harper, Howard P.  
 State/Country CT

Title Helicopter virtual image display system incorporating structural outlines

Abstract A virtual image display system provides video displays based upon virtual images of the external world having synchronized structural outlines superimposed on the video displays to a pilot operating an aircraft such as a helicopter in non-visual flight conditions. The virtual image display system includes a virtual imaging subsystem for generating virtual images of the external world, a video display subsystem for generating video images based upon the virtual images and for displaying the video images for the pilot's viewing, a sensing means for providing signals corresponding to the spatial location and perspective of the video display subsystem, a map comprising structural outlines corresponding to structural members forming the canopy structure of the helicopter, and a computer subsystem providing electronic interfacing between the elements of the virtual image display system, for synchronizing the orientation of the virtual imaging subsystem with the video display subsystem, and for processing the virtual image signals to provide signals to the video display subsystem to generate video displays. The computer utilizes the helmet position signals to define the relative position and orientation of the video display subsystem in the cockpit, and utilizes such definition to reconstruct structural outlines from the map that are synchronized to the perspective of the video images. The synchronized structural images are superimposed upon the video display.

Exmp. Claim 1

Ex Claim text A virtual image display system for use by a pilot in an aircraft having a canopy structure of predetermined configuration, comprising:  
 virtual imaging means for generating virtual images of the external world;  
 video display means for generating and displaying video images based upon said virtual images of the external world for viewing by the pilot.  
 sensing means disposed in interactive relation with said video display means for generating position signals corresponding to the spatial location and perspective of said video display means;  
 map means for storing structural outlines corresponding to the predetermined configuration of the canopy structure; and  
 computer processing means for defining the spatial location

and perspective of said video display means based upon said position signals generated by said sensing means; said computer processing means being further operative for reconstructing structural outlines of segments of the canopy structure from said stored structural outlines of said map means, said reconstructed structural outline segments being based upon and synchronized with said defined spatial location and perspective of said video display means; said computer processing means being further operative to superimpose said reconstructed structural outline segments onto said displayed video images to provide the pilot with a high-definition pictorial representation of the external world wherein said superimposed, reconstructed structural outline segments occlude corresponding segments of said displayed video images such that said superimposed, reconstructed structural outline segments provide the pilot with a referential framework during viewing of said occluded displayed video images.

U.S. Class 340/980 340/973 345/9  
 IPC G01C 21/00  
 U.S. Refs 4028725 4961626 5072218

Foreign Refs EPX 198902 0330147  
 EPX 198902 0330184  
 GBX 197810 1527049

Related Data The present application is a continuation of U.S. patent application Ser. No. 07/689,405, filed Apr. 22, 1991, abandoned. The present application is related to U.S. Pat. No. 5,072,218 entitled CONTACT-ANALOG HEADUP DISPLAY METHOD AND APPARATUS, and U.S. patent application Ser. No. 07/160,059, filed Feb. 24, 1988, entitled AIRCRAFT HELMET POINTING ANGLE DISPLAY, now abandoned.

Examiner Swarthout, Brent  
 Agent Radke, Terrance J.  
 Image Disc # This patent is on PatentImages disc# 1994\028

Heads-up display (HUD) incorporating cathode-ray tube

Patent Number 5302964  
 Issue Year 94  
 Assignee Hughes Aircraft Co.  
 Assignee Code 260265  
 State / Country CA  
 Classification 345/7 345/14 345/16  
 Title Heads-up display (HUD) incorporating cathode-ray tube image generator with digital look-up table for distortion correction  
 Abstract A heads-up display (50) for an aircraft includes a digital image generator (52), a cathode ray tube (CRT) (54) and an optical system (56) which projects an image (58) formed on the CRT screen (54a) indicating the status of the aircraft operation onto a holographic mirror combiner (60) at a slant angle. The combiner (60) is transparent to the pilot's direct view through the aircraft windshield, but produces a reflected image of the CRT screen (54a) which is

superimposed on the direct view. Pincushion distortion in the CRT (54) and geometric distortion caused by the slant projection angle are corrected by a digital look-up table memory (82, 84) which alters the initially orthogonal CRT horizontal and vertical deflection signals ( $V_h, V_v$ ) in a manner which is the inverse of the distortion such that the image (58) on the combiner (60) as viewed by the pilot appears undistorted. The size of the look-up table memory (82, 84) is greatly reduced by making approximations based on analysis of the mathematical functions which define the distortion.

Digital map generator and display system; 2D

Patent Number 5140532  
 Issue Date 1992 08 18  
 Appl. Data 242125 1988 09 09  
 Assignee Harris Corporation  
 Inventor(s) Beckwith, Jr., Paul B.  
 Bascle, Kent P.  
 Chan, Luen C.  
 Basta, Wayne E.  
 State/Country FL

Title Digital map generator and display system

Abstract A digital information storage and read-out system in which digital elevation and cultural terrain data is read from a magnetic tape in compressed form into an intermediate memory which operates as a speed buffer memory. The data in the intermediate memory is read out to a reconstruction processor in which the compressed data is reconstructed and applied to a scene memory. A navigation computer determines the instantaneous position of a vehicle with respect to the terrain and controls the reading of data into the scene memory in blocks with the vehicle position occupying a center of scene location. In order to provide a heading up display of the terrain, the data in the scene memory is read out at an angle to its north-up storage orientation and interlaced scanning of pixel data in the scene memory improves resolution and enhances line display. The data read out of the scene memory controls the generation of video control signals to effect a display of the elevation and cultural data as a moving map related to the vehicle position.

U.S. Class 395/101 340/747 340/971 382/56  
 IPC G06F 15/66  
 U.S. Refs 4152766 4295135 4489389 4520506 4539704 4583185  
 4660157 4734690 4751660 4801207 4833721

Related Data This is a divisional of application Ser. No. 168,437, filed Mar. 15, 1988, which is a divisional of application Ser. No. 641,179, filed Aug. 15, 1984, now abandoned, which is a continuation of application Ser. No. 224,242, filed Jan. 13, 1981, now abandoned.

Examiner Harkcom, Gary V.

Agent Evenson, Wands, Edwards, Lenahan & McKeown  
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Digital map generator and display system

Patent Number 4970682  
 Issue Date 1990 11 13  
 Appl. Data 168437 1988 03 15  
 Assignee Harris Corporation  
 Inventor(s) Beckwith, Jr., Paul B.  
 Bascle, Kent P.  
 Chan, Luen C.  
 Basta, Wayne E.  
 State/Country FL

Title Digital map generator and display system

Abstract A digital information storage and read-out system in which digital elevation and cultural terrain data is read from a magnetic tape in compressed form into an intermediate memory which operates as a speed buffer memory. The data in the intermediate memory is read out to a reconstruction processor in which the compressed data is reconstructed and applied to a scene memory. A navigation computer determines the instantaneous position of a vehicle with respect to the terrain and controls the reading of data into the scene memory in blocks with the vehicle position occupying a center of scene location. In order to provide a heading up display of the terrain, the data in the scene memory is read out at an angle to its north-up storage orientation and interlaced scanning of pixel data in the scene memory improves resolution and enhances line display. The data read out of the scene memory controls the generation of video control signals to effect a display of the elevation and cultural data as a moving map related to the vehicle position.

U.S. Class 395/425 340/727 340/728 340/747 342/176 342/179  
 364/DIG2 364/920.7 364/922.8 364/923.4 364/925  
 364/925.1 364/927.2 364/927.4 395/100 434/2  
 IPC G09B 9/00 G09G 1/16 G06F 3/153 H04N 7/18  
 U.S. Refs 4489389 4520506 4660157 4702698 4729127

Related Data This is a continuation of application Ser. No. 641,179 filed Aug. 15, 1984, now abandoned, which is a continuation of application Ser. No. 224,742 filed Jan. 13, 1981, now abandoned.

Examiner Tarcza, Thomas H.  
 Agent Antonelli, Terry, Stout & Kraus

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Patent Number 4939663  
 Issue Date 1990 07 03  
 Appl. Data 177325 1988 04 04  
 Assignee Harris Corporation  
 Inventor(s) Baird, Charles A.  
 State/Country FL

Title Elevation map-referenced mechanism for updating vehicle

navigation system estimates

Abstract

A drift correction mechanism for a vehicle (e.g. aircraft) navigation system makes use of a digital map data base, in order to correct for errors in position estimates, so that the estimated flight path of the aircraft will more closely track its actual flight path, and thereby effectively compensate for the long term error to which the navigation system is subjected. During the flight, altimeter readings are periodically carried out in order to generate elevation values that are representative of the actual elevation of the terrain over which the aircraft is flying. These elevation values are then used as inputs to a digital map database, from which elevation profile contour lines of respective elevation values may be derived. At the time that a respective altimeter reading is effected, the position estimate output of the aircraft's navigation system is also sampled. This position estimate is then compared with the contour line that passes through the actual position of the aircraft at the time the altimeter measurement is made. The separation between the navigation system's position estimate and that geographical position on the contour line which is closest to the position estimate is then used as a correction factor to update the position estimate to a set of corrected geographical coordinates that more closely approximate the coordinates of the actual flight path of the aircraft.

U.S. Class 364/449 342/64 364/443 364/457  
 IPC G06F 15/50  
 U.S. Refs 4144571 4179693 4495580 4514733 4520445 4584646

Examiner Chin, Gary  
 Agent Antonelli, Terry & Wands

Patent Number 4829304  
 Issue Date 1989 05 09  
 Appl. Data 864843 1986 05 20  
 Assignee Harris Corp.  
 Inventor(s) Baird, Charles A.  
 State/Country FL

Title Map-aided navigation system employing TERCOM-SITAN signal processing

Abstract

A navigation system contains a modified Kalman filter processor which continuously receives both TERCOM and SITAN control information so that the operation of the SITAN processing is effectively continuously optimized. The system employs an over flight terrain data storage map to which position and altitude signals are coupled for extracting both elevation and slope information from the stored map. The extracted elevation and slope data are coupled, together with the outputs of barometric and radar altimeter sensors and estimated altitude and position data outputs from the navigation unit, to a correlation/modified Kalman filter processor. Elevation profile data accessed from the map is correlated with elevation profile signals derived from aircraft on-board sensors, in order to find that flight path

on the stored map, parallel to, but displaced from the flight path indicated by the navigation unit, for which successive elevation data values correspond most closely to the elevations measured by the altimeter sensors. In this correlation processing operation the "most likely" path is selected by defining a performance index associated with each path and selecting that path with the best performance index. The result of the correlation processing provides a position fix to be combined with the position estimates in the modified Kalman filter.

U.S. Class 342/63 364/449  
IPC G06F 15/50  
U.S. Refs 4144571 4584646

Other Refs L. D. Hostetter et al.; "Nonlinear Kalman Filtering Techniques for Terrain-Aided Navigation"; IEEE Trans on Automatic Control; vol. AC-28 Mar. 83.  
"Continuous Kalman Updating . . . "; R. D. Andreas et al.; Sandia National Laboratories, pp. 1263-1270, IEEE 1978.  
"An Alternative Approach for Terrain Aided . . . "; T. C. Sheives et al.; Sandia National Laboratories, New Mexico, Dec. 1979.  
"Application of Multiple Model Estimation . . . "; W. Tang et al.; pp. 757-764; IEEE; 1981.

Examiner Tarcza, Thomas H.  
Agent Antonelli, Terry & Wands

Patent Number 4682160  
Issue Date 1987 07 21  
Appl. Data 517037 1983 07 25

Assignee Harris Corporation  
Inventor(s) Beckwith, Jr., Paul B.  
Bistarkey, Donald S.  
State/Country FL

Title Real time perspective display employing digital map generator

Abstract A system for generating a real time perspective view of the terrain lying along an aircraft's flight path accesses terrain data stored in a digital map generator and converts the data into a perspective representation of the terrain on the face of a suitable display such as a cockpit instrument panel CRT. The stored map data that is accessed provides, in real time, information pertaining to elevation features of the terrain over which the aircraft is flying, so that upon conversion to a perspective presentation to the pilot, there is provided a real time perspective image of the contours of the terrain as though the pilot were looking out a windscreen at the terrain in high visibility conditions. The invention also is capable of providing perspective scene rotation and translation (corresponding to roll and pitch of the aircraft).

U.S. Class 340/729 340/727 340/728 340/747 340/750  
IPC G09G 1/16

U.S. Refs 2921124 3454822 4442495

Foreign Refs WOX 197910 WO79/00830  
 GBX 197808 1520452  
 GBX 198105 2061074  
 GBX 198212 2100098

Other Refs Rural Scene Perspective Transformations, Devich SPIE vol.  
 303 Visual Simulation & Image Realism II pp. 54-66.  
 Display Technology for Digital Map Information, Moon.  
 The Perspective Representation of Functions of Two Variables  
 Kubert et al; JACM Apr. 1968; Reprinted in Interactive  
 Computer Graphics, IEEE Cat. No. EH0156-0 pp. 272-283.

Examiner Curtis, Marshall M.  
 Agent Antonelli, Terry & Wands

Patent Number 4660157  
 Issue Date 1987 04 21  
 Appl. Data 670933 1984 11 13  
 Assignee Harris Corporation  
 Inventor(s) Beckwith, Paul B.  
 Bascle, Kent P.  
 Pearce, Jeffrey B.

State/Country FL

Title Real time video perspective digital map display method

Abstract A digital system for producing a real-time visual display in  
 perspective of the terrain over which an aircraft is passing  
 on the basis of compressed digital data stored on a cassette  
 tape includes a perspective processor for transforming the  
 addresses of points in a two-dimensional data pattern to the  
 addresses these points occupy in a three-dimensional scene  
 and for a filing in points between the transformed points to  
 provide a complete display of the terrain in perspective.

U.S. Class 395/121 358/103 364/731 395/126 395/127 395/166  
 IPC G06F 3/153 G06F 15/66 H04N 7/18  
 U.S. Refs 3418459 3602702 3899662 4071895 4152766 4240108  
 4340878 4360876 4384338 4489389

Other Refs Devich et al: Rural Scene perspective transformations, SPIE,  
 vol. 303, Visual Simulation and Image Realism II, 1981, pp.  
 54-66.

Related Data The present application is a continuation of U.S. patent  
 application Ser. No. 308,166 filed Oct. 2, 1981, entitled  
 "Perspective Digital Map Video Display System", now U.S.  
 Pat. No. 4,489,389 issued Dec. 18, 1984.

Examiner Gruber, Felix D.  
 Agent Antonelli, Terry & Wands

Patent Number 4489389  
 Issue Date 1984 12 18  
 Appl. Data 308166 1981 10 02  
 Assignee Harris Corporation  
 Inventor(s) Beckwith, Paul B.

Bascle, Kent P.  
Pearce, Jeffrey B.

State/Country FL

Title Real time video perspective digital map display

Abstract A digital system for producing a real-time visual display in perspective of the terrain over which an aircraft is passing on the basis of compressed digital data stored on a cassette tape includes a perspective processor for transforming the addresses of points in a two-dimensional data pattern to the addresses these points occupy in a three-dimensional scene and for filling in points between the transformed points to provide a complete display of the terrain in perspective.

U.S. Class 395/121 340/728 340/729 340/988 340/995 358/103  
364/731 382/1 395/126 395/127 395/166  
IPC G06F 3/153 H04N 7/18  
U.S. Refs 3418459 3602702 3899662 4071895 4086632 4138726  
4152766 4181956 4240108 4340878 4360876 4384338

Examiner Gruber, Felix D.  
Agent Antonelli, Terry & Wands

Patent Number 5179638  
Issue Date 1993 01 12  
Appl. Data 514598 1990 04 26  
Assignee Honeywell Inc.  
Inventor(s) Dawson, John F.  
Snodgrass, Thomas D.  
Cousens, James A.

State/Country NM

Title Method and apparatus for generating a texture mapped perspective view

Abstract A method and apparatus for providing a texture mapped perspective view for digital map systems. The system includes apparatus for storing elevation data, apparatus for storing texture data, apparatus for scanning a projected view volume from the elevation data storing apparatus, apparatus for processing, apparatus for generating a plurality of planar polygons and apparatus for rendering images. The processing apparatus further includes apparatus for receiving the scanned projected view volume from the scanning apparatus, transforming the scanned projected view volume from object space to screen space, and computing surface normals at each vertex of each polygon so as to modulate texture space pixel intensity. The generating apparatus generates the plurality of planar polygons from the transformed vertices and supplies them to the rendering apparatus which then shades each of the planar polygons. In one alternate embodiment of the invention, the polygons are shaded by apparatus of the rendering apparatus assigning one color across the surface of each polygon. In yet another alternate embodiment of the invention, the rendering apparatus interpolates the intensities between the vertices of each polygon in a linear fashion as in Gouraud shading.

Exmp. Claim 1

Ex Claim text A system for providing a texture mapped perspective view for a digital map system wherein objects are transformed from texture space having U, V coordinates to screen space having X, Y coordinates comprising:

- (a) a cache memory means for storing terrain data including elevation posts, wherein the cache memory means includes an output and an address bus;
- (b) a shape address generator means for scanning cache memory having an ADDRESS SIGNAL coupled to the cache memory means address bus wherein the shape address generator means scans the elevation posts out of the cache memory means;
- (c) a geometry engine coupled to the cache memory means output to receive the elevation posts scanned from the cache memory by the shape address generator means, the geometry engine including means for
  - i. transformation of the scanned elevation posts from object space to screen space so as to generate transformed vertices in screen coordinates for each elevation post, and
  - ii. generating three dimensional coordinates;
- (d) a tiling engine coupled to the geometry engine for generating planar polygons from the generated three dimensional coordinates;
- (e) a symbol generator to the geometry engine for transmitting a vertex list to the geometry engine wherein the geometry engine operates on the vertex list to transform the vertex list into screen space X, Y coordinates and passes the screen space X, Y coordinates to the tiling engine for generating planar polygons which form icons for display and processing information from the tiling engine into symbols,
- (f) a texture engine means coupled to receive the ADDRESS SIGNAL from the shape address generator means including a texture memory and including a means for generating a texture vertex address to texture space correlated to an elevation post address and further including a means for generating a texture memory address for scanning the texture memory wherein the texture memory provides texture data on a texture memory data bus in response to being scanned by the texture memory address;
- (g) a rendering engine having an input coupled to the tiling engine and the texture memory data bus for generating image data from the planar polygons; and
- (h) a display memory for receiving image data from the rendering engine output wherein the display memory includes at least four first-in, first-out memory buffers.

U.S. Class	395/125	395/127	395/130			
IPC	G06F	15/62				
U.S. Refs	4677576	4876651	4884220	4899293	4940972	4985854
	5020014					

Examiner	Harkcom, Gary V.
Agent	Champion, Ronald E. Leone, Sr., George A.

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