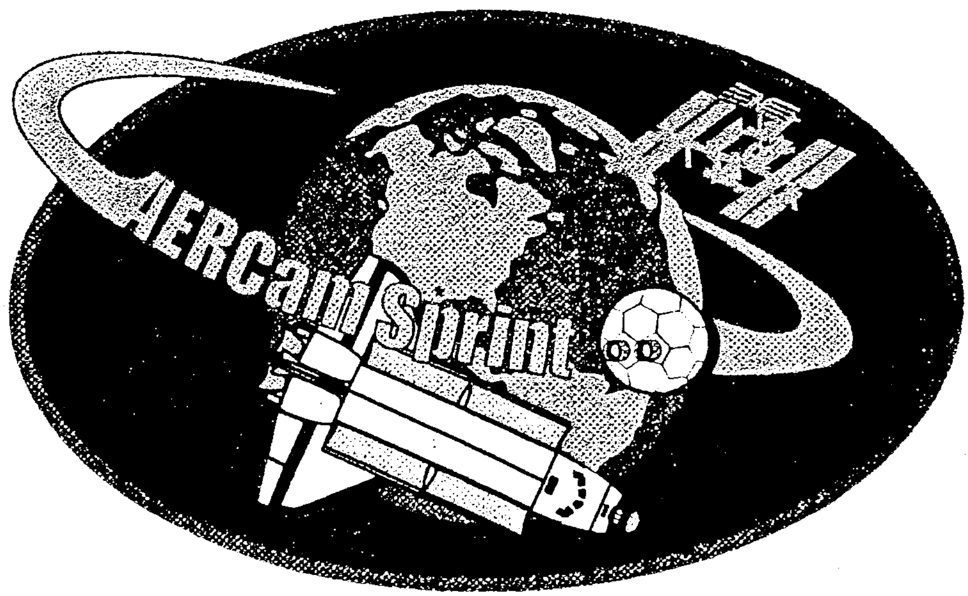
1996 Annual Report

Automation, Robotics, & Simulation Division



National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, TX

03868

Portable Diagnostic Terminal Software for the X-38

Francisco J. Delgado

The Portable Diagnostic Terminal (PDT) is an IBM Thinkpad that can be carried about and connected to the onboard X-38 flight computer via an ethernet TCP/IP connection. The PDT serves as the interface to all X-38 subsystems. On the ground before the vehicle is launched the PDT provides the capability to checkout the health and status of the vehicle subsystems and perform software loads. While docked with the Space Station the PDT will be used to conduct routine subsystem health monitoring and to perform software loads. When the X-38 lands, the PDT will be used to download data from the flight recorder and perform immediate vehicle checkout. During test phases the PDT will be used to perform initialization loads for the flight computer, flight performance data monitoring, system activation, and vehicle test and checkout.

The PDT will be used to upload/download: flight software, flight software initialization data files (I-loads), and recorded flight data. It will also perform flight system sequence execution and monitoring for system activation sequences, system deactivation sequences, and test sequences. Further more it will also provide flight test operator support of the test vehicle for ground flight data display and recording, system commanding, and vehicle release go/no-go decision support.

During 1996, requirements were collected from all the different subsystems. These requirements were used to create the different subsystem displays, produce a PDT requirements document, and produce a PDT testing/operational procedures document. The PDT software written has been used to support a wide assortment of tests conducted, some of which include: two KC-135 X-38 test flight experiments, an early Electro-Mechanical Actuator testbed experiment, INS/GPS testbed experiments, and early 131 X-38 test vehicle integration. All the PDT software created was written under the LabView 3.1 environment. Figure 1.0 depicts the object oriented approached selected for the PDT software architecture. Along with the individual subsystem displays, a summary screen has been developed that gives the user a summarized description of the health and launch commit criteria status for all the different subsystems. Subsystems monitoring and commanding displays have been developed for: Parachute and Pyrotechnics, INS/GPS, Communication & Tracking, Flight Safety, Power and Distribution, Flush Air Data System, and Fire Suppression. Along with these subsystems, additional displays have been built to accommodate for unit testing of different hardware components, test boxes, and PDT to flight computer remote commanding.

Future plans are to continue development of the PDT software. This continued development includes: adding any additional subsystem displays necessary, adding PDT resident FDIR software, and modifying the current displays on an as needed basis.

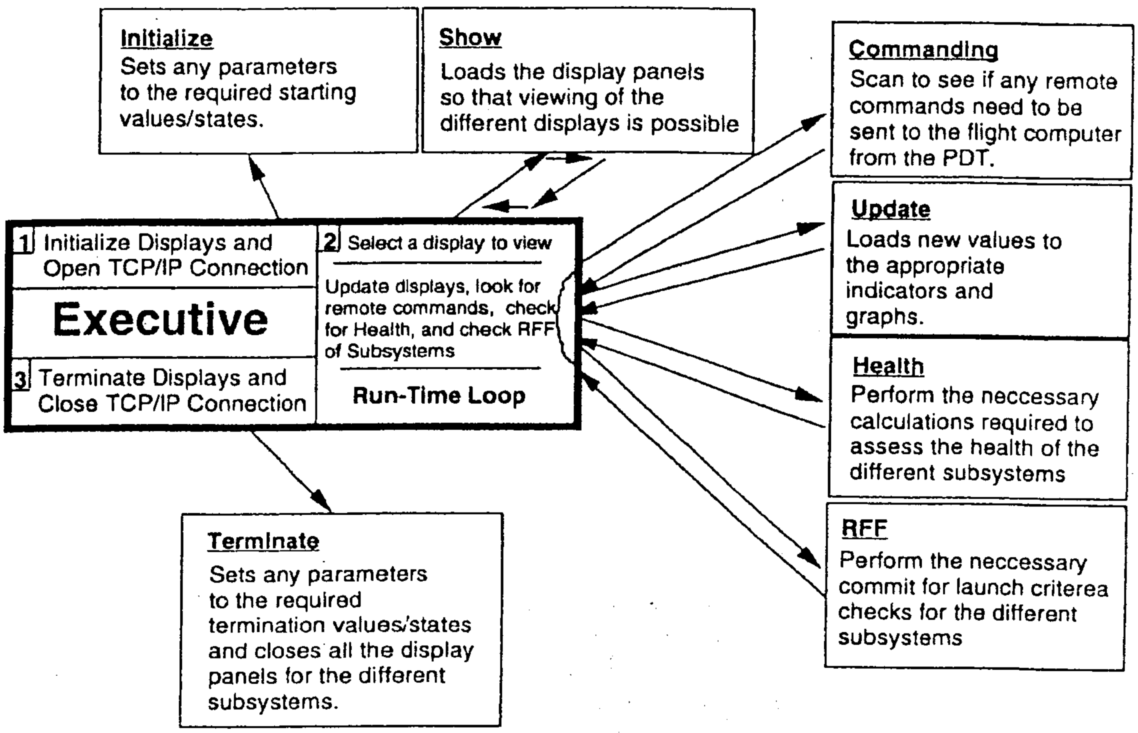


Figure 1.0: This figure illustrates the object oriented approach selected as the software architecture for the PDT. Each subsystem display, 18 in all to this point, has seven different methods associated with it. These methods are: Initialize, Show, Update, Commanding, RFF, Health, and Terminate. The executive calls each method of each display in the sequential order depicted above.

Advanced Algorithms for the X-38 Flush Air Data System

Francisco J. Delgado

Increasingly, flight systems designs for advanced aerospace vehicles are requiring the availability of accurate and high-fidelity air data; such as, angle of attack (alpha) and side slip angle (beta), see figure 1.0. As a means of circumventing many difficulties associated with conventional air data system, a flush air data sensing system (FADS) concept was originated at NASA Langley Research Center and flight tested at the NASA Dryden Flight Research Facility (DFRF). This FADS has been chosen for use on the X-38 vehicle to calculate the air data parameters used during flight.

The X-38 FADS system is depicted in figure 2.0. It consists of a total of nine pressure sensors arranged in a crucifix fashion on the nose-cone of the vehicle. The current software that calculates the required air data parameters uses an analytical algorithm, referred to a TRIPLES. TRIPLES takes every possible subset of three pressure sensors on the vertical axis and using non-linear regression algorithms calculates alpha for the vehicle. It then takes alpha and every possible combination of three pressure sensor readings on the horizontal axis and using more non-linear regression techniques, calculates beta. The current X-38 flight computer is a Motorola 68040 running on a 40 milli-second clock cycle. The FADS system is part of the data conversion/FDIR (SOP) which is allocated 3.5 ms. Of this 3.5 ms, the FADS system can use 2.0 ms to perform any required calculations. TRIPLES is currently taking about 11 ms to perform the required calculation, which is too slow. The FADS system does not include any FDIR to detect if any of the pressure sensors have failed.

Different neural network, fuzzy logic, signal processing, and statistical techniques are being investigated in an attempt to create and implement a fast, efficient, and accurate pattern recognition and function approximation system for the X-38 FADS. Wind tunnel data collected from a Texas A&M wind tunnel experiment for an X-38 model, in conjunction with abductive information modeling techniques have been used to develop polynomial functions which can quickly and effectively calculate alpha and beta given the nine pressure readings from the FADS pressure sensors. The abductive information modeling technology being investigated creates polynomial approximators in a supervised fashion, given a set of inputs and desired outputs it creates polynomials that map the inputs to the outputs. The wind tunnel data was randomly split into a training set, using 70% of the data, and a test set, using the remaining 30% of the data. Polynomials were created that can predict alpha and beta to within ± 1/2 degree. The polynomials created to calculate alpha and beta are simple, see figure 3.0. The polynomial used to calculate alpha takes approximately 6 micro-seconds to run, while the polynomial that calculates beta takes approximately 8 micro-seconds to run. Some redundancy management is being investigated to assure that the results obtained are a function of pressure sensors which have not failed. Figure 4.0 illustrates the total error associated with the polynomial functions created to predict alpha and beta. The error achieved is within ± 1/2 degree accuracy and performs all the required calculations well within the required 2 ms of CPU time.

Work is in progress to automatically detect and exclude any failed pressure sensor in any air data calculation, reducing the error from 1/2 to 1/3 degree accuracy, and providing greater redundancy in the alpha and beta calculations. Everything is proceeding on schedule and all indications are that a fast, accurate, and robust computer algorithm can be developed for the X-38 FADS using the advanced technologies being investigated.

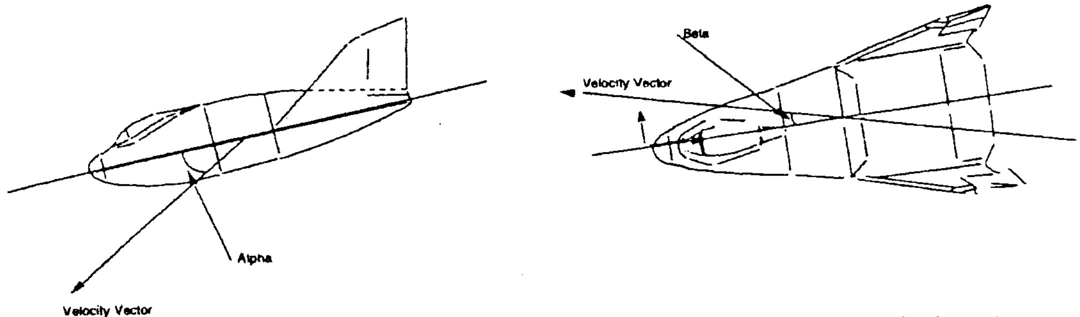
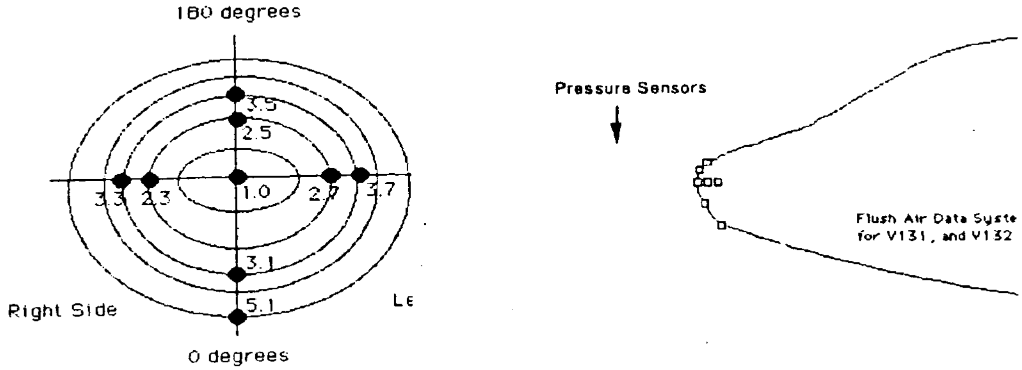


Figure 1.0: Depiction of the angle of attack (alpha), and the side slip angle (beta)



FADS nose ports looking aft

FADS ports looking at a side snapshot

Figure 2.0

$$\alpha = -113.66190943945461\,63 - 0.10619649978475709\,83 \cdot (port_{1,0}) + 0.23227296933655348\,70 \cdot (port_{2,1}) + 0.52033467222134310\,26 \cdot (port_{2,[illegible]}) - 0.69355405848193474\,75 \cdot (port_{2,[illegible]}) - 0.06176579284750127\,28 \cdot (port_{3,1}) - 0.31728533057476042\,64 \cdot (port_{3,3}) - 0.37921397684197324\,14 \cdot (port_{4,[illegible]}) + 0.40676968170923367\,48 \cdot (port_{4,[illegible]}) + 0.45740063887770753\,69 \cdot (port_{4,[illegible]})$$

$$\beta = 13484.87438897148928 + 62.102661399903339560000\,00 \cdot (port_{2,3}) - 0.028990601479148646980000 \cdot (port_{2,3})^2 + 0.0000045385231736699341\,63 \cdot (port_{2,3})^3 - 81.805957754415936630000\,00 \cdot (port_{[illegible]}) + 0.038592090250964505440000 \cdot (port_{[illegible]})^2 - 0.0000060988046636833319\,46 \cdot (port_{[illegible]})^3$$

Figure 3.0: Simple polynomials created to predict alpha and beta, using the 9 pressure port sensor readings

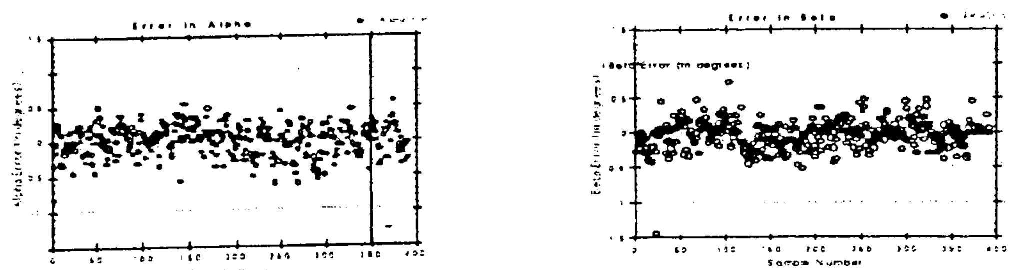


Figure 4.0: Absolute error (in degrees) for the polynomials used to predict alpha and beta.

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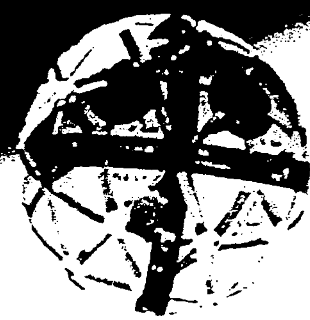

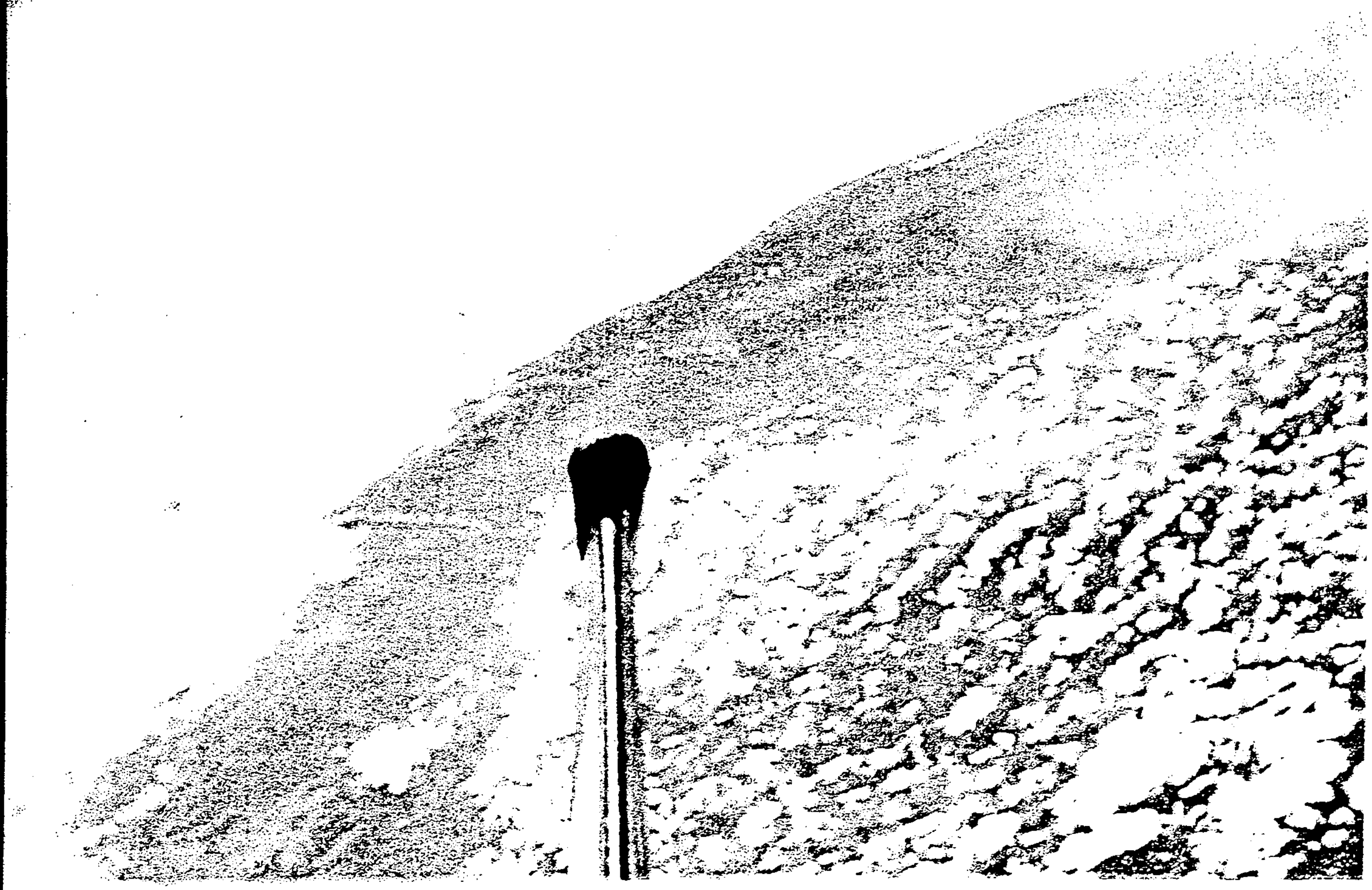

Automation, Robotics, & Simulation Division

03873

Accurate Determination of Flight Control Air Data Parameters Using Artificial Neural Networks and the X-38 Flush Air Data System

Frank Delgado

The X-38 program is developing a series of prototype flight test vehicles leading to a functional Crew Return Vehicle (CRV). The development of these prototype vehicles will demonstrate which technologies are needed to build an inexpensive, safe, and reliable spacecraft that can rapidly return astronauts from onboard the International Space Station (ISS) to Earth. These vehicles are being built using an incremental approach and where appropriate, are taking advantage of advanced technologies that may help improve safety, decrease development costs, reduce development time, and outperform traditional technologies. The operational CRV will be fully automated and require very little crew interaction during its return trip to Earth.

A Flush Airdata System (FADS), originally developed at the NASA Langley Research Center and flight tested at the NASA Dryden Flight Research Facility (DFRF), is being used on the X-38 program to provide airdata parameters required for an automated flight control system. The X-38 FADS uses a matrix of 9 pressure ports arranged in a crucifix pattern around the nose of the vehicle, figure 1.0. The differences between the pressure values at the different port locations can be used to determine: the angle of attack (α), angle-of-sideslip (β), Mach number (M), and free stream static pressure (P_{inf}), figure 2.0. The determination of other airdata parameters can be computed from these parameters using standard aerodynamic equations. The software used at the DFRF with this FADS is called TRIPLES. The slow execution of the TRIPLES software on the X-38 flight computer, a Motarola 68040 running in a 40 ms clock cycle, raised concerns and initiated an investigation into the use of Neural Network (NN) technology as a possible replacement for TRIPLES.

Wind tunnel data collected at different α, β, M, and P_{inf} for a 5.2-percent scaled version of the X-38 vehicle was used to create different Neural Networks that can quickly and accurately determine the required flight control airdata parameters, given the 9 pressure port readings on the nose of the vehicle. The NN paradigm selected is called abductive information modeling and is implemented in a software package called ModelQuest Enterprise, which was developed by Abtech corporation under a NASA phase II Small Business Innovative Research program grant. Additional training and testing data was collected during four X-38 captive carry tests.

The desired accuracy for the different airdata parameters are: +- 0.50° for α and β, +-0.03 for Mach, and +-50 psf for P_{inf}. The parameters must all be calculated within an extremely constrained computing environment. The FADS systems is allocated 2.0 ms of CPU time to perform all its required calculations. The TRIPLES algorithm is currently taking about 4.5 ms to run, while the NN can calculate the same parameters in ~0.90 ms. The NN achieved an average error of less than: +-0.11° for α and β, +-0.006 for M, and +-8.3 psf for P_{inf}, figure 3.0.

Work is in progress to automatically detect and exclude any failed pressure sensor in all air data calculations. The actual FADS system, TRIPLES or NN, that will used during active flight control will be selected early 1998. Everything is proceeding on schedule and the NN system developed so far has exceeded our initial expectations.

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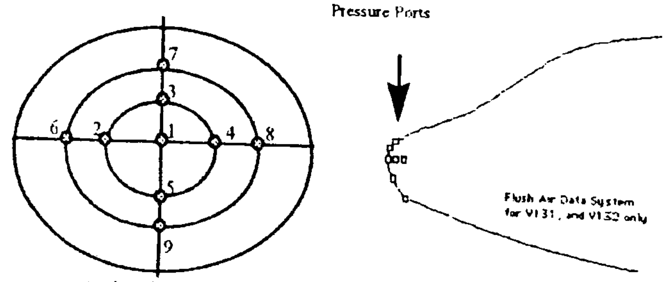
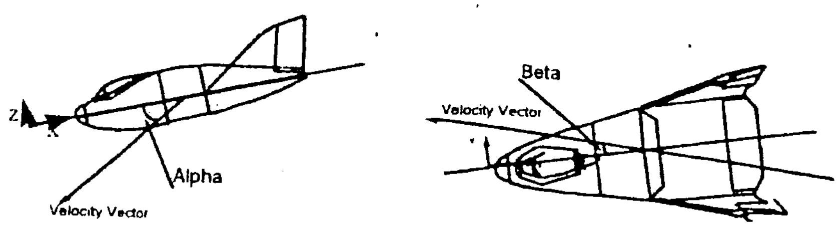


(a) FADS nose ports looking aft toward the nose

(b) FADS ports looking at a side snapshot of the vehicle

Figure 1.0



(a) Alpha is the angle that the XY plane makes with the velocity vector

(b) Beta is the angle that the XZ plane makes with the velocity vector

Figure 2.0

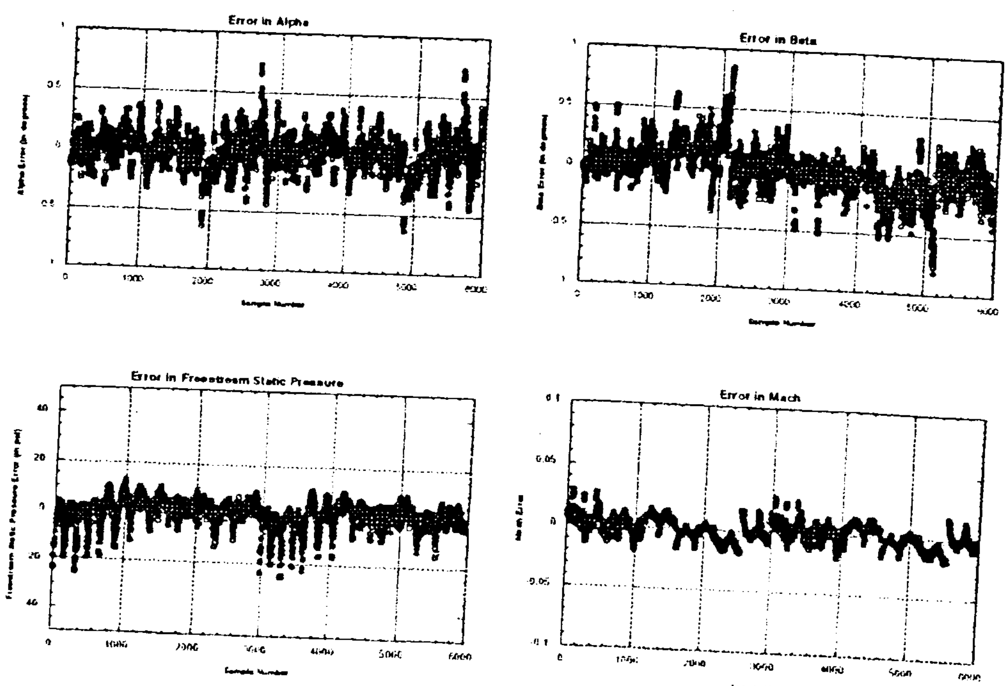


***Figure 3.0**: Error plots for α, β, M, and P_{inf} Using the Lockheed Martin Vought Systems Windtunnel Data*

Portable Diagnostic Terminal Software for the X-38

Frank Delgado

The Portable Diagnostic Terminal (PDT) is an IBM Thinkpad that can be carried about and connected to the onboard X-38 flight computer via an ethernet Transmission Control Protocol/Internet Protocol (TCP/IP) connection. The PDT serves as the interface to all the X-38 subsystems. On the ground before the vehicle is launched the PDT provides the capability to checkout the health and status of the vehicle subsystems and perform software loads. During captive carry tests, when the vehicle is attached to the B52 (figure 1.0), the PDT will be used to conduct routine subsystem health monitoring, and mode the vehicle into a free flight mode. When the X-38 lands, the PDT will be used to download data from the flight recorder, perform immediate vehicle checkout, and begin post flight shutdown procedures. During non-flight tests the PDT will be used to perform initialization loads for the flight computer, flight performance data monitoring, system activation, and vehicle test and checkout.

The PDT will be used to upload/download: flight software, flight software initialization data files (I-loads), and recorded flight data. It will also perform flight system sequence execution and monitoring for system activation sequences, system deactivation sequences, and test sequences. Furthermore, it will provide flight test operator support of the test vehicle for ground flight data display and recording, system commanding, and vehicle release go/no-go decision support.

During 1997, additional requirements, above and beyond those collected in 1996, were collected from different subsystems and incorporated into the PDT testing/operational procedures document. These new requirements were also implemented into the operational PDT code. The PDT was used to support several KC135 flights, and 4 captive carry tests. All the PDT software was written under the LabView 4.0.1 environment. Figure 2.0 depicts the object oriented approached selected for the PDT software architecture. Along with the individual subsystem displays, a summary screen was developed that gives the user a summarized description of the health and launch commit criteria status for all the different subsystems. Subsystems monitoring and commanding display support was provided for: Parachute and Pyrotechnics, Inertial Navigation System/Global Positioning System (INS/GPS), Communication and Tracking, Flight Safety, Power and Distribution, Flush Air Data System, and Fire Suppression. Along with these subsystems, additional displays have been built to accommodate for unit testing of different hardware components, test boxes, and PDT to flight computer remote commanding.

A fully functional PDT has been developed, tested, and delivered to the X-38 program. Routine maintenance of the PDT has been handed over to Avionic Systems Division personnel and the Automation, Robotics, and Simulation Division's only involvement is in a consulting role.

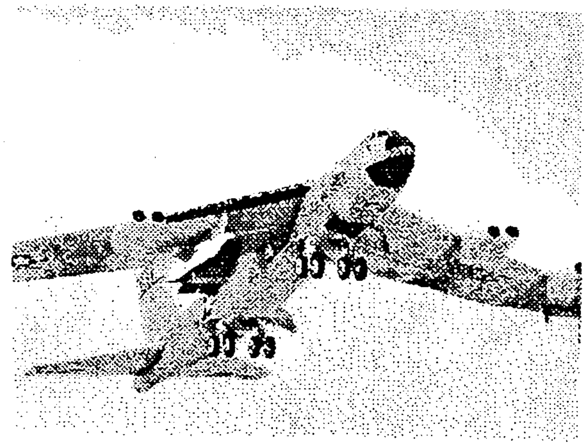


Figure 1.0: Photograph of X-38 during captive carry flight 1. The X38 vehicle is attached to the wing of the B52 and flown around at different altitudes and velocities to collect data. To date four captive carry flights have been performed.

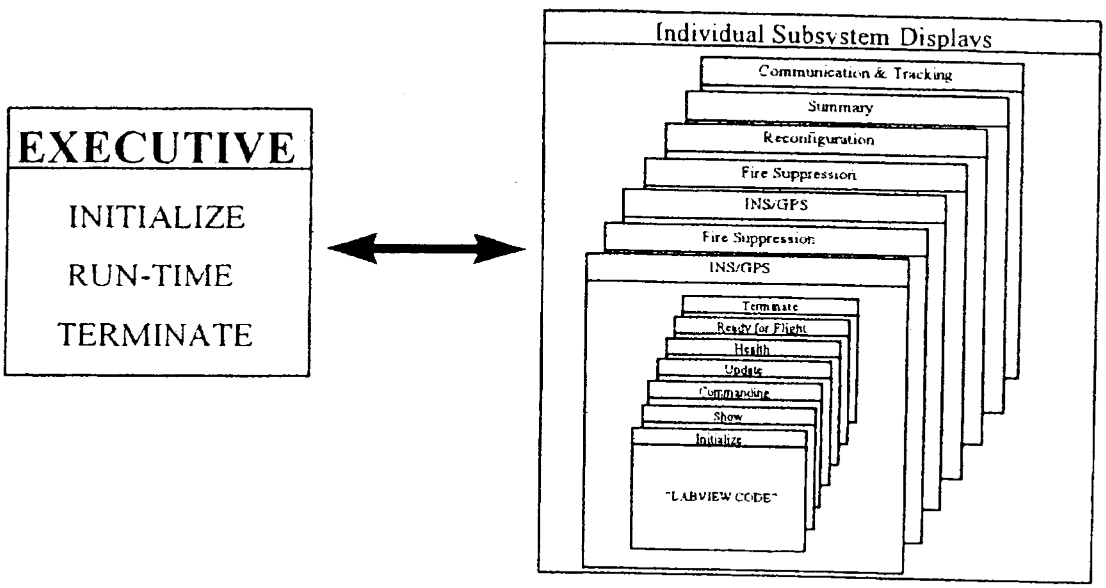


Figure 2.0: This figure illustrates the object oriented approach selected for the PDT software architecture. Each subsystem display has seven different methods associated with it: Initialize, Show, Commanding, Update, Ready for Flight (RFF), Health, and Terminate. The Executive begins by initializing every subsystem display, system level routines, and data warehouses. It then proceeds to the run-time loop, during which it brings in data, calibrates it, and calls the appropriate methods for each of the subsystem displays. The Executive remains in the run-time loop until one wishes to exit, at which time a couple of buttons are pressed on the screen and the executive calls the terminate method of each display and exits to a higher level starting screen.

The Automation & Human Interface Computer for the X-38

Frank Delgado

The X-38 program was started in early 1995 to explore the feasibility of building a space station Crew Return Vehicle (CRV). The X-38 program is developing a series of test vehicles to demonstrate the low-cost technologies and methods required to developed a fully functional CRV. The X-38 program will use gradual buildup approach. It will start with a series of atmospheric and ground-based tests vehicles, known as: vehicle 131 (V131), vehicle 132 (V132), and vehicle 133 (V133), and culminate with the development of a space-capable test vehicle called vehicle 201 (V201). V201 be flown on the space shuttle as a payload experiment in 2001.

The Automation and Human Interface Computer (AHIC) will provide a graphical user interface that will provide astronauts, launch panel operators, and subsystem leads with the necessary feedback to quickly and accurately determine the health of the vehicle and its subsystems. AHIC will also include advanced Fault Detection Isolation and Recovery (FDIR) software and a mechanisms for operators to change the state of certain onboard devices using remote commands. Additionally AHIC will also include a documentation archive where one can access an assortment of document which may include: flight rules, flight procedure, diagrams, subsystem requirements, cue cards, etc.

Figure 1.0 illustrates the V133 and V201 AHIC architecture. The data comes into our system via the computer interface (RS422) and placed into the Data Collection & Calibration Module. The calibrated data is then passed to the Data Distribution and Inter-Module Communication (DDIMC), which acts as our architecture's nervous system and distributes the data to all the modules requiring the data. DDIMC also handles any inter-module communication that may be necessary.

For the graphical user interface on V133, we will focus on developing a virtual cockpit for the parachute system. We have acquired a 3 dimensional model of the X-38 and are currently collecting United States Geological Survey data at different altitudes. This terrain data will give us a realistic 3 dimensional terrain map of the region we will be flying over. We are also using a variety of virtual reality modeling tools to build objects which will be used in the virtual cockpit. We will take all of this and tie it together using Template Graphics 3D Mastersuite to build a virtual cockpit that will give the visual affect of what it would look like, from the vehicle, from the post parachute deploy phase to the actual landing of the vehicle. The cockpit will have the ability to uplink commands to the vehicle, using a UHF system, which will give it the ability to steer the parachute. This cockpit could be used to control the parachute from any remote location, whether its out in the desert, in hanger or where ever one may be. For V201 we will take all the information we have learned from our V133 endeavor, all the information that Steve Harris (human factors person) can provide, and all the information that's coming from the weekly human interface meetings to help us begin developing the human interface software for V201.

The monitoring modules (inter-system and subsystem) will provide fault detection, isolation, and recovery procedure for subsystem and vehicle level systems. The inter-system module will detect inter-system failures, which is very difficult for individual subsystems to detect because subsystems typically do not have the required insight into other subsystems. Both modules will prioritize failures based on: flight phase, procedure being performed, or the current state of the system.

The situation assessment module will behave as a data retrieval agent who's job is to go out and gather as much information as possible about a specific situation. Let's say we are flying around and some sort of anomaly is detected. This module's task is to go out and collect all the information that may be required to aid the operators in determining what caused the anomaly. The information it retrieves may be parameters, schematics, procedures, or any other information it believes is relevant.

The documentation archive will be a document warehouse where electronically formatted documents can be stored. Some examples of the types of documents that may be stored are: schematics, flight rules, flight procedures, cue cards, etc. We will have a special interface into this archive that will allow easy hyper-linked access to the documents stored. This interface will work like the help wizards found in many of today's applications.

The next three modules are closely inter-related and may actually be combined into one element as we finalized the architecture. The remote command module will allow the operator to send individual commands to the flight computer, much like the X-38 Portable Diagnostics Terminal does today. It will perform some minor checks to assure that command was received and understood by the flight computer. Automated sequencing will allow a pre-determined set of commands to be sent to the flight computer. This module can be placed in one of two modes: automatic or manual. In automatic mode the commands would be automatically sent to the flight computer one after the other. In manual mode, the user would tell the system it wants to manually execute a specific procedure, at which point the system would pull up the required commands and place them on the screen. The user would have to manually arm and fire each of the commands individually. The Procedure tracking module monitors the sequencing activities occurring and makes sure that the procedures being executed are causing the right actions to take place.

The hardware selected for the 133 vehicle will consist of two Computer Dynamics™ flat panel computers. These computer are 200 MHZ Pentium machines with MMX, 64 megabytes of RAM, and a 1 gigabyte hard drive. The dimensions of the entire unit (CPU + flat panel display) is 16" x 11.7" x 3.5". The hardware for vehicle 201 is TBD. Our code development will be done using C++ in a Windows NT environment. We will also be using Template Graphics 3D Mastersuite.

An evaluation into the different 3D terrain modeling tools, flight planning software ,and virtual reality modeling tools is being performed. The basic AHIC architecture for the V133 and V201 is being finalized and the development of the serial interface between the flight computer and the AHIC is currently being written. Everything is proceeding on schedule and no major problems are expected.

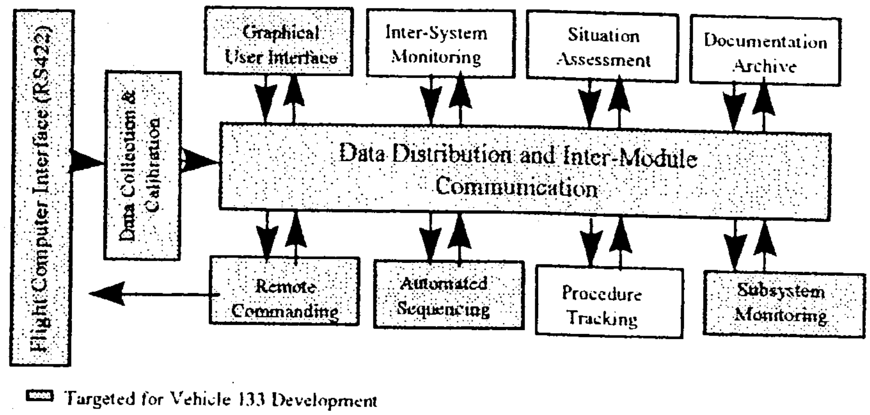


Figure 1.0: Automation and Human Interface Computer Architecture for vehicles 133 and 201. The shaded modules (boxes) will be the modules developed for vehicle 133.

The Application of a Polynomial Network in Failure Detection, Isolation, and Recovery (FDIR) of the Flush Air Data System (FADS) for the X-38 Spacecraft

James Carvajal and Frank Delgado

The following figure represents the process used by the X-38 Flush Air Data System (FADS) software to determine when a pressure measurement is not reasonable based upon previously calculated aerodynamic parameters. For this figure, α is the angle of attack, β is the angle of sideslip, M is the mach number, $\bar{q}$ is the dynamic pressure, and P_∞ is the ambient pressure.

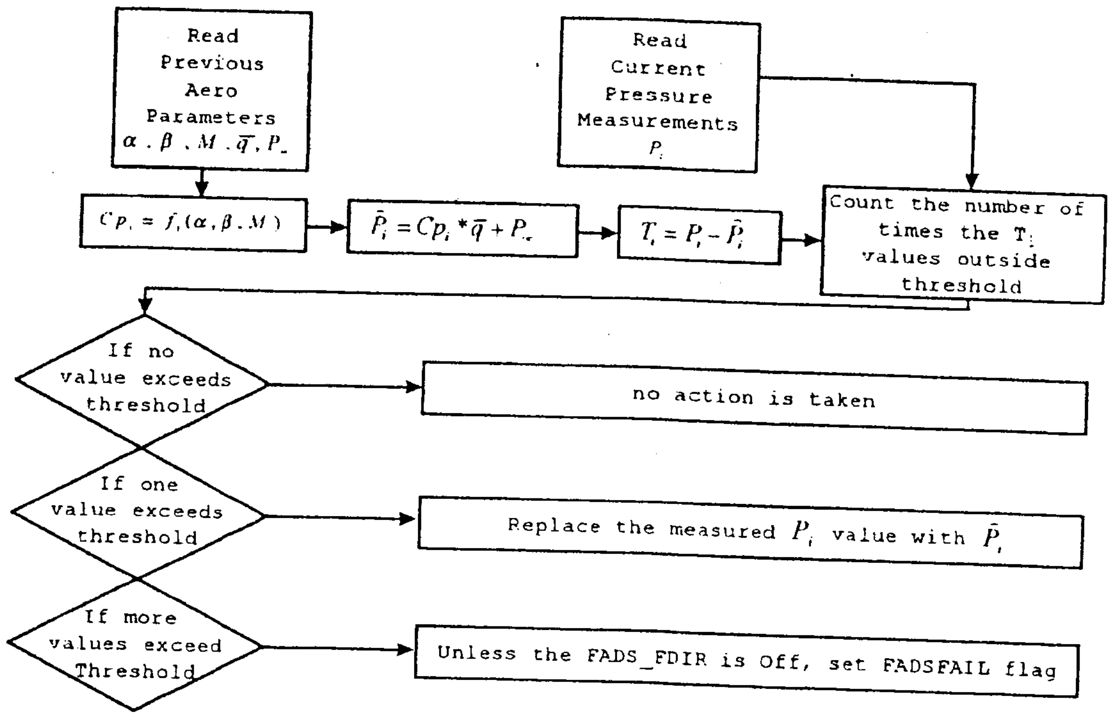


Figure 1: The Failure Detection, Isolation, and Recovery Scheme

The most significant consequence of this approach is how to develop the appropriate mapping functions, labeled f_i's, which can sufficiently approximate the actual system dynamics so that failing sensors are properly rejected, while simultaneously ensuring that the noise encountered in the flight does not cause good sensor measurements to be considered failed. For the current X-38 prototype, there are nine high pressure ports (rated at plus or minus five psi), and the operating range for α is between minus 20 to 50 degrees, β between plus and minus five degrees, and mach between 0.1 and 0.95. Figure 2 provides an example of the data mapping that must be captured for a single port, in this case the second one, at a selected angle of sideslip of 5 degrees. Given the considerable volume of data required to be mapped and the strict real-time performance constraints available in the X-38's flight computer, nine separate Polynomial Networks were developed to model the total system. The final plot, Figure 3, provides a graph of the differences between the measured pressure value and the output of the trained Polynomial Network for the second pressure port as measured in the first captive carry flight.

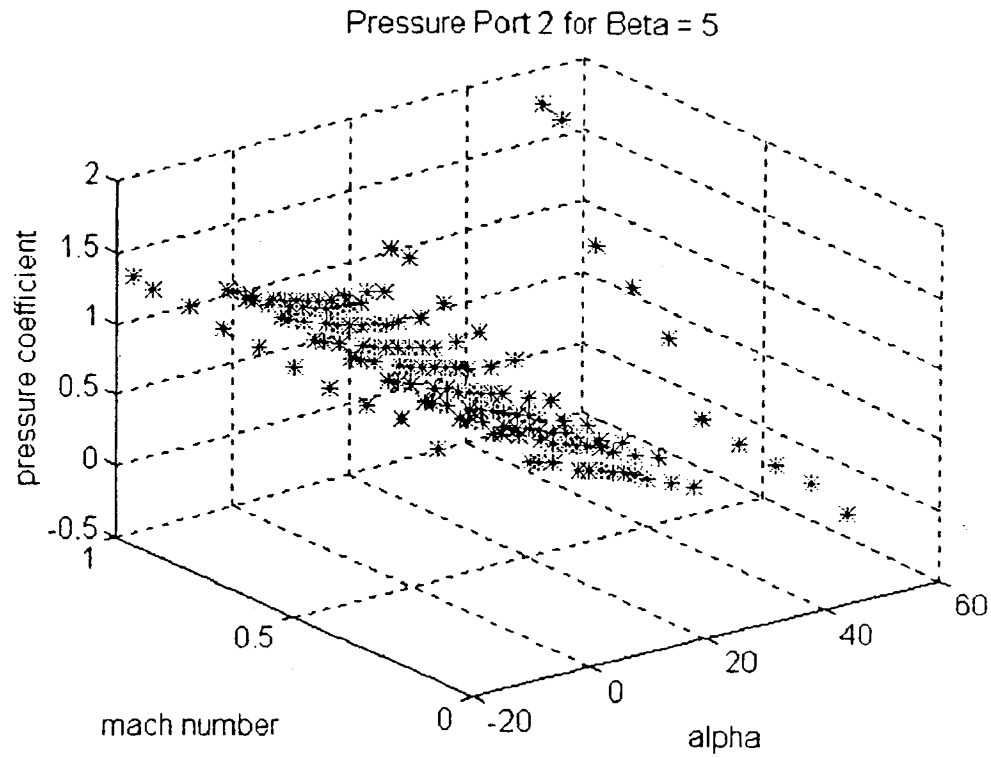


Figure 2: Example of Pressure Coefficients for the Second Pressure Port

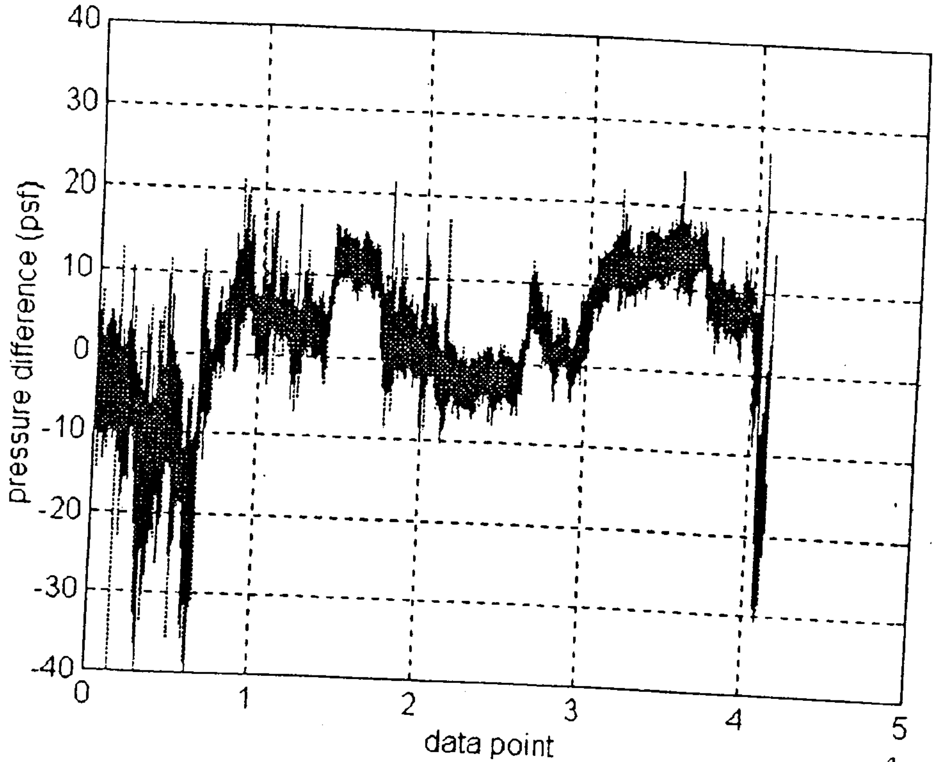


Figure 3: Flight Results from First Captive Carry Flight

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Flight Results from the X-38 Flush Air Data System Software

James Carvajal and Frank Delgado

The technology developments required for an advanced spacecraft, such as the X-38, can be an overwhelming task unless it is carefully merged together in a controlled process. The approach chosen for the X-38 was to develop a series of test vehicles, each of which is progressively more advanced and refined. The first flight test vehicle, designated Vehicle 131 was designed and built here at the JSC, and was shipped to the Dryden Flight Research Center (DFRC) last June. Vehicle 131 has a flight control system for the parafoil, but does not have any active control surfaces. As conventional air data probes would not be able to survive the heat of a reentry, a Flush Air Data System (FADS) was selected to be one of the critical systems to demonstrate early in the program using Vehicle 131.

On July 24, Vehicle 131 was attached to the B-52 pylon and the first taxi test was accomplished. Figure 1 presents a picture of how Vehicle 131 was attached to the carrier aircraft. The first captive carry flight test was then completed on July 30. Figure 2 shows some flight results from this flight, both for the new "Triples Algorithm" developed by DFRC, and, for an alternative technique based upon neural and statistical networks known as a Polynomial Networks. Note that both solutions compare favorably with the results from the original X24a manned vehicle.

Three other captive carry test were also successfully completed in 1997. This allowed for additional data to be gathered in other flight regimes for the evaluation of the performance of the FADS system. Extra flight objectives included the validation of avionics systems in flight environments, clearance of the flight envelope, and end-to-end communications.

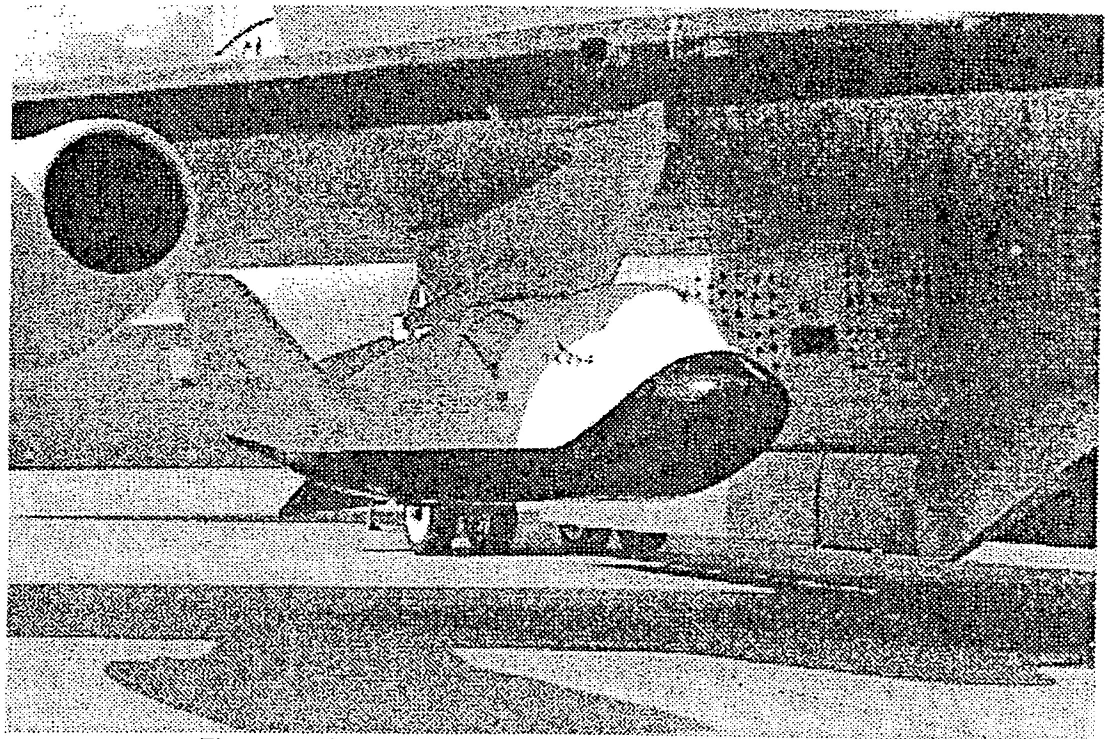

Figure 1: Vehicle 131 under the wing of the Boeing B-52.

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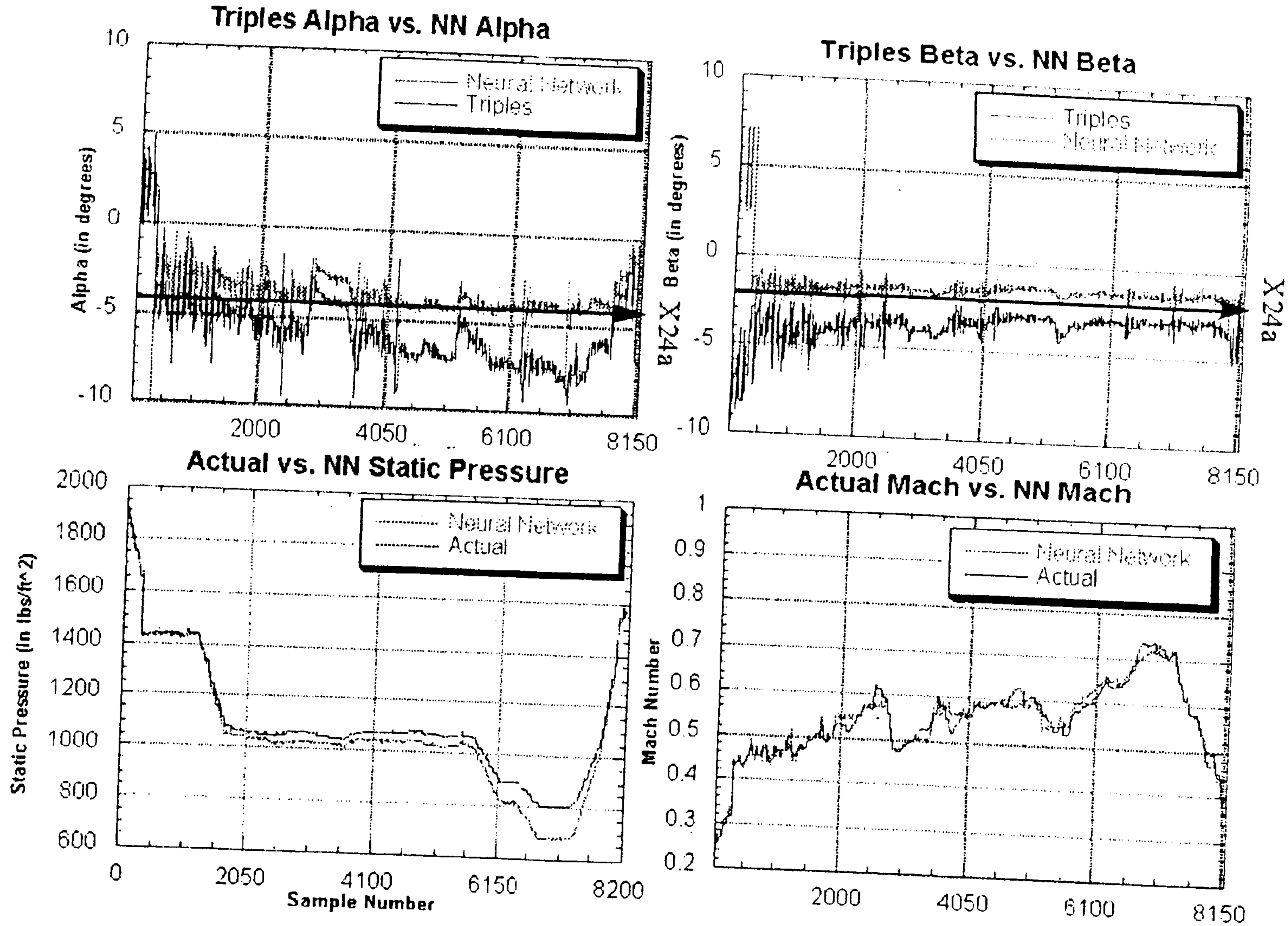

Figure 2: The Results from the Flush Air Data System for the First Captive Carry Flight

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AUTOMATION ROBOTICS AND SIMULATION DIVISION

NASA-JSC

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Portable Diagnostic Terminal Software for the X-38

Frank Delgado

The X-38 program was started in early 1995 to explore the feasibility of building a space station Crew Return Vehicle (CRV). The X-38 program is developing a series of test vehicles to demonstrate the low-cost technologies and methods required to develop a fully functional CRV that can rapidly return astronauts from onboard the International Space Station (ISS) to earth. The X-38 program will use a gradual buildup approach, building a series of atmospheric and ground-based tests vehicles. There will be three atmospheric test vehicles and one space rated vehicle developed and tested during the X-38 program. The vehicles are known as vehicle 131 (V131), vehicle 132 (V132), vehicle 133 (V133), and vehicle 201 (V201). V201 is space-rated and will fly on the shuttle as a payload bay experiment in November 2000.

The Portable Diagnostic Terminal (PDT) is an IBM ThinkPad that can be carried about and connected directly into the X-38 prototypes' patch panel. The PDT uses the Transmission Control Protocol/Internet Protocol (TCP/IP) to talk to the onboard flight computer. It's our one way of communicating with the onboard flight computer and determining what's going on before releasing the vehicle. On the ground before the vehicle is launched, the PDT provides the capability to checkout the health and status of the vehicle subsystems and perform software loads. During captive carry tests, see figure 1.0, the PDT is used to conduct subsystem health monitoring, and prepare the vehicle for free flight mode. When the X-38 lands, the PDT is used to download data from the flight recorder, perform vehicle checkout, and begin post flight shutdown procedures. During non-flight tests, the PDT is used to perform initialization loads for the flight computer, flight performance data monitoring, system activation, and vehicle test and checkout. The PDT is also used for software/hardware testing on several of the X-38 testbeds, including: the avionics testbed, the simulation testbed, and the guidance, navigation, and control testbed.

For V131, additional requirements, above and beyond those collected in 1997, were defined and incorporated into the V131 PDT load. This load was used to support 7 captive carry flights and one free flight, see figure 2.0. The load was also used to support KC135 testing, and the X-38 mobile test simulator. In addition to the V131 PDT load, a new PDT version was developed to support the buildup, testing, and delivery of V132.

The PDT software was written under the LabView 4.0.1 environment using an object-oriented approach. Along with the individual subsystem displays, a summary screen was developed that gives the user a summarized description of the health and launch commit criteria status for all the different subsystems. Subsystems monitoring and commanding display support was provided for the: Parafoil System, GNC System, Electrical Mechanical Actuator System (EMA), Pyrotechnic System, Inertial Navigation System/Global Positioning System (INS/GPS), Communication and Tracking System, Flight Safety, Power and Distribution System, Flush Air Data System, and the Fire Suppression System. Along with these subsystems, additional displays have been built to accommodate for unit testing of different hardware components, test boxes, and PDT to flight computer remote commanding.

Plans for this coming year include the use of both V131 and V132 PDT loads to: support upcoming captive carries and free flights for both vehicles, support testbed activities, and support the mobile cockpit.

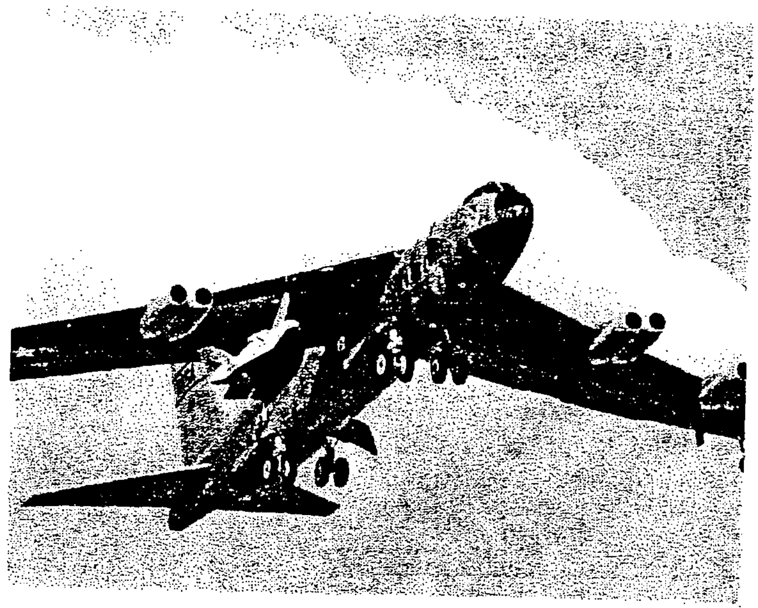


Figure 1 - Photograph of X-38 V131 during captive carry flight 1. The X38 vehicle is attached to the wing of the B52 and flown around at different altitudes and velocities to collect data. To date seven captive carry flights have been performed.

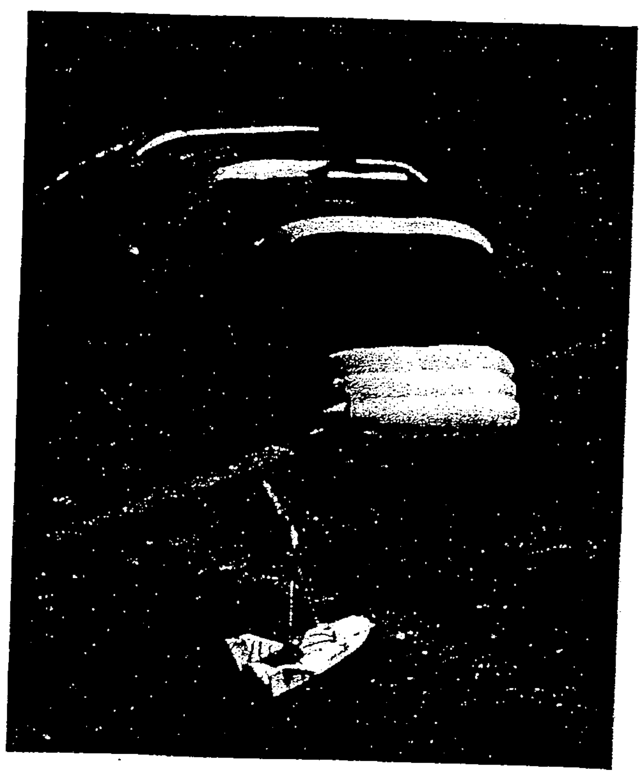


Figure 2 - Photograph of X-38 V131 during free flight 1. The vehicle is released from the wing of the B-52, after several seconds of "free flight," a parafoil system is deployed and is used to land the vehicle.

Immersive Situation Awareness for the X-38 Program

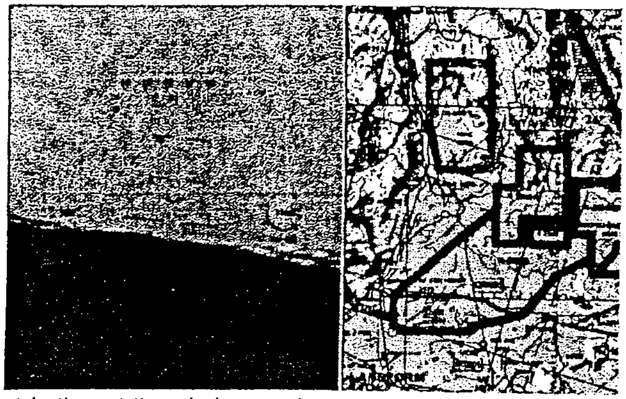
Frank Delgado

The NASA Johnson Space Center is developing a series of prototype flight test vehicles leading to a functional Crew Return Vehicle (CRV). The development of these prototype vehicles, designated as the X-38 program, will demonstrate which technologies are needed to build an inexpensive, safe, and reliable spacecraft that can rapidly return astronauts from onboard the International Space Station (ISS) to earth. These vehicles are being built using an incremental approach and where appropriate, are taking advantage of advanced technologies that may help improve safety, decrease development costs, reduce development time, and outperform traditional technologies.

The X-38 vehicles are unique in that they do not afford crew members a forward view through a wind screen. As a result, we have begun developing an application, based on Rapid Imaging Systems latest technology, that creates a computer generated immersive environment to provide the necessary information concerning the vehicles position, attitude, and status of the vehicle. The immersive environment consists of a set of 3-D displays that can be used for flight guidance and situation awareness. These displays feature the incorporation of real-time INS/GPS data for position and attitude, three dimensional terrain models, Heads-Up Display (HUD), ideal and actual glide path, recommended landing areas, vehicle in the scene, as well as typical system monitoring information. Maps, such as aeronautical charts, as well as satellite imagery are optionally overlayed on the 3-D terrain model to provide additional situation awareness, see figure 1.0. The HUD indicators created have been based upon both military aircraft HUD standards (MIL-STD-1787B) and Space Shuttle HUD standards (STS83-0020V2-26B).

During this year a sophisticated HUD was created and tested that included various two-dimensional and three-dimensional display indicators. The developed application was evaluated by X-38 engineers, human factors engineers, and astronauts. We have used the application developed, in unison with a European Space Agency (ESA) provided X-38 parafoil simulator, to allow engineers & crew members to simulate a person-in-the-loop X-38 parafoil landing. The application has proven very useful helping define what information is required to manually fly the X-38 during parafoil flight. We have also used the application for data analysis by playing back captive carry and free flight data from previous flights, see figure 2.0. Additionally we have incorporated the application into the X-38 mobile cockpit simulator.

Some of the questions that we will answer this coming year are: is the frame update rate sufficient to support realistic situational awareness, do the displays present adequate information density throughout the flight, and are the display modes useful in this environment. We will also integrate this application in the monitoring and control stations that will be used to remotely pilot the X-38 vehicles during parafoil flight. Additionally, we will continue a process of feedback and development, which will support crew members and X-38 engineers requirements for utility in HUD overlays and modes of operation during all flight phases of the X-38 vehicles.



a) In the out-the-window section we see a virtual "out a window view" with HUD symbology superimposed. In the GODS eye-view section, we can see an aeronautical chart.

b) This display incorporates the use of high-resolution satellite imagery. In the out-the-window section, we see a virtual environment that includes the vehicle in the scene along with typical HUD symbology. In the GODS eye-view section we see an overhead view of the area we are flying.

Figure 1 - These are typical situation awareness displays. The displays are created in a window that is divided into 2 sections: an out-the-window section and a birds eye-view section.

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the occasions when this assumption is violated, as for example on crossing a coast, the model's constraint curve is the wrong shape but the parameter fitting strategy maintains acceptably (but not optimally) enhanced output imagery.

It has not been possible to make a full study and analysis of the noise processes in the video system; this is essential if the model fitting technique using overflow and underflow population distributions is to be optimized. For simplicity, a zero-mean, additive Gaussian noise model has been used in the demonstrator. A more detailed understanding of ground-truth statistics would also be of benefit since the underlying objective is to produce an image with these same statistics.

Despite these practical difficulties, the technology demonstrator has shown some very impressive results. We view the identification of its shortcomings as an important positive step towards specifying a prototype system, which we believe, is now a practical proposition.

5. CONCLUSIONS

A parallel signal processing computer was built and programmed to demonstrate that a method, previously reported by Oakley, of enhancing the contrast of hazy images from an airborne camera could be speeded up by between four and five orders of magnitude and made to work in real-time. The demonstration computer was constructed from off-the-shelf commercial modules, installed on the expansion bus of an ordinary PC, and programmed in C. A systematic study identified a combination of data pipelining techniques and algorithmic simplifications that allowed us to increase throughput by a factor of between ten thousand and one hundred thousand times. None of these simplifications to the underlying geometric and contrast-loss models perceptibly degrades the appearance of the enhanced imagery, which remains restricted by physical phenomena such as noise from various sources. The demonstrator has performed impressively well on recorded test data even in the presence of calibration and synchronization errors, and we are confident that even better results would be obtained with live data. The feasibility of implementing a real-time contrast enhancement method based on an atmospheric scattering model using readily available computer equipment has been amply demonstrated.

ACKNOWLEDGEMENTS

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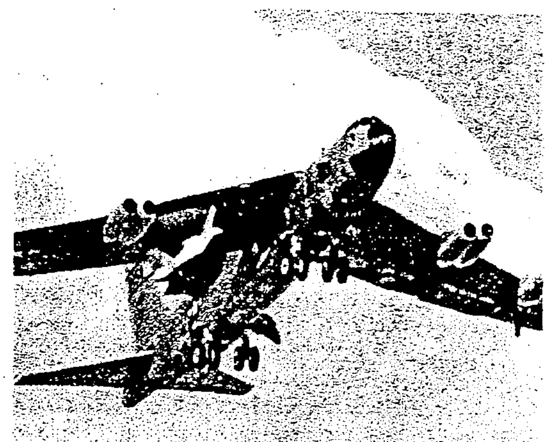
The X-38 employs a "lifting body" concept originally developed by the U.S. Air Force's X-24A project in the mid-1960s. The concept uses the aerodynamic shape of the vehicle itself to generate the lift that a normal aircraft gets from its wings. This gives the X-38 vehicle good reentry maneuverability capabilities. More important, as a lifting body, the X-38 has excellent cross-range characteristics. These cross-range characteristics assure multiple opportunities for a dry terrain landing within the 9-hour lifetime of the vehicle consumables. The ability to return to earth quickly is very important and is a major advantage that the X-38 CRV has over the Russian Soyuz capsule, which is also under consideration for possible use as a CRV. Unfortunately, the Soyuz has two major drawbacks. The foremost is its inability to accommodate crewmembers that vary greatly in size, and the second is its limited crew carrying capacity, its not capable of carrying more than 3 crewmembers at a time. These issues caused concerns because the ISS will house crewmembers that vary greatly in size (5^{th} percentile Asian female to 95^{th} percentile U.S. male). Additionally, there are plans to have up to 7 crewmembers on the ISS at any time. Because of these concerns, an investigation into the development of an alternate method of returning crewmembers to earth was launched. This effort became known as the X-38 program. The X-38/CRV is being designed to accommodate the necessary range of crewmember sizes and have the capability of carrying 7 crewmembers at any time

V131 and V132 have composite fiberglass bodies and have undergone extensive testing during captive carry tests and free flight tests. During a captive carry test, a vehicle is attached to the wing of a B-52 and flown at different velocities and altitudes to collect data (Figure 1). During a free flight test the vehicle is carried to an altitude between 20k and 50k feet, under the wing of the B-52, and released. The vehicle flies "free" for several seconds before a large parafoil is deployed and used to return the vehicle safely to the ground.

V131 has undergone 7 captive carry tests and 2 free flight tests. V132 has undergone 1 captive carry and 1 free flight test. V133 is an atmospheric test vehicle similar to V132 and is currently being built. V201 is being built in-house at the Johnson Space Center and will be the first space-rated X-38 test vehicle. It will be taken into space on the Space Shuttle in November of 2000. Once in space, it will be taken out of Shuttle payload bay by the Remote Manipulator System and released. The X-38 will then run through its automated check out procedures and begin the de-orbit sequence. The vehicle will then enter earth's atmosphere and at an altitude of about 30k feet a large steerable parafoil, with active guidance from an on-board GPS receiver, will deploy and safely return the vehicle to the ground.



Dryden Flight Research Center EC97-44163-16 Photographed 10Jul1997
Reminiscent of lifting body flights of yesteryear, NASA's X-38 flew captive-carry for the first time on July 10. The flight, during which the X-38 remained attached to Dryden's B-52 carrier aircraft, proved very successful, lasting two hours and reaching an altitude of 27,00 feet. (NASA/Tony Landis)

Figure 1: V131 during captive carry test 1.

The current X-38 CRV mission requirements include returning up to 7 crewmembers from the ISS safely to earth, have the ability to insure a dry terrain landing, and have enough cross-range to insure three landing opportunities in nine hours. This would be done in the event that any of the following situations arise: an ISS catastrophe, an emergency medical evacuation, or the Shuttle is unavailable to re-supply the ISS. Because we must design to a worst case scenario, a medical emergency where crewmembers are unable to pilot the vehicle back to earth, a fully autonomous vehicle must be built.

The basic assumption that a pilot is not necessary to return the CRV to earth meant that a forward-looking window was not required on the CRV. Although full autonomy is necessary for the medical evacuation scenario, keeping crewmembers in-the-loop to take care of unforeseen situations whenever possible is also a must. Synthetic environment technology is ideal for augmenting a crewmembers situational awareness and helping them to reselect a landing site or to fly the vehicle during the parafoil phase, when necessary. Additional software is being developed that allows crewmembers the ability to power subsystems on/off and more fully interact with several X-38 systems. We have been using our synthetic environment system to monitor flights, and to analyze/playback data during our V131 and V132 testing. In this role it acts as a tele-presence tool. To this end the LandForm Real-time 3-D Terrain Modeler, a commercial off the shelf (COTS) software package is being used. This product was selected because it met the above requirements, is very easy to use, and offers substantial cost and time savings.

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The X-38 uses a large parafoil for the final landing phase. This parafoil is the subject of a significant engineering effort and considerable effort has been spent testing the parafoil system. Testing is done using large instrumented pallets attached to the parafoil. The pallets are released from the back of a C-130 aircraft and data on the aerodynamics, deployment sequence, and overall performance are recorded and closely analyzed. Early testing has yielded an ample amount of data which has been used to successfully build a parafoil system that has safely returned the V131 vehicle back to the ground during both free flights. Additional testing is being conducted to fine-tune the parafoil performance with the use of a remotely piloted vehicle, known as the buckeye. A pilot on the ground will fly the buckeye using visual feedback from one or more onboard video cameras. It is desirable to augment the pilot's view of the world with our system acting as a three-dimensional heads up display (HUD). In this way, information about landing zones and obstacles obscured from the camera could still be visible in our displays. Such tele-operation tools can considerably reduce the risks of remotely operating aircraft.

Initial tests with the product were very successful, and as astronauts came in contact with the system being developed, it became apparent that it would also serve well as a space-crew-training tool, and could considerably improve pilot situational awareness as a ground-based or onboard avionics display. However, for it to be used in these particular situations, it will need to be embedded into other applications, and not operate as a stand-alone program. Therefore, it would need to be accessible as a toolkit, which NASA engineers could use to augment any avionics software systems.

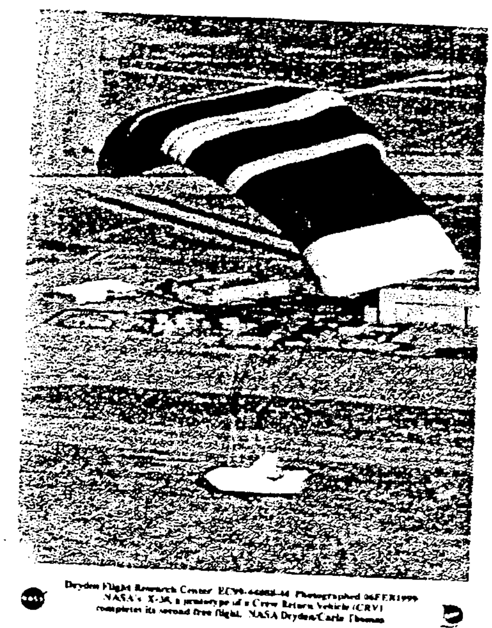

Figure 2: Parafoil deployed prior to landing.

2. Requirements

Fundamentally the system must provide a real-time three-dimensional display of the environment, incorporating diverse terrain, navigation, and aircraft data. This display should be a natural perspective from a viewpoint controlled to six degrees of freedom (6 DOF). In most cases degrees of freedom applied to the viewpoint include latitude, longitude, altitude, pitch, heading and roll, versus time. Typically such data is obtained from an Embedded GPS Inertial Navigation Systems on board the aircraft and either used on-board, transmitted and viewed live, or recorded and replayed as a flight track at a later time. The camera modeled by the software must be a perspective camera that can be placed at any point in our 3-D virtual environment, and rotated about 3 axes to any orientation to simulate any viewpoint in which a real camera might be found. This 3-D synthetic vision of the world must also incorporate diverse elements including:

- land surface shape (topography),
- textures or draped imagery including digital maps,
- satellite and aerial imagery,
- geo-stationary objects like landing zones and obstacles,
- man-made or other transient objects, including aircraft, (we use the name *entities* for such objects)
- heads-up displays which project important information about the situation.

Incorporating dynamic object entities into the scene is important for the X-38 so that the program could show the vehicle, the flight path (actual and ideal), as well as showing the parafoil and drogue shoot. The parafoil model is not only moving in real-time, but is changing shape as different control forces are applied. The ability to observe these effects in real-time is a requirement for flight testing, so entities must not only be controlled by 6 DOF, but it must be possible to incorporate a dynamically changing body shape model.

Simplicity of operation is a vitally important requirement for operation of a crew return vehicle. Most existing terrain software requires that expert users edit the terrain model for a given region of the world, and thus create the topography. The update rate of the 6 DOF viewpoint is up to 60 times per second, as is the update rate for entities moving in the virtual environment model for the virtual environment. Such a constraint is unacceptable for this application. As the X-38 might be compelled to begin its landing sequence from anywhere, it is not practical to have astronauts editing terrain models for a

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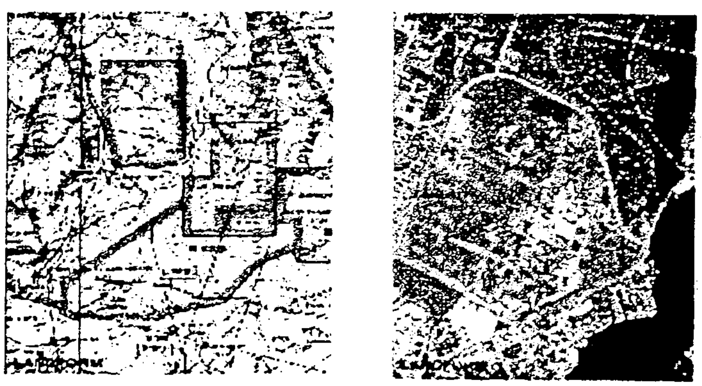
virtual planet. Fortunately, LandForm accepts most common forms of terrain models, such as DTED, DEM, DTM and will automatically generate a land surface model for a given region of interest. The region of interest can be automatically moved by the program, based on the view position. Landform can automatically load files needed to make the terrain models. As a result, operation of the software can be automated to a very large extent, while providing greatly enhanced situation awareness. Figure 3 and Figure 4 are typical situation awareness displays for the X-38.

3 (a) 3 (b) 3 (c)

Figure 3: These are typical out-the-window displays that have been prototyped for use on the X-38 program. In Figure 3(a) we have an out-the-window display that uses terrain elevation models and HUD symbology. In Figure 3(b) we have an out-the-window display created using high-resolution imagery data, a vehicle model, and HUD symbology. In Figure 3(c) we have an out-the-window display created using terrain elevation models, vehicle and parafoil models, and HUD symbology.

We are developing a "mobile cockpit" for use as a rapid development testbed for the synthetic environment system we are developing. The "mobile cockpit" is a 15 passenger van that has been outfitted with tinted windows to decrease light, a Global Positioning System, display computers, adjustable crew displays, hand controllers, a remote-controlled camera, an avionics rack for flight computers, and wireless headsets that allow the driver of the van to communicate with the individual handling the avionics systems and with crew members who lay supine in the back of the van. The result is a generic platform that may be used as a remote cockpit, as a rapid prototyping test bed, as a motion based simulator and as a vehicle for real-time flight following. Figure 5 shows the mobile cockpit avionics rack and its associated hardware components. Figure 6 shows the prototype mobile cockpit seats and display computers. The software being developed will be target to run on any Windows computer platform. The software should make use of 3-D accelerator hardware if available, but should not require it.



4(a) 4(b)

Figure 4: These are typical birds-eye-view displays. 4(a) is birds-eye-view display created using an aeronautical chart. 4(b) is birds-eye-view displays created using a high-resolution satellite image.

Figure 5: Computers and GPS equipment used in the mobile cockpit.

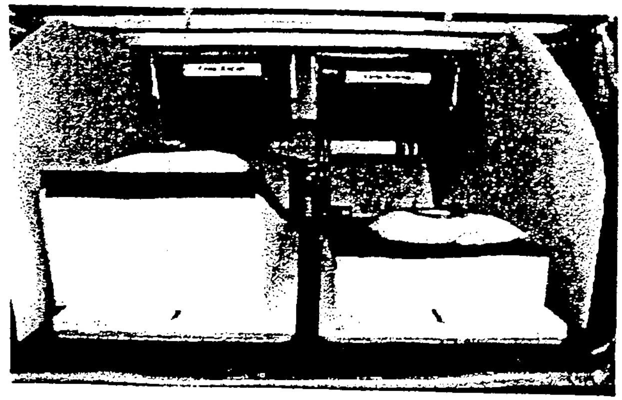


Figure 6: Mobile cockpit seats with display consoles.

3. Architecture

Our idea in approaching this work was that it should be possible to create a package or library that would encapsulate the easy-to-use LandForm Real-Time 3-D Terrain technology in programmer-accessible modules. If successful in our object-oriented design for this system, the package would expose only those methods or elements of importance to the user, and would hide those things which they did not need to worry about. This idea of *abstraction* is fundamental to maintaining interface simplicity.

The functional architecture, figure 7, was designed to achieve an optimal balance between power and simplicity. To this end the most obvious component encapsulates the LandForm 3-D Terrain display, herein called the LandView3D. This component uses the land surface model produced by the LandForm Server, and the viewpoint to render the 3D perspective. Camera model elements, such as field of view, are intrinsic to the LandView3D component. The LandForm Server is responsible to manage the terrain and overlay image data, flight track data, and time/event management provides this information to the views. A third component, the MapView provides a 2D parallel to the LandView3D. The MapView can be used for navigation, and to display the vehicle position in a traditional two-dimensional, North-up display, of predefined scale.

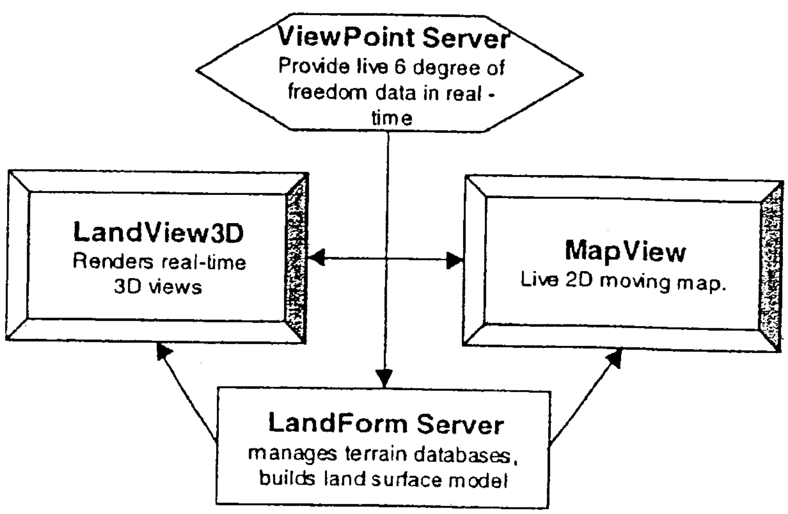


Figure 7: Basic architecture

While the viewpoint server provides data for the camera and vehicle position, it can also be used to provide data on other objects (like aircraft) in the scene.

One of the key considerations for this system was the selection of a graphical API (Application Programming Interface) which would provide near-real-time 3-D rendering of the scene (including simulated land surface and vehicles). The OpenGL API was selected for this purpose, over alternatives like DirectX, for several reasons. First, having tested other APIs, OpenGL has the most reliable performance on a variety of graphics adapters and platforms. Second, it provided ample rendering speed, provided reasonable care was taken in programming the OCX controls and application. And third, it is distributed as a standard part of the Windows operating system and thus should be well supported over a period of years by the operating system vendor.

4. Implementation

The first step was to determine whether the ActiveX API would allow us to create an OpenGL display within a control, and whether such an implementation would be as fast, in terms of rendering speed, as LandForm. If so, then ActiveX would appear to be the logical choice for implementation. To test this idea, we created an ActiveX control that contains the LandForm 3D scene renderer, and the LandForm Server component described above. (This is the LandView3D control we discussed earlier).

We tested the rendering speed and found it was comparable to the stand-alone LandForm program. By achieving 20 frames per second on a modestly equipped machine, the LandView3D control provides more than adequate rendering performance. This key data point cleared the way for full implementation using the ActiveX paradigm. ActiveX is a form of the Component Object Module (COM) architecture, which offers excellent interoperability of libraries between programming languages and operating environments.

In parallel with the LandView3D control, we began the development of a 2-D map display that would function similarly to the right-hand map view in LandForm. This was relatively straightforward, and was also implemented using the Active X paradigm. One part of the development that was not trivial was the creation of a transparent control to be overlaid on the map so that other data could be displayed, such as a compass, or windsock. This required some research and experimentation before a truly successful method was developed.

The LandForm Server, which contains the core of LandForm's capability had to be implemented in a programmably accessible form. While it would be simplest to create an object as a dynamic link library, we felt interoperability was better served by creating a COM version of this object. The logical choice here was as an ActiveX. Finally, a sample application was created which combined these basic capabilities. To this end we used Microsoft Visual C++ to develop a dialog based Windows application containing the new sample tools and to serve as a template for developers to model their own applications upon. Figure 8 shows a sample application.

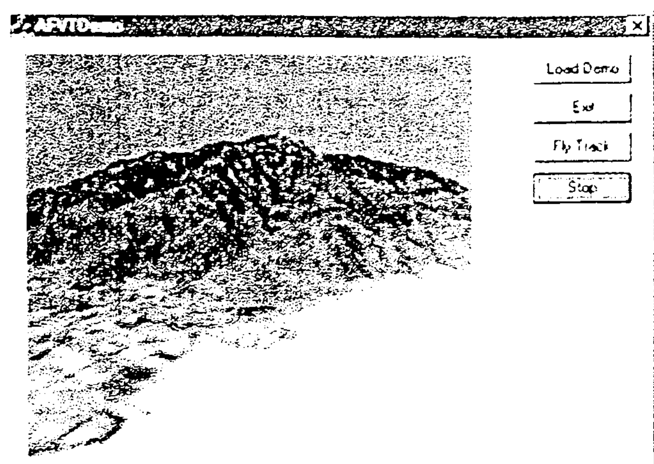


Figure 8: Sample application with LandForm 3D view control.

5. Application: A 3-D Heads Up Display

One powerful application of LandForm is to combine simulated LandForm 3-D scenery with live video, to create an enhanced situational awareness display. For pilots of both full scale and remotely piloted aircraft, such a display will provide a view of the surroundings which includes live video, and enhanced with outlines of terrain, other aircraft, landing zones, targets or other objects of importance. Furthermore because the terrain portion of the display is generated from digital data, it is not subject to the limitations of visibility inherent to video. While darkness, terrain occlusion, smoke, fog, and haze all impact the video, the overlays will be unobstructed. Figure 9 expresses the fundamental concept. A computer running the LandForm ActiveX control utilizing the current vehicle position models the real video camera field of view and orientation.

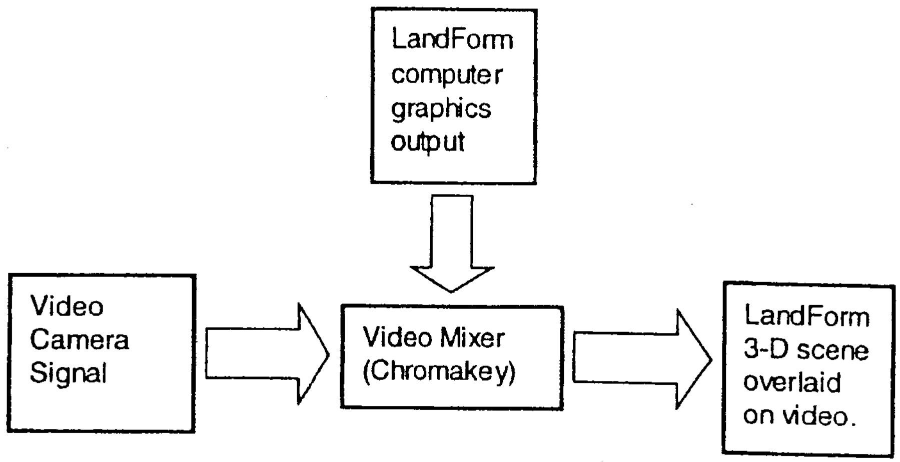


Figure 9: Enhanced situational awareness is achieved with the combination of LandForm 3-D scenery and live video.

The real camera is mounted at a known orientation on the vehicle, thus the video from the camera and the LandForm simulated scene constitute parallel views of the world – one based upon photons at the sensor, the other based upon the LandForm database. LandForm is then configured to render wire-frame rather than solid surfaces, which may then be overlaid upon the real-time video. So if a mountain appears in the LandForm terrain database, in front of the camera it should be rendered in the same place and orientation in the real video. Indeed it should overlay as precisely upon the live mountain scene as the data permit. Likewise if a landing zone is indicated in the scene it should appear at just the same location as in the video.

Figures 10 and 11 show a parallel view of the world from a video camera's perspective and LandForm's simulated scene respectively. Figure 10 is a video digital image of the Mt. Jacinto area in California. Figure 11 shows the same area rendered by LandForm based on the field of view of the camera and camera viewpoint.

Figure 10: Digital image of Mt. Jacinto, Ca.

Figure 11: LandForm simulation of the terrain from the camera and viewpoint for the photo above.

6. Results

We believe we have demonstrated the utility of a general purpose 3D terrain-enabled software display toolkit for flight guidance applications, both for operation and teleoperation of aircraft and spacecraft. It is clear that even PC computers may have adequate performance to provide a smooth real-time 3D display of the terrain and aircraft in flight. One of the most important uses of this technology will be as a 3D heads up display (HUD), and in the case of the X-38 program to improve a pilot's situation awareness.

Before a tool of this type can be used in operational spacecraft and aircraft, testing must be performed to validate the limits of performance of the software. We think that this system offers a substantial step forward in flight guidance via a virtual environment. We are also interested in the opinions of others. Free downloadable sample versions of the software can be obtained from www.landform.com/AFVT.htm on the World Wide Web. The LandForm plug-ins developed for the X-38 program can be acquired by contacting fdelgado@ems.jsc.nasa.gov.

7. Acknowledgements

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[redacted]

From: Robert Adams-OTG [[redacted] b(6)
Sent: Tuesday, March 10, 2009 8:11 AM
To: McNutt, Jan (HQ-MC000)
Subject: RE: Jan S. McNutt, Please see the attached letter; it is your response to your most recent letter.

10MAR09

Jan,

Can you please provide me an update as to this matter?

Dr. Adams

From: McNutt, Jan (HQ-MC000) [mailto:[redacted] b(6)
Sent: Friday, February 20, 2009 2:07 PM
To: Robert Adams-OTG
Subject: RE: Jan S. McNutt, Please see the attached letter; it is your response to your most recent letter.

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[redacted] b(6)

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[redacted] Phone
Fax

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Attachments: Optima Claim Response Letter.pdf

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[redacted]hone
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National Aeronautics and Space Administration

Headquarters
Washington, DC 20546-0001

March 19, 2009

Reply to Attn of: Office of the General Counsel CERTIFIED MAIL

Dr. Robert Adams, CEO
Optima Technology Group
1981 Empire Road
Reno, NV 89521

RE: Administrative Claim for Infringement of US Patent No. 5,904,724;
NASA Case No. I-222

Dear Dr. Adams:

This letter concerns the above-identified administrative claim for patent infringement.

NASA received the initial notification of this claim in an email dated May 12, 2003, from Mr. Jed Margolin addressed to attorneys at the NASA Langley Research Center claiming that "NASA may have used one or more of [Mr. Margolin's] patents in connection with the X-38 project and may be using one or more of my patents in other projects using Synthetic Vision". Mr. Margolin identified two patents that he believed NASA may be infringing; the subject patent and Patent No. 5,566,073. On June 7, 2003, Mr. Margolin submitted his claim by fax to the NASA HQ attorney, Mr. Alan Kennedy. Mr. Kennedy responded by letter dated June 11, 2003 acknowledging the administrative claim and requesting that Mr. Margolin give a more detailed breakdown of the exact articles or processes that constitute the claim. Mr. Margolin responded by letter dated June 17, 2003, withdrawing his claim with regard to U.S. Patent No. 5,566,073, leaving the remaining claim for the subject patent. NASA is aware of the long pendency of this matter and we regret the delay.

On July 14, 2008 Optima Technology Group sent a letter addressed to Mr. Kennedy stating that they were the owners of the Jed Margolin patents due to an assignment and requesting that NASA now license the technology of the subject patent. With an email dated August 6, 2008 from Optima, NASA received a copy of a Patent Assignment, dated July 20, 2004, executed by Jed Margolin, the sole inventor on the subject patent, by which the entire right, title and interest in the patent has been assigned to Optima Technology Group, Inc. We previously noted in a letter dated August 20, 2008 from Mr. Jan McNutt of our office addressed to you that NASA believes there are certain irregularities surrounding this and collateral assignment documents associated with the subject patent. However, NASA will at this time forestall a detailed consideration of that issue. Instead, we will assume your *bona fides* in asserting that you are the legitimate owner of the subject patent and communicate our findings directly with you. To the extent that Mr. Margolin has any interest in this matter, formally or informally, we will leave it up to you whether or not to communicate with him.

In light of the prior claim by Mr. Margolin, we consider your license proffer as an administrative claim of patent infringement. We turn now to the substance of your claim. In response to your initial letter dated July 14, 2008, Mr. McNutt's August 20, 2008 letter posed a number of questions, the purpose of which was to enable NASA to fully evaluate the details of your claim. Your organization failed to respond to these questions and, further, advanced the position that this matter does not involve a *new* claim (*Adams letter to McNutt, August 25, 2008*). We disagree that this is not a new claim. Nevertheless, NASA proceeds – in order to bring closure to this matter – on the basis that this claim centers around allegations that infringement arose from activities associated with NASA's X-38 Program, as advanced by Mr. Margolin. Accordingly, our investigation of this claim necessarily reflects the answers previously furnished by Mr. Margolin in response to NASA's June 11, 2003 letter to him containing substantially the same set of questions.

U.S. Patent No. 5,904,724 issued with twenty claims, claims 1 and 13 being the sole independent claims.

In order for an accused device to be found infringing, each and every limitation of the claim must be met by the accused device. To support a finding of literal infringement, each limitation of the claim must be met by the accused device exactly, any deviation from the claim precluding a finding of infringement. See *Lantech, Inc. v. Keip Mach. Co.*, 32 F.3d 542 (Fed. Cir. 1994). If an express claim limitation is absent from an accused product, there can be no literal infringement as a matter of law. See *Wolverine World Wide, Inc. v. Nike, Inc.*, 38 F.3d 1192, 1199 (Fed. Cir.1994).

In applying these legal precepts, reproduced below are the relevant portions of claims 1 and 13.

> Claim 1. A system comprising:
>
> * * *
>
> a computer
>
> * * *
>
> said computer is. . .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. (emphasis added.)
>
> Claim 13. A station for flying a remotely piloted aircraft that is real or simulated comprising:
>
> * * *
>
> a computer
>
> * * *

> said computer. . . to *determine a delay time* for communicating. . .flight control information between said computer and [a] remotely piloted aircraft, and said computer to adjust the sensitivity of [a] set of remote flight controls based on said delay time. . . .(emphasis added.)

NASA has investigated activities surrounding the X-38 program at its Centers that conducted X-38 development efforts and has determined that no infringement has occurred. This result is compelled because none of NASA's X-38 implementations utilized a computer which is "for determining a delay time for communicating said flight data between said computer and said remotely piloted aircraft," as required by claim 1, nor a "computer ... to determine a delay time for communicating ... flight control information between said computer and [a] remotely piloted aircraft," as required by the limitations of claim 13.

Given that a computer which measures delay time is lacking from the NASA X-38 configuration, it follows that the NASA X-38 configuration had no "adjusting of the sensitivity of [a] set of one or more remote flight controls based on said delay time", as required in claim 1. Similarly, because the NASA X-38 configuration had no "computer to determine a delay time for communicating ... flight control information between said computer and [a] remotely piloted aircraft, the configuration also had no adjusting of "the sensitivity of [a] set of remote flight controls based on said delay time", as called for by claim 13.

For at least the above-explained exemplary reasons, claims 1 and 13 have not been infringed. It is axiomatic that none of the dependent claims may be found infringed unless the claims from which they depend have been found to be infringed. *Wahpeton Canvas Co. v. Frontier, Inc.*, 870 F.2d 1546 (Fed. Cir. 1989). One who does not infringe an independent claim cannot infringe a claim dependent on, and thus containing all the limitations of, that claim. *Id.* Thus, none of claims 2-12 and 14-20 have been infringed.

NASA's X-38 development efforts ended in 2002. There may also be other features in NASA's X-38 development efforts that, upon further analysis, would reveal yet more recited claim limitations that are lacking in the NASA configuration related to those efforts.

We also note as a point of particular significance that the limitations included in claims 1 and 13 discussed above were added by amendment during the prosecution of the patent application. It is clear from an analysis of the patent application file wrapper history that the individual prosecuting the application stressed the importance of "the measurement of a communication delay in order to adjust the sensitivity of flight controls based on that delay." Also noted is the distinguishing arguments that these claims require that there be a "computer ... located in the pilot station" and that "at least one real time measurement of the delay and some adjustment is contemplated." (See *Applicant's Amendment and Remark*, February 27, 1998 and *Response Under 37 C.F.R. § 1.116*, July 6, 1998). Clearly, the Patent Office Examiner allowed the application based on these prosecutorial arguments.

We have completed our investigation regarding the claim of patent infringement of U.S. Patent No. 5,904,724 and have determined that there is no patent infringement by, or unauthorized use on behalf of, NASA. The above detailed discussion explains the basis for NASA's analysis and decision regarding the subject administrative claim.

As an aside, during NASA's investigation, numerous pieces of evidence were uncovered which would constitute anticipatory prior knowledge and prior art that was never considered by the U.S. Patent and Trademark Office during the prosecution of the application which matured into Patent No. 5,904,724. In view of the clear finding of lack of infringement of this patent, above, NASA has chosen to refrain from a discussion that would demonstrate, in addition to non-infringement, *supra*, invalidity of the subject patent. However, NASA reserves the right to introduce such evidence of invalidity in an appropriate venue, should the same become necessary.

This is a FINAL agency action and constitutes a DENIAL of the subject administrative claim for patent infringement.

Pursuant to 35 U.S.C. § 286, the statute of limitations for the filing of an action of patent infringement in the United States Court of Federal Claims is no longer tolled. Thus, any further appeal of this decision must be made by filing a claim for patent infringement in the United States Court of Federal Claims, pursuant to 28 U.S.C. § 1498(a).

Sincerely,

Gary G. Borda
Agency Counsel for Intellectual Property

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City, State, ZIP+4 RENO NV 89521

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03915

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> Optima Technology Group
> [redacted] Phone b(6)

[redacted] Fax b(6)

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03926

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From: Robert Adams-OTG [mailto:[redacted] b(6)
Sent: Tuesday, September 30, 2008 1:04 PM
To: McNutt, Jan (HQ-MC000)
Subject: FW: Jan S. McNutt, Please see the attached letter; it is your response to your most recent letter.

Sir,

b(4) [redacted]

Dr. Adams

From: Robert Adams-OTG [mailto:[redacted] b(6)
Sent: Monday, August 25, 2008 3:48 PM
To: 'McNutt, Jan (HQ-MC000)'; '[redacted]
Subject: Jan S. McNutt, Please see the attached letter; it is your response to your most recent letter.

> Sent via U.S. Mail with tracking number
>
> Jan S. McNutt,
>
> Please see the attached letter; it is your response to your most recent letter.
>
> Thank you,
>
> Dr. Robert Adams – CEO

Optima Technology Group
[redacted] Phone
[redacted] Fax
b(6)

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13 Sheets

Jed Margolin [redacted]
Phone: [redacted] **_Email:_**[redacted] b(6)

June 7, 2003

Mr. Alan J. Kennedy
Office of the General Counsel
National Aeronautics and Space Administration
[redacted] b(6)

Dear Mr. Kennedy,

Mr. Barry Gibbens of your Langley Research Center suggested I contact you. I missed you when I called on Friday so I am sending this fax to provide background.

I believe that NASA may have used one or more of my patents in connection with the X-38 project and may be using one or more of my patents in other projects using Synthetic Vision.

This fax contains a number of Internet links. If you would like an email version of this fax containing active links please send me an email (jm@jmargolin.com) with your email address.

Summary

In Synthetic Vision (NASA's term), the aircraft's position and orientation are used with a terrain database (such as the Digital Elevation Database) to produce a 3D projected view of the terrain over which the aircraft is flying. One of the advantages of this system is that the pilot is able to "see" the terrain regardless of weather conditions or whether it is day or night.

My U.S. Patent that pertains to this use of synthetic vision is: **U.S. Patent 5,566,073 Pilot Aid Using a Synthetic Environment** issued October 15, 1996 to Margolin. (I am the inventor and owner of the patent.) The patent application was filed August 9, 1995, and was a continuation of Application Ser. No. 08/274,394, filed July 11, 1994.

With synthetic vision it is not necessary for the pilot to be in the aircraft. I believe the X-38 project used this method.

My U.S. Patent that pertains to this use of synthetic vision is: **U.S. Patent 5,904,724 Method and Apparatus For Remotely Piloting an Aircraft** issued May 18, 1999 to Margolin. (I am the inventor and owner of the patent.) The patent application was filed January 19, 1996.

X-38 Project

I became aware that NASA was using synthetic vision in the X-38 project in the January 2003 issue of NASA Tech Briefs, page 40, **"Virtual Cockpit Window" for a Windowless Aerospacecraft**. The article is available at: http://www.nasatech.com/Briefs/Jan03/MSC23096.html

This led me to Rapid Imaging Software, Inc. and their press release (http://www.landform.com/pages/PressReleases.htm) which states:

> *"On December 13th, 2001, Astronaut Ken Ham successfully flew the X-38 from a remote cockpit using LandForm VisualFlight as his primary situation awareness display in a flight test at Edwards Air Force Base, California. This simulates conditions of a real flight for the windowless spacecraft, which will eventually become NASA's Crew Return Vehicle for the ISS. We believe that this is the first test of a hybrid synthetic vision system which combines nose camera video with a LandForm synthetic vision display. Described by astronauts as 'the best seat in the house', the system will ultimately make space travel safer by providing situation awareness during the landing phase of flight."*

The RIS press release provided a link to an article in Aviation Week & Space Technology:
http://www.aviationnow.com/avnow/news/channel_space.jsp?view=story&id=news/sx381211.xml

As a result of more searching I have discovered a link to a Johnson Space Center SBIR Phase II award to Rapid Imaging Systems at http://sbir.gsfc.nasa.gov/SBIR/successes/ss/9-058text.html .

It includes a particularly relevant paragraph:

> *The Advanced Flight Visualization Toolkit (VisualFlight™) project is developing a suite of virtual reality immersive telepresence software tools which combine the real-time flight simulation abilities with the data density of a Geographic Information System (GIS). This technology is used for virtual reality training of crews, analysis of flight test data, and as an on-board immersive situation display. It will also find application as a virtual cockpit, and in teleoperation of remotely piloted vehicles.*

{The emphasis on teleoperation of remotely piloted vehicles is mine.}

A search of the SBIR archive shows the following entries.

For 2001 Phase I:
Rapid Imaging Software, Inc.
[redacted] b(6)
Mike Abernathy [redacted]
[redacted]
Integrated Video for Synthetic Vision Systems

For 2001 Phase II:
Rapid Imaging Software, Inc.
[redacted] b(6)

Synthetic Vision

I became aware of NASA's Synthetic Vision program perhaps two years ago from a program on NASA TV. I was unable to follow it up at that time due to health problems and the demands of my other patenting activity.

According to the NASA Aviation Safety Program Web site (http://avsp.larc.nasa.gov/program_svs.html)

Synthetic Vision Systems

TECHNOLOGY WOULD REDUCE AIRLINE FATALITIES
Synthetic Vision would give pilots clear skies all the time

A revolutionary cockpit display system being developed with seed money from NASA would help prevent the world's deadliest aviation accidents.

And I agree.

My U.S. Patent that pertains to this use of synthetic vision is: **U.S. Patent 5,566,073 Pilot Aid Using a Synthetic Environment** issued October 15, 1996 to Margolin. (I am the inventor and owner of the patent.) The patent application was filed August 9, 1995, and was a continuation of Application Ser. No. 08/274,394, filed July 11, 1994.

The patent can be downloaded from the USPTO Web site (www.uspto.gov) in html (no drawings) or in an odd tif format (with the drawings) that requires a special viewer.

The patent can also be downloaded from my Web site in PDF format at:
http://www.jmargolin.com/patents2/pilot.htm

As with the X-38 program I have no way of knowing exactly what method(s) NASA used in its Synthetic Vision program (unless you are willing to make a full disclosure). My patent covers techniques as exemplified by claim 1.

> *1. A pilot aid which uses an aircraft's position and attitude to transform data from a digital data base to present a pilot with a synthesized three dimensional projected view of the world comprising:*
>
> *a position determining system for locating said aircraft's position in three dimensions;*
>
> *a digital data base comprising terrain data, said terrain data representing real terrestrial terrain as at least one polygon, said terrain data generated from elevation data of said real terrestrial terrain;*
>
> *an attitude determining system for determining said aircraft's orientation in three dimensional space;*
>
> *a computer to access said terrain data according to said aircraft's position and to transform said terrain data to provide three dimensional projected image data according to said aircraft's orientation; and*
>
> *a display for displaying said three dimensional projected image data.*

NASA's Visits to My Web Site

There is good reason to believe that NASA was aware of my work in these areas through visits to my Web site. NASA has been visiting my Web site (www.jmargolin.com) regularly since I started it in December 2000. (I have no objection to NASA's visits; I am flattered that NASA considers my Web site worth visiting.)

A listing of NASA access statistics follows the end of this fax.

I also have regular visits from http://cap.nipr.mil, which I understand is a secure gateway to other military networks. I don't know if NASA uses nipr so I have not included it in my listing.

The Web Statistics software provided by my Web Hosting Service tell me who is visiting my Web site and what people are looking at but not who is looking at what, (In January of this year I discovered there are raw Web log files containing this information but my Web Hosting Service does not keep backup log files older than the previous month.)

I am including an example of the detailed Web log data; it's understandable why my Web Hosting Service abstracts it into a less detailed form.

The article being referenced is **Unit Vector Math for 3D Graphics** (www.jmargolin.com/uvmath/uvmenu.htm)

Now that I can see what people are looking at I have noticed a great deal of interest in this article as well as **The Relationship between Unit Vector Rotations and Euler Angle Functions** . (www.jmargolin.com/uvmath/euler.doc)

These articles also seem to interest military contractors like Lockheed Martin (lmco.com), Boeing (boeing.com), Northrop Grumman (northgrum.com), and SAIC (saic.hq.nasa.gov) as well as a large number of educational institutions.

Some accesses are obviously just for fun, to articles such as to **Gas Music From Jupiter** (www.jmargolin.com/gmfj/gmfj.htm)

There are also visits from most of our national labs. I expect they are interested in **U.S. Patent 6,377,436 Microwave Transmission Using a Laser-Generated Plasma Beam Waveguide** issued April 23, 2002 to Jed Margolin.

Abstract

A directed energy beam system uses an ultra-fast laser system, such as one using a titanium-sapphire infrared laser, to produce a thin ionizing beam through the atmosphere. The beam is moved in either a circular or rectangular fashion to produce a conductive shell to act as a waveguide for microwave energy. Because the waveguide is produced by a plasma it is called a plasma beam waveguide. The directed energy beam system can be used as a weapon, to provide power to an unmanned aerial vehicle (UAV) such as for providing communications in a cellular telephone system, or as an ultra-precise radar system.

There is a possibility that this device could be used to make a linear Tokamak. (www.jmargolin.com/debs/debs.htm)

Conclusion

I realize this is a great deal of material to wade through, but I would appreciate confirmation that you have received it and, if possible, an estimate as to when I can expect to hear NASA's decision on this claim.

Hopefully, then we can discuss compensation. The '724 patent is available for sale if NASA wishes to purchase it to avoid setting the precedent of the U.S. Government paying compensation for each flight of an aircraft using my patent. (I don't think this would be popular with DOD.) I expect that the first UAV to crash due to Pilot Induced Oscillation (or just Flight Computer Induced Oscillation, as occurred in the first flight of the Predator) would cost more than the cost of buying my patent. I believe this patent also has commercial applications like using UAVs for traffic reporting and in Law Enforcement so your Commercialization Department may be able to generate income with it.

Sincerely yours,

Jed Margolin

Jed Margolin
[redacted]
Phone: [redacted]
Email: [redacted]

b(6)

Here are NASA's visits to my Web site:

June 2001
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
2	0.02%	1	2	73232	0.02%	[redacted]

b(6)

July 2001
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
24	0.27%	24	1	216909	0.08%	[redacted]
1	0.01%	1	1	96274	0.04%	[redacted]
25	0.28%	25	2	313183	0.11%	

b(6)

August 2001
nasa.gov

Total hits Files Pageview Bytes sent | Hostname

Total hits		Files	Pageview	Bytes sent		Hostname
40	0.38%	40	1	184514	0.06%	[redacted]
24	0.23%	24	1	216909	0.07%	[redacted]
64	0.61%	64	2	401423	0.12%	

October 2001
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
1	0.01%	1	1	549657	0.11%	[redacted]

November 2001
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
48	0.39%	24	2	216909	0.06%	[redacted]
42	0.34%	42	1	532111	0.14%	[redacted]
1	0.01%	1	1	21505	0.01%	[redacted]
91	0.73%	67	4	770525	0.21%	

b(6)

December 2001
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
1	0.01%	1	1	90494	0.01%	[redacted]

February 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
1	0.01%	1	0	120832	0.03%	[redacted]
1	0.01%	1	1	504805	0.11%	[redacted]
2	0.01%	2	1	625637	0.13%	

March 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
58	0.35%	45	5	319389	0.05%	[redacted]
6	0.04%	5	4	1299302	0.22%	[redacted]
1	0.01%	1	0	120832	0.02%	[redacted]

65	0.39%	51	9	1739523	0.29%

April 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
40	0.23%	40	1	184514	0.03%	[redacted]
7	0.04%	7	2	45302	0.01%	[redacted]
1	0.01%	1	1	5735	0.00%	[redacted]
1	0.01%	1	0	120832	0.02%	[redacted]
49	0.29%	49	4	356383	0.06%	

May 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
4	0.02%	0	0	0	0.00%	[redacted]
1	0.00%	1	0	120832	0.02%	[redacted]
1	0.00%	1	1	96274	0.02%	[redacted]
6	0.03%	2	1	217106	0.03%	

b(6)

June 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
3	0.02%	1	1	96694	0.02%	[redacted]

July 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
43	0.19%	43	4	190275	0.03%	[redacted]
42	0.19%	42	3	189552	0.03%	[redacted]
2	0.01%	2	2	7802	0.00%	[redacted]
1	0.00%	1	1	350096	0.06%	[redacted]
1	0.00%	1	1	93686	0.02%	[redacted]
89	0.39%	89	11	831411	0.14%	

August 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
24	0.11%	24	1	216909	0.03%	[redacted]

Total hits	%	Files	Pageview	Bytes sent	%	Hostname
1	0.00%	1	1	90494	0.01%	[redacted]
1	0.00%	1	1	142144	0.02%	[redacted]
26	0.12%	26	3	449547	0.06%	

September 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
5	0.02%	1	0	121528	0.02%	[redacted]
1	0.00%	1	0	285696	0.04%	[redacted]
1	0.00%	1	0	120832	0.02%	[redacted]
7	0.03%	3	0	528056	0.08%	

October 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
98	0.45%	98	14	827297	0.11%	[redacted]
1	0.00%	1	1	49690	0.01%	[redacted]
1	0.00%	1	0	120832	0.02%	[redacted]
1	0.00%	1	0	285696	0.04%	[redacted]
101	0.47%	101	15	1283515	0.16%	

b(6)

November 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
27	0.12%	25	1	506284	0.06%	[redacted]
7	0.03%	7	2	45342	0.01%	[redacted] v
2	0.01%	2	2	1155686	0.15%	[redacted]
1	0.00%	1	1	350096	0.04%	[redacted]
37	0.17%	35	6	2057408	0.26%	

December 2002
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
7	0.03%	7	2	45269	0.01%	[redacted]

January 2003
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname

2	0.01%	2	2	29129	0.00%	[redacted]

February 2003
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
2	0.01%	2	2	29138	0.00%	[redacted]

b(6)

April 2003
nasa.gov

Total hits		Files	Pageview	Bytes sent		Hostname
40	0.17%	40	1	184514	0.02%	[redacted]
8	0.03%	5	4	40212	0.00%	
5	0.02%	1	0	121528	0.01%	
4	0.02%	3	3	63471	0.01%	
3	0.01%	3	3	29881	0.00%	
60	0.25%	52	11	439606	0.05%	

Example of Detailed Web Log Data

This is an example of the detailed Web log data, so it's understandable why my Web Hosting Service abstracts it into a less detailed form.

The article being referenced is Unit Vector Math for 3D Graphics (www.jmargolin.com/uvmath/uvmenu.htm)

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khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/fig1.gif HTTP/1.1" 200 2590 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m1.gif HTTP/1.1" 200 2237 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m2.gif HTTP/1.1" 200 1464 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m3.gif HTTP/1.1" 200 715 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m4.gif HTTP/1.1" 200 1720 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m5.gif HTTP/1.1" 200 1738 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m7.gif HTTP/1.1" 200 1549 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m8.gif HTTP/1.1" 200 1939 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m6.gif HTTP/1.1" 200 1762 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m9.gif HTTP/1.1" 200 4152 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m10.gif HTTP/1.1" 200 2732 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m11.gif HTTP/1.1" 200 2572 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m12.gif HTTP/1.1" 200 2580 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m13.gif HTTP/1.1" 200 3915 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m14.gif HTTP/1.1" 200 2591 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m15.gif HTTP/1.1" 200 2224 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m16.gif HTTP/1.1" 200 1858 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m17.gif HTTP/1.1" 200 1742 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m18.gif HTTP/1.1" 200 2642 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m19.gif HTTP/1.1" 200 1738 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m20.gif HTTP/1.1" 200 1762 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:14 -0500] "GET /uvmath/m21.gif HTTP/1.1" 200 1696 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m22.gif HTTP/1.1" 200 2224 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m23.gif HTTP/1.1" 200 1858 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m24.gif HTTP/1.1" 200 1711 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig6.gif HTTP/1.1" 200 3304 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig7.gif HTTP/1.1" 200 995 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig8.gif HTTP/1.1" 200 4441 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig11.gif HTTP/1.1" 200 3186 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig12.gif HTTP/1.1" 200 3743 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig14.gif HTTP/1.1" 200 1936 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)" khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/fig16.jpg HTTP/1.1" 200 61706 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m25.gif HTTP/1.1" 200 1358 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m26.gif HTTP/1.1" 200 1413 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m27.gif HTTP/1.1" 200 1052 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m28.gif HTTP/1.1" 200 1017 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m29.gif HTTP/1.1" 200 1673 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:15 -0500] "GET /uvmath/m30.gif HTTP/1.1" 200 2224 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:24 -0500] "GET /uvmath/uvmath.htm HTTP/1.1" 200 40231 "http://www.google.com/search?q=+%22euler+angle%22+normal+openGL&hl=en&lr=&ie=UTF-8&oe=UTF-8&start=10&sa=N" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

khgmac.larc.nasa.gov - - [01/Apr/2003:09:32:24 -0500] "GET /uvmath/fig3.gif HTTP/1.1" 200 2524 "http://www.jmargolin.com/uvmath/uvmath.htm" "Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; Q312461; .NET CLR 1.0.3705)"

---end

Jed Margolin [redacted] [redacted]
Phone: [redacted] ***Email:*** [redacted] (b)(6)

June 17, 2003

Mr. Alan J. Kennedy
Director, Infringement Division
Office of the Associate General Counsel
National Aeronautics and Space Administration
Headquarters
[redacted] (b)(6)

Attn: GP(02-37016)

Dear Mr. Kennedy,

I have received your letter dated June 11, 2003.

In my contacts with NASA personnel I have repeatedly stressed my desire that this matter be resolved in a friendly manner. However, since NASA has rejected my request to consider a license proffer and in view of your letter of June 11, it is clear that NASA has decided to handle this in an adversarial manner.

Before I respond to your letter in detail, I want to make things easier for me by withdrawing my U.S. Patent **5,566,073** ***Pilot Aid Using a Synthetic Environment*** from this administrative claim in order to focus more directly on NASA's infringement of my U.S. Patent **5,904,724** ***Method and Apparatus For Remotely Piloting an Aircraft***. However, I reserve the right to file a claim concerning the '073 patent at a later time.

(1) The identification of all claims of the patent(s) alleged to be infringed.

As I stated in my email of May 13, 2003 to Mr. Hammerle of LARC and in my fax of June 7, 2003 to you, I have no way of determining exactly which claims the X-38 project may have infringed unless NASA makes a full and complete disclosure to me of that project. I also have no way of determining if NASA has (or has had) other projects that also infringe on my patent unless NASA makes a full and complete disclosure of those projects as well.

Therefore, in order to answer your question, I must request that NASA make a full and complete disclosure to me of the X-38 project as well as any other current or past projects that may infringe on my patent.

If this information requires a security clearance (I have none) I suggest you start the required security investigation immediately. If there is further information that you require in this regard feel free to contact me.

(2) ***The identification of all procurements known to the claimant or patent owner which involve the alleged infringing item or process, including the identity of the vendor or contractor and the Government procuring activity.***

As I stated in my fax to you of June 7, 2003, I became aware that NASA was using synthetic vision in the X-38 project in the January 2003 issue of NASA Tech Briefs, page 40, **"Virtual Cockpit Window" for a Windowless Aerospacecraft**. The article is available at: http://www.nasatech.com/Briefs/Jan03/MSC23096.html

This led me to Rapid Imaging Software, Inc. and their press release (http://www.landform.com/pages/PressReleases.htm) which states:

> *"On December 13th, 2001, Astronaut Ken Ham successfully flew the X-38 from a remote cockpit using LandForm VisualFlight as his primary situation awareness display in a flight test at Edwards Air Force Base, California. This simulates conditions of a real flight for the windowless spacecraft, which will eventually become NASA's Crew Return Vehicle for the ISS. We believe that this is the first test of a hybrid synthetic vision system which combines nose camera video with a LandForm synthetic vision display. Described by astronauts as 'the best seat in the house', the system will ultimately make space travel safer by providing situation awareness during the landing phase of flight."*

The RIS press release provided a link to an article in *Aviation Week & Space Technology*: http://www.aviationnow.com/avnow/news/channel_space.jsp?view=story&id=news/sx381211.xml

As a result of more searching I discovered a link to a Johnson Space Center SBIR Phase II award to Rapid Imaging Systems at http://sbir.gsfc.nasa.gov/SBIR/successes/ss/9-058text.html .

It includes a particularly relevant paragraph:

> *The Advanced Flight Visualization Toolkit (VisualFlight™) project is developing a suite of virtual reality immersive telepresence software tools which combine the real-time flight simulation abilities with the data density of a Geographic Information System (GIS). This technology is used for virtual reality training of crews, analysis of flight test data, and as an on-board immersive situation display. It will also find application as a virtual cockpit, and in teleoperation of remotely piloted vehicles.*

The emphasis on *virtual reality immersive telepresence* and *teleoperation of remotely piloted vehicles* is mine.

A search of the SBIR archive shows the following entries.

For 2001 Phase I:
Rapid Imaging Software, Inc.
[redacted] b(6)
Mike Abernathy
[redacted]
Integrated Video for Synthetic Vision Systems

For 2001 Phase II:
Rapid Imaging Software, Inc.
[redacted]
Carolyn Galceran [redacted]

b(6)

Since my sources of information are limited to those available to the public (magazines such as *Aviation Week & Space Technology* as well as whatever I can find on the Internet) I have no way of knowing if there are other procurements, vendors, contractors, and Government procuring activity related to Claim I-222.

I believe that NASA is in a better position to know what it is (or has been) working on than I am.

(3) A detailed identification of the accused articles or processes, particularly where the article or process relates to a component or subcomponent of the item procured, an element by element comparison of the representative claims with the accused article or process. If available, this identification should include documentation and drawings to illustrate the accused article or process in suitable detail to enable verification of the infringement comparison.

I believe I have answered this in section (2) as much as I am able to without NASA's cooperation.

(4) The names and addresses of all past and present licenses under the patent(s), and copies of all license agreements and releases involving the patent.

There are no past licenses for this patent, and as of this date there are no present licenses for this patent. Naturally, I reserve the right to license this patent in the future as I see fit.

(5) A brief description of all litigation in which the patent(s) has been or is now involved, and the present status thereof.

There has been no past litigation involving this patent, and as of this date there is no present litigation regarding this patent.

(6) A list of all persons to whom notices of infringement have been sent, including all departments and agencies of the Government, and a statement of the ultimate disposition of each.

As of this date NASA is the only agency or department of the Government against which I have filed a claim.

5/11/03 – sent email to comments@hq.nasa.gov

I believe that NASA may have infringed on one or more of my U.S. Patents.
How do I file a claim and whom do I contact?

5/11/03 – Received reply:

Date: Sun, 11 May 2003 17:48:46 -0400 (EDT)
From: "PAO Comments" <comments@bolg.public.hq.nasa.gov>
Message-ID: <200305112148.h4BLmkhJ011314@bolg.public.hq.nasa.gov>
To: <[redacted]
Subject: Thank you for your email.

b(6)

Thank you for your message to the NASA Home Page. The Internet Service Group will attempt to answer all e-mail regarding the site, but cannot guarantee a response by a particular time. The group will not be able to answer general inquiries regarding NASA, which should instead be sent to public-inquiries@hq.nasa.gov

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5/11/03 – Sent email to <public-inquiries@hq.nasa.gov>

I believe that NASA may have infringed on one or more of my U.S. Patents.
How do I file a claim and whom do I contact?

Jed Margolin

As far as I can tell I did not receive a response.

5/12/03 – Sent email to [redacted] (found on Web site) b(6)

I believe that NASA may have infringed on one or more of my U.S. Patents
How do I file a claim and whom do I contact?
(Or is my only recourse to sue in Federal Court?)

Jed Margolin

5/12/03 – Received reply:

Mr. Margolin,

Thank you for contacting NASA with your concerns. I have referred this matter to the Patent Counsel Office, and they will be contacting you to work with you on this issue.

Best wishes,
Jesse Midgett

5/12/03 – Given my experience with trying to contact Government officials via email (or mail, or fax) I hadn't waited for the reply from J. Midgett. I had found the web site for the LARC (NASA Langley) Patent Counsel Office, and called up. I was connected to Kurt Hammerle and we had a nice talk. I sent him an email the next day (May 13, 2003). b(6)

I received a phone call from Barry Gibbens [redacted] who, apparently, was calling because of my email to to J.C.Midgett and hadn't seen the email I sent to K. Hammerle. (I explained to him what I had done.) We had a nice talk. He said he had already sent me a letter.

I received his letter and sent a reply on May 18, 2003 (USPS), adding to the email I had sent K. Hammerle.

Thursday, June 5, 2003 – Received message from B. Gibbens, asking me to call him because I should contact Alan Kennedy at NASA Headquarters [redacted] b(6)

Friday, June 6, 2003 - I called B. Gibbens. Then I called A. Kennedy but he was out.

Saturday, June 7, 2003 – Sent a fax to A. Kennedy. The first number I tried [redacted] only accepted 4 pages (out of 13). I tried a few times. Then I tried [redacted] It turned out that [redacted] was the correct number and that [redacted] was another group. As a result, A. Kennedy initially only got 4 pages. b(6)

Monday, June 9, 2003 – Received message from A. Kennedy and called him back.

He had not gotten the fax so he went and found it. I learned the next day that he had only gotten 4 pages.

We had a "free and frank" discussion. I stressed that I wanted to resolve it in a friendly manner and that I preferred to have NASA buy the patent for the Government.

Tuesday, June 10, 2003 – Received a message from A. Kennedy and called him back.

He said that his Manager has turned down my request that NASA consider a license proffer and has decided to handle it as a Claim, and that the investigation would take 3-6 months.

However, NASA is not the only agency or department of the Government I have contacted.

7/5/1999 Email to: [redacted] b(6)
Dr. Birckelbaw, Project Manager for the UCAV contract awarded to Boeing.

Introduced myself and asked if DARPA was interested in my patent.
Response: none

7/26/1999 USPS Mail to:
Dr. Larry Birckelbaw
Program Manager, Aerospace Systems
DARPA Tactical Technology Office
[redacted] b(6)

Introduced myself and asked if DARPA was interested in my patent. Enclosed copy of patent.
Response: none

Office of the Secretary of Defense (OSD)
Mr. E.C. "Pete" Aldridge
Under Secretary of Defense for Acquisition, Technology, and Logistics
U.S. Department of Defense
Contact Method: Email: [redacted] b(6) May 3, 2002 and June 6, 2002
Response: none

Army - AATD, Fort Eustice, VA.
Col. Wado Carmona, Commander
Applied Aviation and Training Directorate (AATD)
Army Aviation and Missile Command
[redacted]

b(6)

Contact Method:
Email: Ms. Lauren L. Sebring [redacted] June 1, 2002
[redacted]ax:[redacted]

Phone Call Followup: She suggested I talk to Mr. Jack Tansey
Mr. Jack Tansey, Business Development [redacted] June 18, 2002
Email Followup: [redacted] June 18, 2002

Air Force Research Laboratory (AFRL)
Dr. Barbara Wilson
Contact Method: email ([redacted] July 17, 2002
Response - none

Air Force Research Laboratory (AFRL)
Dr. R. Earl Good, Director,
Directed Energy Directorate
Air Force Research Laboratory
[redacted]
Contact Method: Fax [redacted] — July 23, 2002
Response: none

Department of the Air Force
Dr. James G. Roche
Secretary of the Air Force
Washington, DC

b(6)

Contact Method: Fax [redacted] — July 28, 2002

Response: Letter from — August 13, 2002
Lt. General Charles F. Wald
Deputy Chief of Staff, Air & Space Operations, USAF

(7) A description of Government employment or military service, if any, by the inventor and/or patent owner.

I have never been employed by the U.S. Government (or any other government). Likewise, I have never been in military service (in the United States or elsewhere). In the interests of full disclosure, I worked for three summers (1967, 1968, 1969) at the RCA Astro-Electronics Division in Hightstown, NJ . (They had a summer job program for students.)

(8) A list of all Government contracts under which the inventor, patent owner, or anyone in privity with him performed work relating to the patented subject matter.

None. I did this entirely on my own dime.

(9) Evidence of title to the patent(s) alleged to be infringed or other right to make the claim.

This appears to be a two-part question. Does the patent belong to Jed Margolin, and am I that Jed Margolin?

Part 1 - If you look at the front page of the '724 patent you will see that it was, indeed, issued to Jed Margolin, [redacted] — b(6)

If you contact the U.S. Patent and Trademark Office, Document Services Department [redacted] you can order an Abstract of Title to verify that I own the patent. According to 37 CFR 1.12, assignment records are also open to public inspection at the United States Patent and Trademark Office.

Part 2 - If you look up Jed Margolin, [redacted] in a telephone directory you will find assigned to it the telephone number [redacted]. b(6)

When you called me on June 9 and June 10, that was the number you called.

Other than my affirming that I am, indeed, the Jed Margolin in question, I can only suggest that you contact my cousin Lenny (oops, I mean Dr. Len Margolin) who is employed by Los Alamos National Laboratory, and ask him if he has a cousin Jed who is an engineer and an inventor, and who possesses the Margolin gene for being very persistent. (Some say stubborn.) The last time I saw him was in Ann Arbor, Michigan, after he had just passed the orals for his doctorate. (He bought me a beer at a place on South University.)

(10) A copy of the Patent Office file of the patent, if available, to claimant.

I do not have a copy of the USPTO's patent file. What I have is my prosecution file which contains, among other things, privileged communications between my patent attorney and myself.

Besides, in our telephone conversation of June 10, you stated that one of the research centers (I believe it was LARC) had already ordered the file.

(11) Pertinent prior art known to claimant, not contained in the Patent Office file, particularly publications and foreign art.

I have found no relevant prior art.

However, there is an interesting article in the June 2, 2003 issue of *Aviation Week & Space Technology* on pages 48-51 entitled **GA Riding 'Highway-in-the-Sky'** which describes, among other things, the work of Dennis B. Berlinger, lead scientist for flight deck research at the FAA's Civil Aeromedical Institute (CAMI) regarding what is called **Performance-Controlled Systems**. In the Specification of my '724 patent I call it **First Order RPV Flight Control Mode.** In Claim 18:

> 18. The station of claim 13, wherein said set of remote flight controls are configured to allow inputting absolute pitch and roll angles instead of pitch and roll rates.

An Internet search turned up Mr. Beringer's report **Applying Performance-Controlled Systems, Fuzzy Logic, and Fly-By-Wire Controls to General Aviation** as DOT/FAA/AM-02/7.

I am pleased that Mr. Beringer's May 2002 study confirms the value of Performance-Controlled Systems in piloted aircraft and I believe that teaching it in my '724 patent (filed January 19, 1999) gave an additional novel and useful aspect to my invention.

(The article also describes the Synthetic Vision system used in the FAA's Capstone program.)

If you have any further questions, please contact me.

Sincerely yours,

Jed Margolin

Jed Margolin

Enclosed: Response from General Wald
AWST article
Beringer Report
U.S. Patent 5,904,724

Reference 1 (1 Page)

National Aeronautics and
Space Administration

Langley Research Center
100 NASA Road
Hampton, VA 23681-2199

May 14, 2003

Reply to Attn of: 212

Jed Margolin
[redacted]

b(6)

Subject: Infringement Inquiry

Dear Mr. Margolin,

I received notice of your belief that NASA may have infringed one or more of your U.S. patents. In order to address your concerns, we need to receive some more detailed information. Please provide the titles and patent numbers of any patents you feel NASA may have infringed. Please also provide a description of any actions by NASA leading to your belief of possible infringement. Finally, please specify in detail how those actions constitute infringement of your patent(s). This information will allow us to evaluate your assertion and respond and/or react appropriately. Thanks for contacting us. I look forward to hearing from you soon, and discussing your concerns further.

Cordially,

Barry V. Gibbens
Patent Attorney
Technology Commercialization
Program Office

{00009174:1}

Jed Margolin [redacted] b(6)
Phone: [redacted] **_Email:_** [redacted] **_May 18, 2003_**

Mr. Barry V. Gibbens
National Aeronautics and Space Administration
Langley Research Center
[redacted] b(6)

Attn: 212

Dear Mr. Gibbens,

This is in response to your letter dated May 14, 2003.

As we discussed in our telephone conversation on May 16, the information you have requested was supplied in my email to Mr. Kurt Hammerle on May 12, 2003.

After I emailed my inquiry to Mr. Jesse Midgett on May 12, I discovered the web page for the Patent Counsel Office and contacted Mr. Hammerle by telephone.

I apologize for any confusion this may have created.

As a result of more searching I have discovered a link to a Johnson Space Center SBIR Phase II award to Rapid Imaging Software at http://sbir.gsfc.nasa.gov/SBIR/successes/ss/9-058text.html .

It includes a particularly relevant paragraph:

The Advanced Flight Visualization Toolkit (VisualFlight™) project is developing a suite of virtual reality immersive telepresence software tools which combine the real-time flight simulation abilities with the data density of a Geographic Information System (GIS). This technology is used for virtual reality training of crews, analysis of flight test data, and as an on-board immersive situation display. It will also find application as a virtual cockpit, and in teleoperation of remotely piloted vehicles.

(The emphasis on teleoperation of remotely piloted vehicles is mine.)

A search of the SBIR archive shows the following entries.

For 2001 Phase I:

Rapid Imaging Software, Inc.
[redacted] b(6)
Mike Abernathy [redacted]
Integrated Video for Synthetic Vision Systems

For 2001 Phase II:

Rapid Imaging Software, Inc.
[redacted]
Carolyn Galceran ([redacted]
Integrated Video for Synthetic Vision Systems

b)(6)

If there is any additional information regarding my patents that you would find helpful please let me know.

Sincerely yours,

Jed Margolin

Jed Margolin

NASA SBIR SUCCESSES

Johnson Space Center
1998 Phase II

LandForm VisualFlight™

Rapid Imaging Software, Inc.

Alberqueque, NM

Optional Powerpoint file

INNOVATION

LandForm VisualFlight™ is the power of a geographic information system (GIS) and the speed of a flight simulator, accessible from any Windows application.

ACCOMPLISHMENTS

- The Advanced Flight Visualization Toolkit (VisualFlight™) project is developing a suite of virtual reality immersive telepresence software tools which combine the real-time flight simulation abilities with the data density of a Geographic Information System (GIS). This technology is used for virtual reality training of crews, analysis of flight test data, and as an on-board immersive situation display. It will also find application as a virtual cockpit, and in teleoperation of remotely piloted vehicles.
- AFVT will enhance the ability of analysts and operators to interact with large amounts of multidimensional data using the most natural paradigm available: 3D immersion. This operator/data interaction technology will be an advancement comparable to the invention of the Heads-Up Display (HUD). AFVT will move the HUD into the third dimension.
- A simplified user interface, it will fuse real-time 3D displays of terrain with digital maps, satellite data, vehicles, flight paths, and waypoints. This unique and innovative approach will build upon recent software technology research and development from Rapid Imaging Software. VisualFlight™ permits users to construct and deploy their own immersive multidimensional display applications on Windows-based computer platforms.

COMMERCIALIZATION

- VisualFlight™ is sold as a development kit starting with 5 run-time licenses. Users who wish to distribute more applications

GOVERNMENT/SCIENCE APPLICATIONS

- The firm's VisualFlight™ System was used to fly the X-38 on it's latest test flight. The flight vehicle was piloted by astronaut (Ken Ham) using LandForm VisualFlight using LandForm VisualFlight™ technology can purchase additional run-time licenses as needed.

- VisualFlight™ 1.0 has been available to qualified users for several months now, and the response is excellent. VisualFlight™ has been deployed to display live real-time flight data broadcast over a network. Please visit this page for the latest VisualFlight™ developments.
- **LandForm V/O Video Overlay** plug-in for LandForm C3 or Flight Vision is available for the Matrox Corona board only. The price is $4995 for a # single users license. Site license is available for $6995.

For more information about this firm, please send e-mail to: company representative

system as his digital cockpit window.

Return to NASA SBIR Success Listings

Curator: SBIR Support