



16.070

Final Projects

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Moving Maps

- A moving map display is a situational awareness tool used by pilots in both the civil as well as the military aviation world. The display shows a two-dimensional view of different navigation charts.



Figure 1. SM-4000 COLOR Skymap IIIC by Bendix/King*

* Source : <http://www.avionix.com/movmap.html>

Navigation Charts

Acronym	Scale	Range^Ψ	Full Name
GNC	1:5M	160 nmi	Global Navigation Chart
JNC	1:2M	80 nmi	Jet Navigation Chart
ONC	1:1M	40 nmi	Operational Navigation Chart
TPC	1:500k	20 nmi	Tactical Pilotage Chart

Image Formats

- JPEG - Joint Photographic Experts Group
- GIF - Graphics Interchange Format
- BMP - Windows Bitmap
- Links

<http://www.askscott.com/scott/scholastic/GIFJPG.htm>

<http://www.jpeg.org/>

<http://www.dcs.ed.ac.uk/home/mxr/gfx/2d/BMP.txt>

<http://www.w3.org/Graphics/GIF/spec-gif89a.txt>

Value Addition

- Explain the advantages/ limitations of each of the image formats
- Manipulate images
- Apply the knowledge of the image formats to the moving map display design problem

Attitude and Direction Indicator

- The Attitude Direction Indicator shows the roll and pitch of the A/C

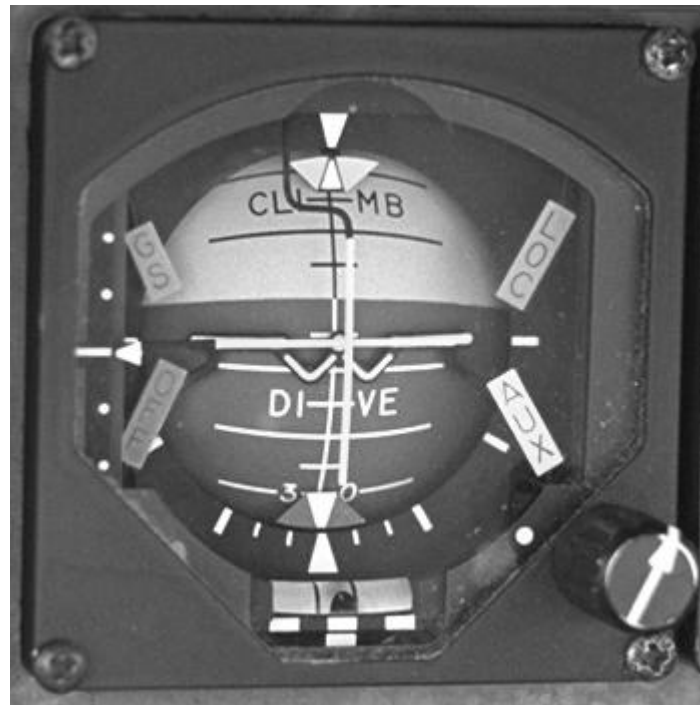


Figure 1. Attitude and Direction Indicator*

* Source: http://xflight.powerweb.de/original/parts/center_console/adi/adi_01.jpg

OpenGL

- Introduced in 1992
- Industry's most widely used and supported 2D and 3D graphics application programming interface (API)
- Stable, Reliable, Portable
- Has an Ada95 API called AdaOpenGL

Value Addition

- Explain the rationale behind multi-function displays
- Use an industry accepted standard for building a simulation
- Understanding the coupling between aircraft and display

Data Links

- Data links allow aircraft to transmit information in real- or near real-time
- Act as a force-multiplier
- Connects information providers with information consumers
 - Fire-Control-Computer – Weapon
 - Aircraft – Air Traffic Controller

RS-232C

- RS-232 is a standard electrical interface for serial communications defined by the Electronic Industries Association ("EIA").
- defines a mark (on) bit as a voltage between -3V and -12V and a space (off) bit as a voltage between +3V and +12V
- The RS-232C specification says these signals can go about 25 feet (8m) before they become unusable

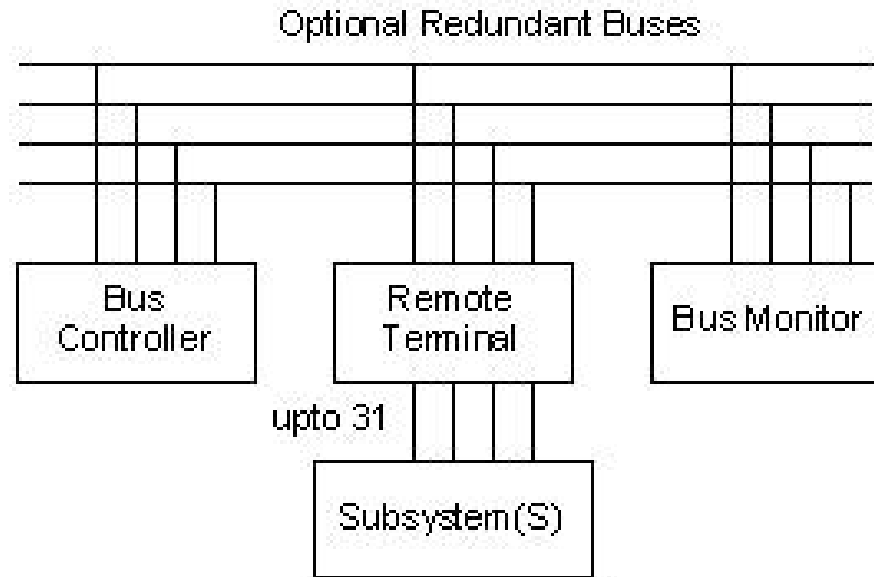
TCP/IP

- TCP and IP were developed by a Department of Defense (DOD) research project to connect a number different networks designed by different vendors into a network of networks (the "Internet").
- Lockheed Martin developed a Maritime Surveillance architecture scaled for P-3C AIP and S-3B Ada P3I systems, and initially demonstrated the capability to link an Ada tactical graphics API to S-3B code

MIL-STD-1553

- The MIL-STD-1553 is a military standard that defines the electrical and protocol characteristics for a data bus
- Commonly used across all military aircraft
- The civil equivalent is ARINC 429, ARINC 629

1553 Architecture



- Bus Controller: Controls bus Access
- Bus Monitor : Records all information flowing on the bus
- Remote Terminal: Talks when instructed by the bus monitor

Value Addition

- Explain how data-links work
- Understand industry standard protocols applicable both in the commercial as well as military world
- Understanding the mapping between application and data link

Fuel Management

- Full Authority Digital Engine Control (FADEC) is an engine manager that monitors fuel consumption and optimizes engine performance.
- The FADEC has to take into consideration the flight envelope of the aircraft, the mode of operation and inform the pilot when bingo fuel is reached.

Value Addition

- Understanding how fuel management works
- Explain the coupling between aircraft mode of operation and fuel management
- Understand complex system modeling.

Kalman Filtering for Position and Velocity Estimation

- The Kalman filter is a set of mathematical equations that provides an efficient computational (recursive) solution of the least-squares method
- Supports estimations of past, present, and even future states, and it can do so even when the precise nature of the modeled system is unknown.

Value Addition

- Explain how Inertial Navigation Systems and Global Positioning System work
- Understand how GPS and INS information can be integrated using a Kalman Filter
- Explain the advantages and disadvantages of using kalman filters

Proportional Navigation

- A method of homing navigation in which the missile turn rate is directly proportional to the turn rate in space of the line of sight.
- Foundational algorithm from which all missile guidance algorithms are derived

Missile Guidance Modeling

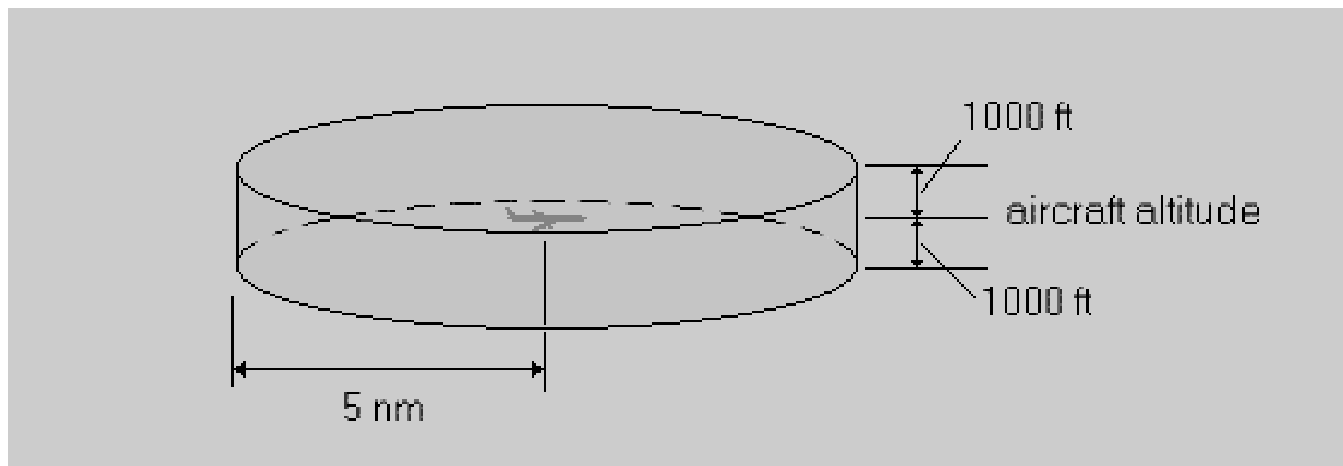
- Numerical solution of differential equations
 - Runge-Kutta integration methods
- Adjoint technique for tactical missile guidance system design
- Proportional navigation and miss distance

Value Addition

- Explain how guidance algorithms work
- Understand how missile engagement simulation can be carried out
- Explain the advantages and disadvantages of using proportional navigation guidance

Conflict Detection

- The task of the conflict detection is to predict an intrusion of the protected zone. This protected zone was chosen to reflect RVSM separation standards: 5 nautical mile radius and a height of 2000 feet (altitude -1000ft to altitude +1000 ft)



Aircraft Modeling

- The aircraft can be modeled using differential equations

$$\dot{x}(t) = v \cos(\theta(t))$$

$$\dot{y}(t) = v \sin(\theta(t))$$

$$\dot{\theta}(t) = (g/v) \tan(\phi(t))$$

Value Addition

- Explain how Conflict detection is carried out for air traffic control
- Understand how separation rules influence the conflict detections process
- Explain the advantages and disadvantages of using different conflict detection algorithms