General Aviation Multi-View Synthetic Vision Display

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Introduction

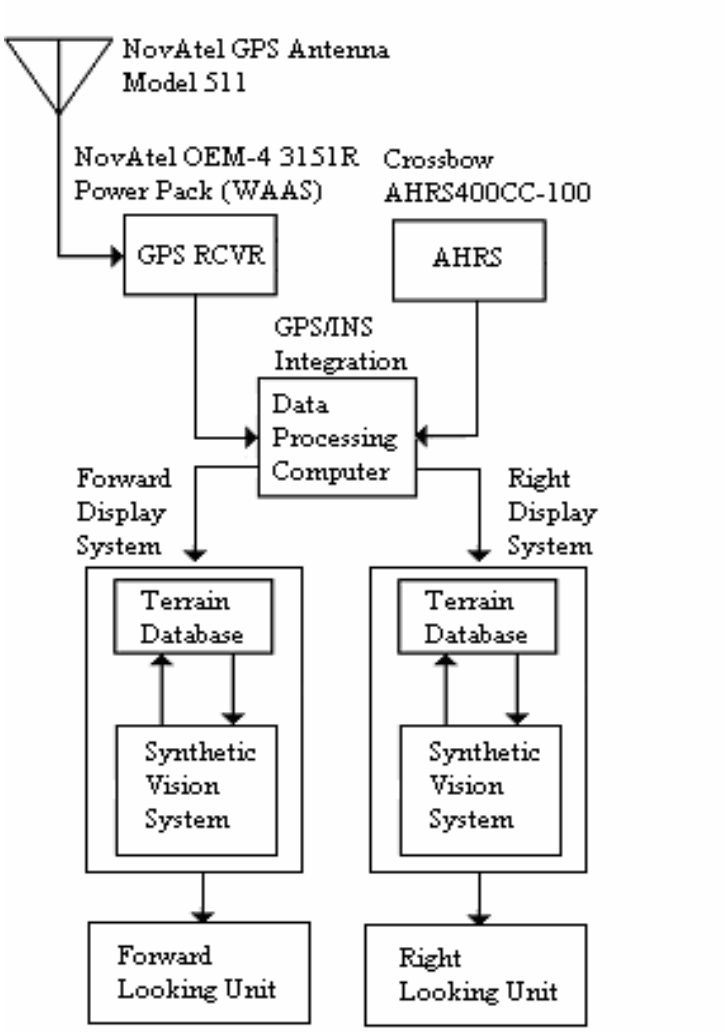
- “Safe is not the equivalent of risk free.” U.S Supreme Court,1972.
- General Aviation instrumentation has undergone little change over the last 50 years.
- Wide variation between the commercial and GA fleet due to the following reasons:

1. Large range of operations with reduced regulation and minimal infrastructure.
2. Large discrepancy in training; flights predominantly single pilot.
3. More take-offs and landings per hour; highest risk phases of any flight.
4. Responsibility of safety primarily on the pilot.
5. Spatial disorientation due to lack of situational awareness.

Multi View Display Architecture

Consists of:

1. **GPS Unit**
   a. GPS Antenna
   b. GPS Receiver
2. **AHRS**
3. **Data Processing Computer**
4. **Right Display System**
   a. Right Synthetic Vision System
   b. Terrain Database
5. **Forward Display System**
   a. Forward Synthetic Vision System
   b. Terrain Database

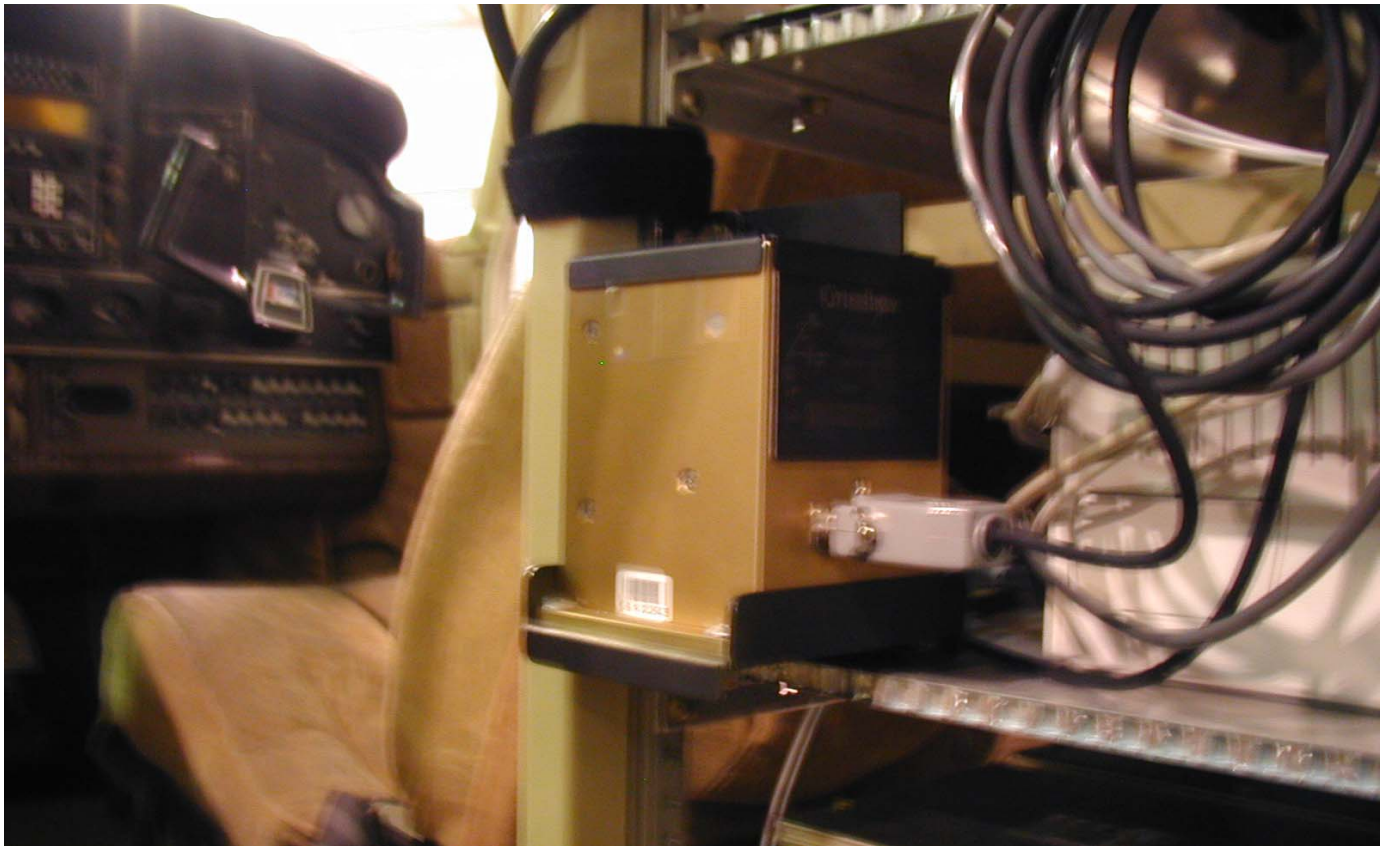


8.4" Backlit 4096 Color TFT Analog VGA LCD Screens.

Equipment Installation

NovAtel GPS receiver capable of providing independent position and velocity estimates up to 20 times per second.

The AHRS Unit



AHRS capable of providing roll, pitch, and yaw at 60 Hz.

Data Processing Computer

Forward Looking Display

Panel Mounted Display

Panel Mounted Display Stowed

Right Looking Display

Panel Mounted vs Head-up Display

- Initial configuration was a Head-up Mounted Display
- Provided the Pilot with a “Out of the Window” View
- Changed to the Panel Mounted Display due to the following benefits:

a. Installation

b. Usability

c. Power consumption

d. Cost

e. Safety

Peripheral Vision Horizon Display (PVHD)

- PVHD is an Expanded Artificial Horizon Line produced by Sweeping a Red Laser across the Instrument Panel in front of the Pilot
- Manufactured by Garrett Manufacturing Limited of Toronto, Canada.
- Reduction in the severity of the Spatial Disorientation.
- The Instrument Panel becomes the Stable Reference and the Artificial Horizon is regarded as the Moving Object.

Advantages of the PVHD

- For the F-111, with plenty of instrument panel available, the PVHD appeared quite compatible
- Less Likelihood of the Perpetual Reversal of Roll Information from the Standard Artificial Horizon
- The PVHD would serve as an Orientation Device and Visual Workload Reduction Device
- Detection of the Aircraft Movements and bring the pilots' attention to the Attitude Indicator (AI)
- Certain deviations in certain flight parameters (e.g., heading and rate of climb errors) were reduced with the PVHD

Disadvantages of the PVHD

- Bright Dots are Substituted for the Horizon at Lower Power Settings
- For the F-15, there were Occasional Annoying Canopy Reflections
- PVHD did not show up when Projected onto Multifunction Display (MFD) Surfaces
- Was Useful Only as a Head-Down Display when Projected below the HUD Control Panel
- When aimed too low, the PVHD struck the Pilot's Knees
- With the Upper Display Area, PVHD caused Major Reflection in the Pilots' Eyes

Disadvantages of the PVHD (Continued)

- For the RF-4C aircraft; too Dim for Effective use in any form of Daylight
- “Pendulum Effect” was Observed in the Roll if Display Repositioned in Pitch at other than its Center
- The PVHD uses a Red Laser. Red laser Signifies Danger
- Motion of the Display Unnecessarily drew the Pilot’s Attention
- Awareness of Peripheral Information was less likely under a High Workload

Flight Tests

- Two Flight Tests Performed at the UNI Airport- Albany, Ohio
- First Flight Test was Conducted at 12.15 hrs on 10th September, 2003
- Forward Looking Display unreadable due to Glare Conditions in Sunlight
- Second Flight Test was Conducted on the 17th September, 2003
- Four Right Traffic Patterns were Flown to Evaluate the GASVD

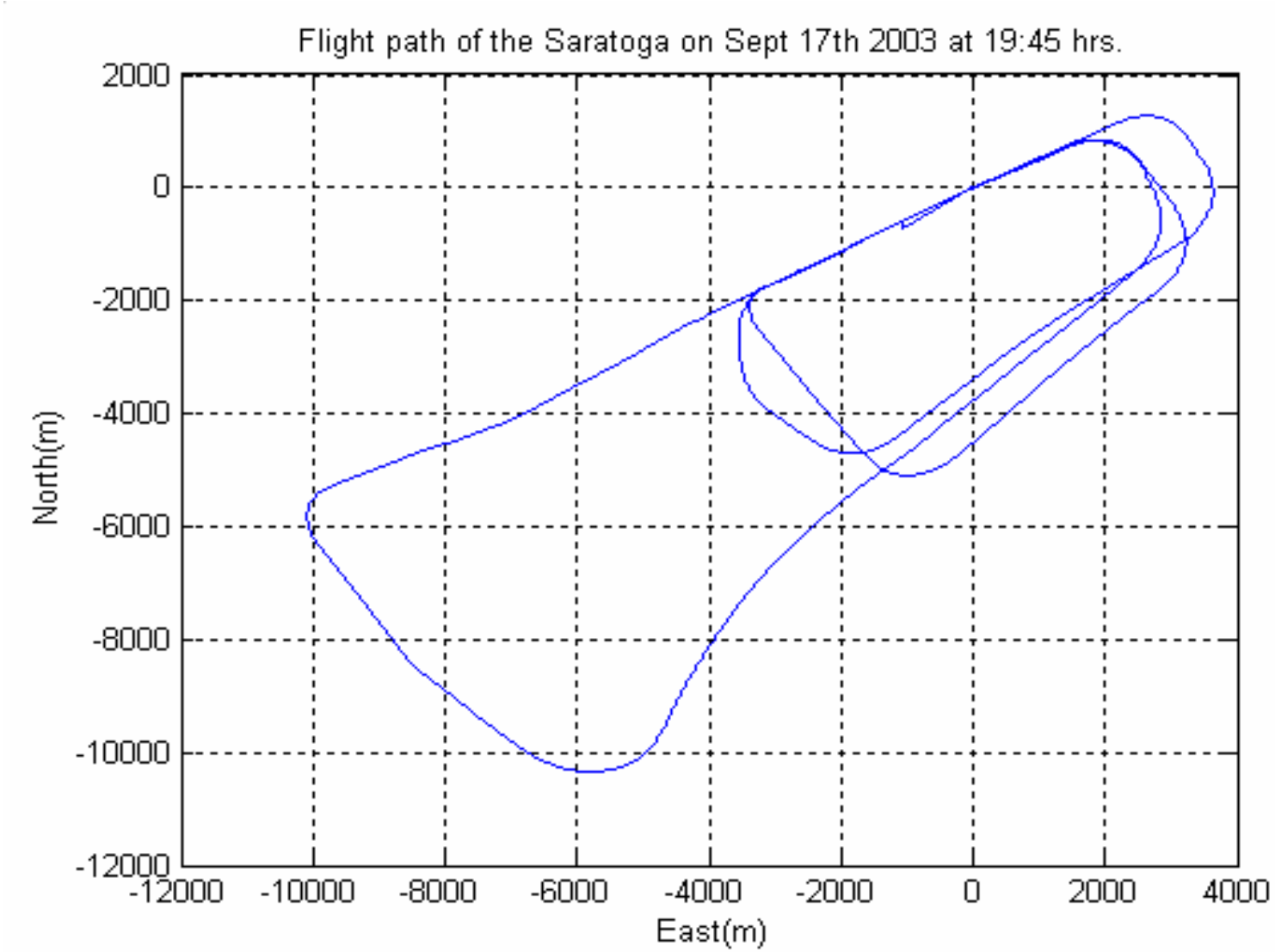
Flight Test (During Right Turn)

Flight Test (During Low Approach)

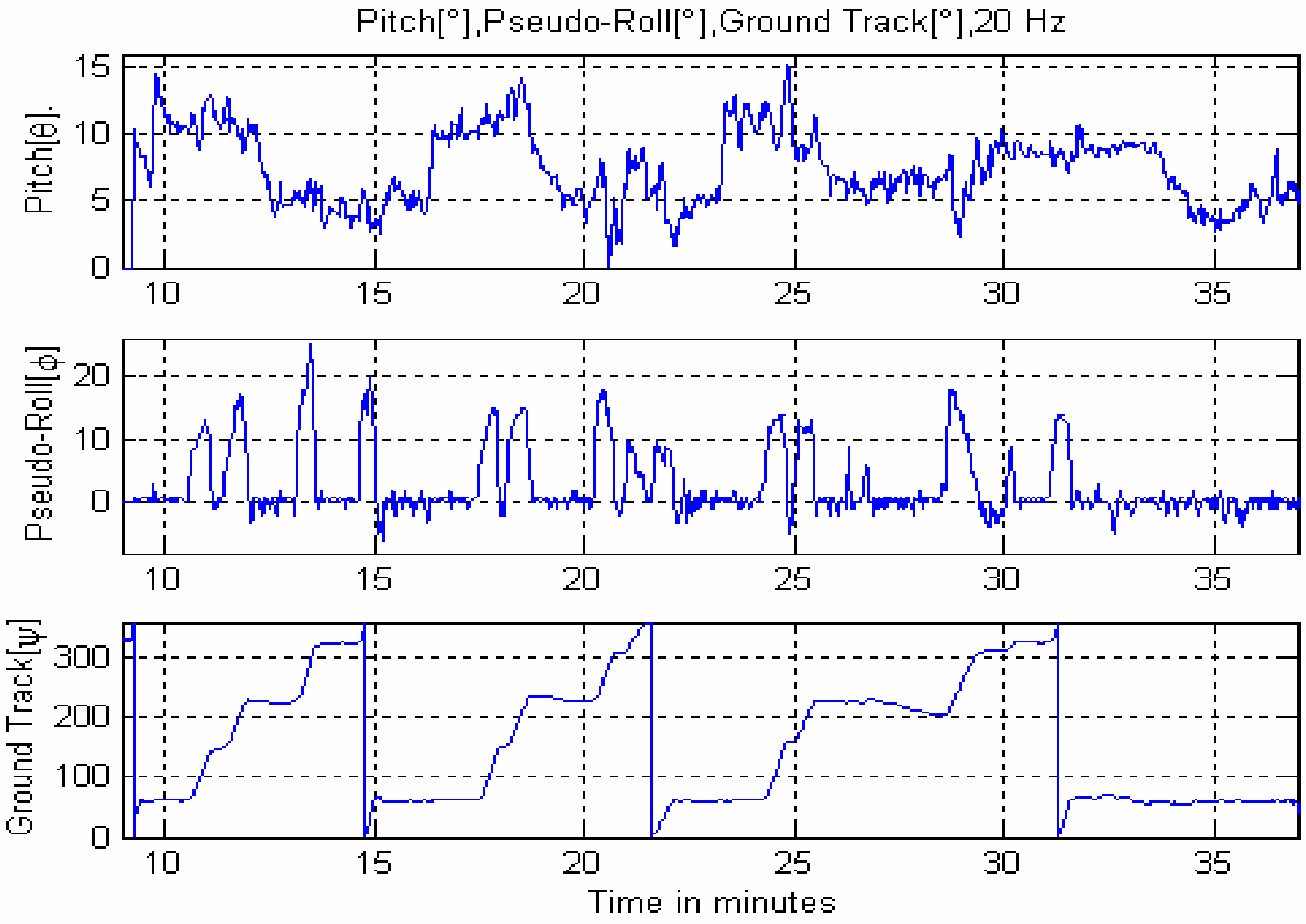
Right Looking Display
(Downwind Leg of Right Traffic Pattern)

Right Looking Display
(Crosswind Leg of Right Traffic Pattern)

Right Traffic Patterns Flown by the Piper Saratoga



Pitch, Pseudo-Roll and Ground Track of the Flight Path

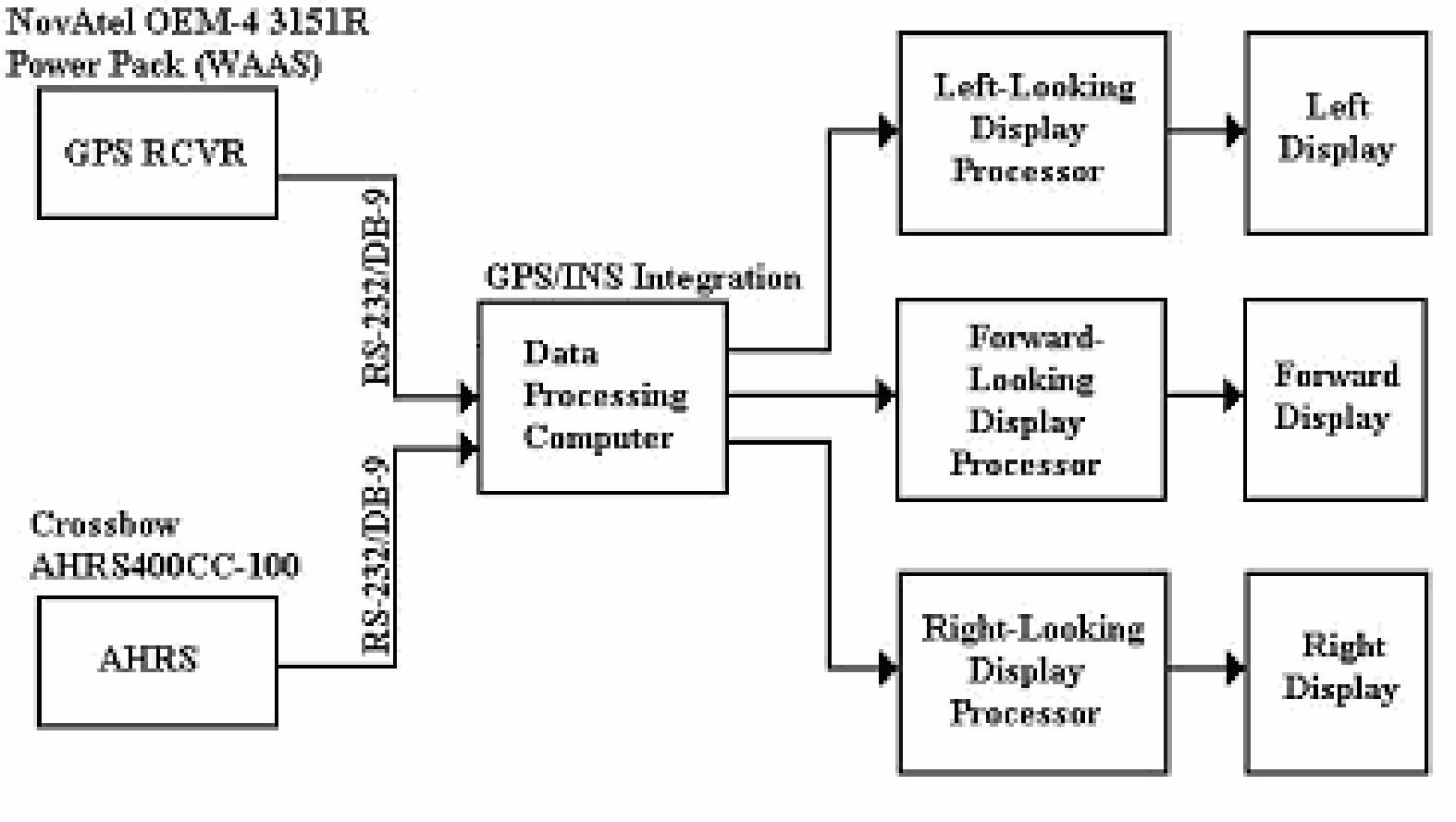


Conclusions

- Provided Accurate Attitude Information and greatly increased Spatial Orientation
- Discrepancy in the Image Size in the Right Looking Display due to increased Peripheral Information
- Very Useful as a Secondary Instrument for Providing Situational and Spatial Awareness
- Parts of the Aircraft (i.e. nose, wing tip) could be included in the Display for Greater Adherence to the Real World
- Placement of LCD Screens within the Instrument Panel to Protect Against Glare from Outside Light Sources

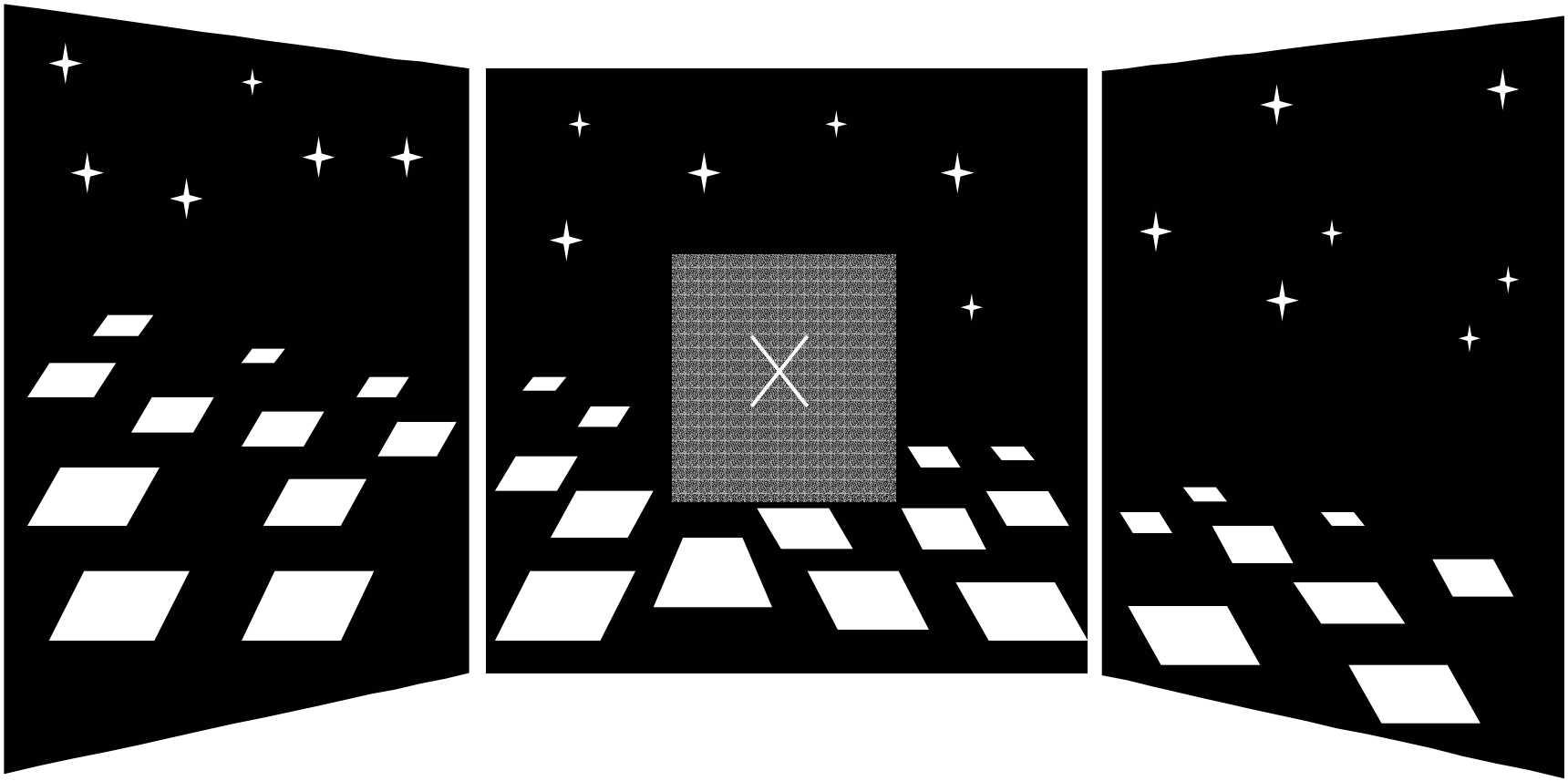
Future Work

- To have a Left, Right, Forward Looking Display for Increased Spatial Awareness



Future Work (Continued)

- Possible Mounting of all the Three Displays on the Front Panel



Future Work (Continued)

- Provision of a Bird's-Eye-View.
- Integration of all the Software onto one Computer.
- Incorporation of the Forward-Looking Display on a Wearable Computer (e.g. Helmet Mounted Displays).

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Questions