SNS COLLEGE OF TECHNOLOGY

COIMBATORE-35

DEPARTMENT OF MECHATRONICS ENGINEERING

19MCT402-APPLIED MECHATRONICS ENGG.

Unit – 3 AVIONICS

INTRODUCTION

Avionics is a combination of aviation and electronics. Avionics system or Avionics sub-system depends on electronics. Avionics grew in 1950"s and 1960 as electronic devices which replaces the mechanical or analog equipment in the aircraft.

Avionics equipment on a modern military or civil aircraft account for around;

- 30% of the total cost of the aircraft
- 40% in the case of a maritime patrol/antisubmarine aircraft or helicopter.
- Over 75% of the total cost in the case of an airborne early warning aircraft (AWACS).

NEED FOR AVIONICS

To enable the flight crew to carry out the aircraft mission safely and efficiently. For civil airliner the mission is carrying passengers to their destination. For military aircraft the mission is intercepting a hostile aircraft, attacking a ground target, reconnaissance or maritime patrol.

Advantages

- Increased safety
- Air traffic control requirements
- All weather operation
- Reduction in fuel consumption
- Improved aircraft performance and control and handling and reduction in maintenance costs

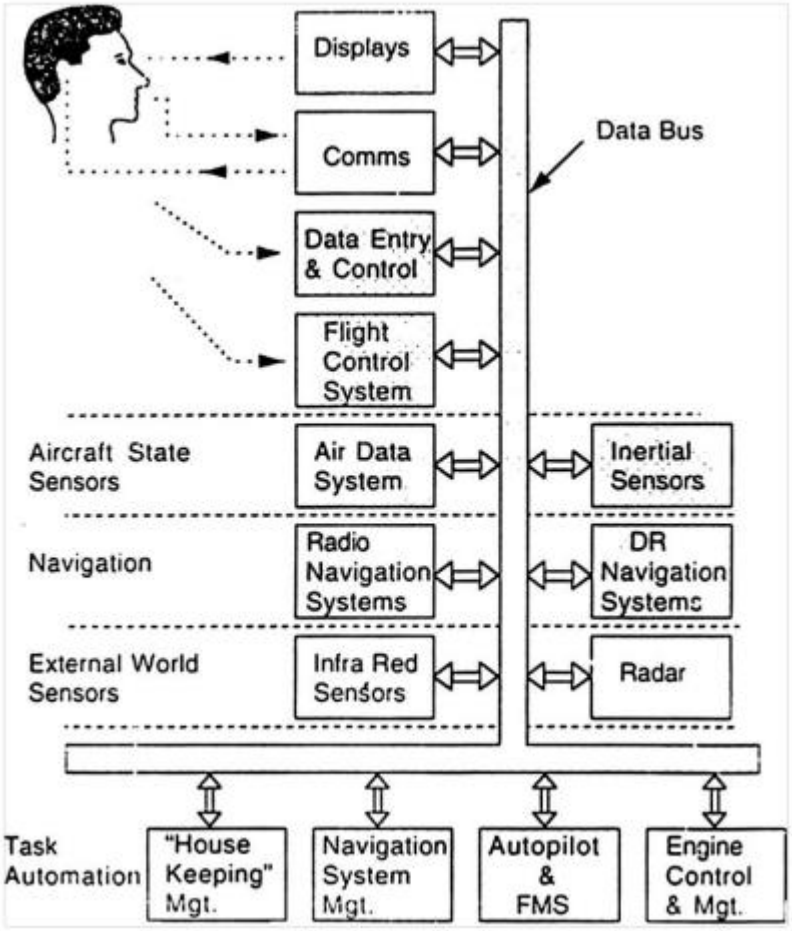
CORE AVIONICS SYSTEMS

A hierarchical structure comprising layers of specific task and avionics system function for enabling the crew to carry out the aircraft mission. The core avionics system is depicted in figure 1.1. In the core avionics system, the systems which directly interface with pilot are given below: Display System It provides the visual interface between the pilot and the aircraft systems. Types

♣ HUD - Head Up Displays

♣ HMD - Helmet Mounted Displays

♣ HDD – Head Down Displays



Communication System

It provides the two way communication between the ground bases and the aircraft or between aircrafts. A Radio Transmitter and Receiver was the first avionics system installed in an aircraft. The different types of frequencies used for several ranges are given below.

Long Range Communication – High Frequency (2 – 30 MHz)

Medium Range Communication – Very High Frequency (30 – 100 MHz)

Military Aircraft – Ultra High Frequency (250 – 400 MHz) Now a days satellite communication systems are used to provide very reliable communication.

Data Entry and Control System

It is essential for the crew to interact with the avionic system. Ex: Keyboards, Touch Panels to use direct voice Input, Voice warning systems and so on. Flight Control System It uses the electronic system in two areas.

(i) Auto Stabilization

• Roll Auto Stabilizer System • Pitch Auto Stabilizer System

(ii) FBW Flight Control Systems It provides continuous automatic stabilization of the aircraft by computer control of the control surfaces from appropriate motion sensors.

Aircraft State Sensor Systems

For control and navigation of the aircraft the air data quantities are essential. Air Data Quantities are,

• Altitude

- Calibrated Airspeed
- Vertical speed
- True Airspeed
- Mach Number
- Airstream Incidence Angle.

The air data computing system computes these quantities from the outputs of sensors which measure the static and total pressure and the outside air temperature.

Inertial Reference System

The aircraft attitude and the direction in which it is heading are provided by the inertial sensor systems (Comprise a set of gyros and accelerometers which measures the aircraft‟s angular and linear motion).

Navigation System

The Navigation system provides Navigation Information (Aircraft‟s position, Ground speed, Track angle).

- Dead Reckoning Systems
- Position Fixing Systems

DR Navigation systems derive the vehicle‟s present position by estimating the distance travelled from a known position from knowledge of the speed and direction of the vehicle.

Types of DR Navigation systems are,

i) Inertial Navigation systems (Most Accurate)
ii) Doppler / Heading Reference Systems (Used in Helicopters)
iii) Air Data / Heading Reference Systems (Low Accuracy when compared to the above systems)

Radio Navigation Systems: (Position Fixing Systems)

Satellite or ground based transmitter is used to transmit the signal and it was received by the receiver in the aircraft. According to the received signals a supporting computer is used to derive the aircraft‟s position. The Prime Position Fixing System used in aircraft is GPS.

ILS

Instrument Landing Systems or Microwave Landing System is used for approach guidance to the airfield.

Outside World Sensor Systems

These systems comprise both radar and infrared sensor which enables all weather and night time operation.

Radar Systems

Weather Radar detects water droplets, cloud turbulence and warning about storms.

Fighter Aircrafts Radars Multi Mode Radars for ground attack role and interception role. The Radar must be able to detect aircraft upto 100 miles away and track several aircraft simultaneously (12 aircraft‟s). The Radar must have a look down capability to track low flying aircraft below it.

Infrared Systems

It is used to provide a video picture of the thermal image scene of the outside world by using fixed Forward Looking Infra Red (FLIR) sensor or a gimbaled IR imaging sensor. The thermal image picture at night looks similar to the visual picture in day time, but highlights heat sources such as vehicle engines. FLIR can also be installed in civil aircraft to provide enhanced vision in addition with HUD.

Task Automation Systems

These systems reduce the crew workload and enable minimum crew operation.

Navigation Management System

It comprises the operation of all radio navigation aid systems and the combination of data from all navigation sources such as GPS and INS systems, to provide the best estimation of the aircraft position and ground speed.

Autopilots and Flight Management Systems

The autopilot relieves the pilot in long range mission. FMS came into use in 1980‟s (Civil Aircraft). The FMS tasks are given below.

(i) Flight Planning
(ii) Navigation Management
(iii) Engine control to maintain the planned speed
(iv) Control of Aircraft Flight Path
(v) Minimizing Fuel consumption
(vi) Ensuring the aircraft is at the planned 3D position at the planned time slot (for Air Traffic Control).

Engine Control and Management

Modern jet engines are having the Full Authority Digital Engine Control System (FADEC). This controls flow of fuel. This control system ensures the engine‟s temperature, speed and acceleration in control. Engine health monitoring system record a wide range of parameters, so it will give early warning of engine.

performance deterioration, excessive wear, fatigue damage, high vibrations, excessive temperature etc.,

House Keeping Management

Automation of the background task which are essential for the aircraft‟s safe and efficient operation.

Background tasks include

i) Fuel management
ii) Electrical power supply management
iii) Hydraulic power supply management
iv) Cabin / Cockpit pressurization systems
v) Environmental control systems
vi) Warning systems
vii) Maintenance and monitoring systems.

AVIONICS SYSTEM DESIGN

Starting point for designing a digital avionics system is a clear understanding of the mission requirements. The three stages of avionics system design are:

- Conceptual design
- Preliminary design
- Detailed design