AVIONICS SYSTEMS FOR UNMANNED AIRCRAFT

Ajoy Raman

AERONAUTICAL DEVELOPMENT ESTABLISHMENT, BANGALORE

ABSTRACT

This paper presents the architecture of the integrated avionics system as implemented on the Mini R.P.V. "FALCON", being developed by the Aeronautical Development Establishment , Bangalore. The modules which implement the avionics functions of Navigation, Guidance, Autopilot and a Secure data link are described and future enhancements are outlined.

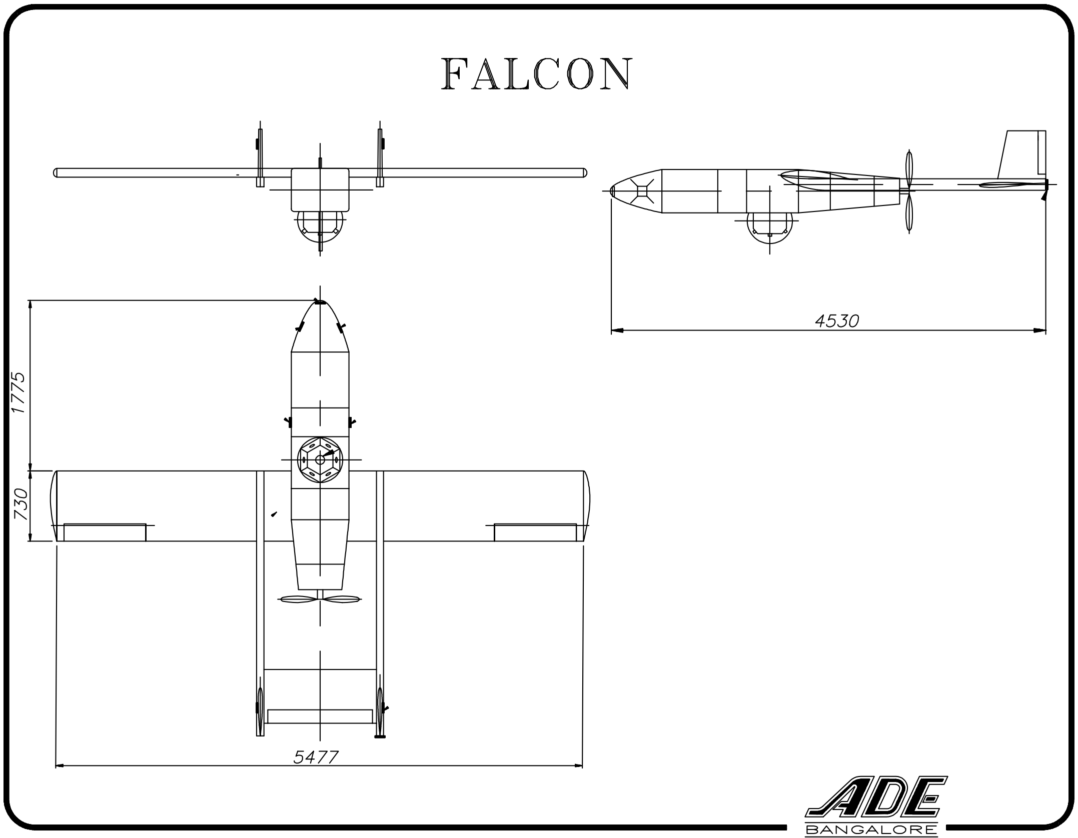
INTEGRATED AVIONICS SYSTEM

MINI RPV 'FALCON'

AND

FUTURE ENHANCEMENT

ADE
BANGALORE

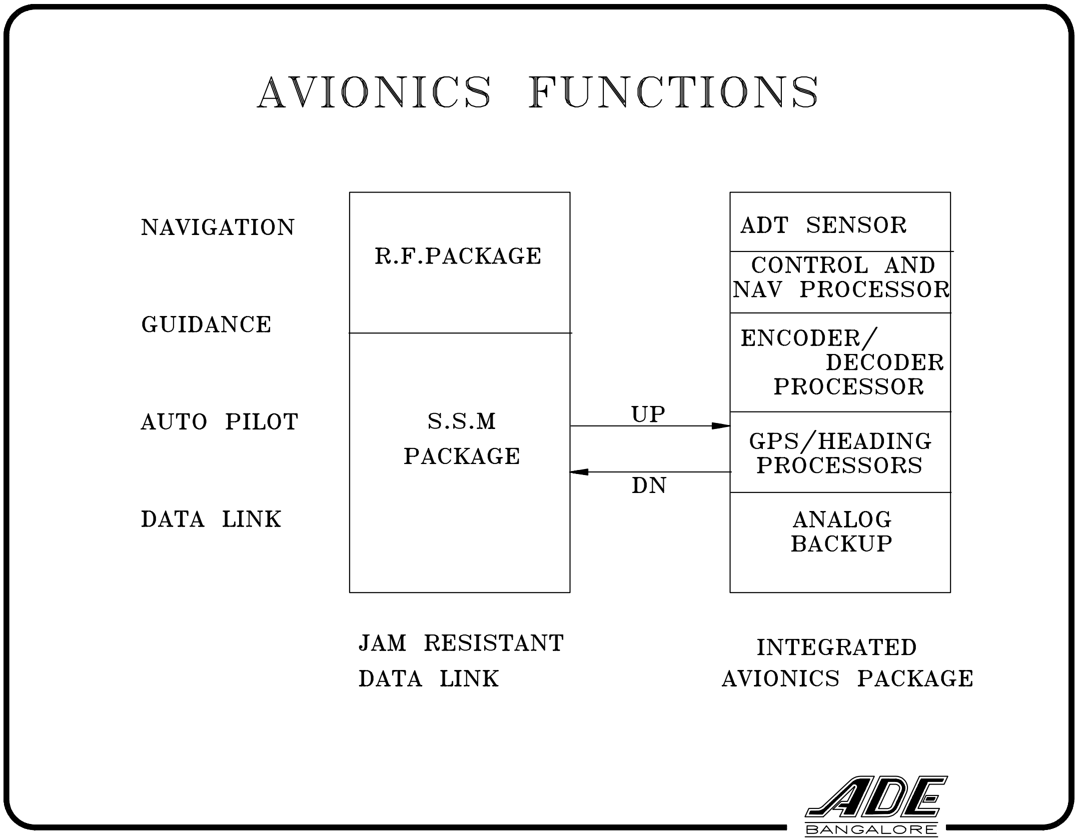


THE MINI RPV "FALCON"

The Mini RPV "Falcon " has a twin boom pusher configuration and is built primarily of composites. It has been designed to carry both hard mounted and gimbal mounted sensors so as to carry out operational roles such as real time, day and night reconnaissance , surveillance and target acquisition.

THE TASK OF THE AVIONICS SYSTEM

The task of the Avionics system is to position the "Falcon" accurately at the intended location so that it can carry out its operational functions. The primary functions of the avionics system are Navigation, Guidance, the Autopilot and the Secure data link.

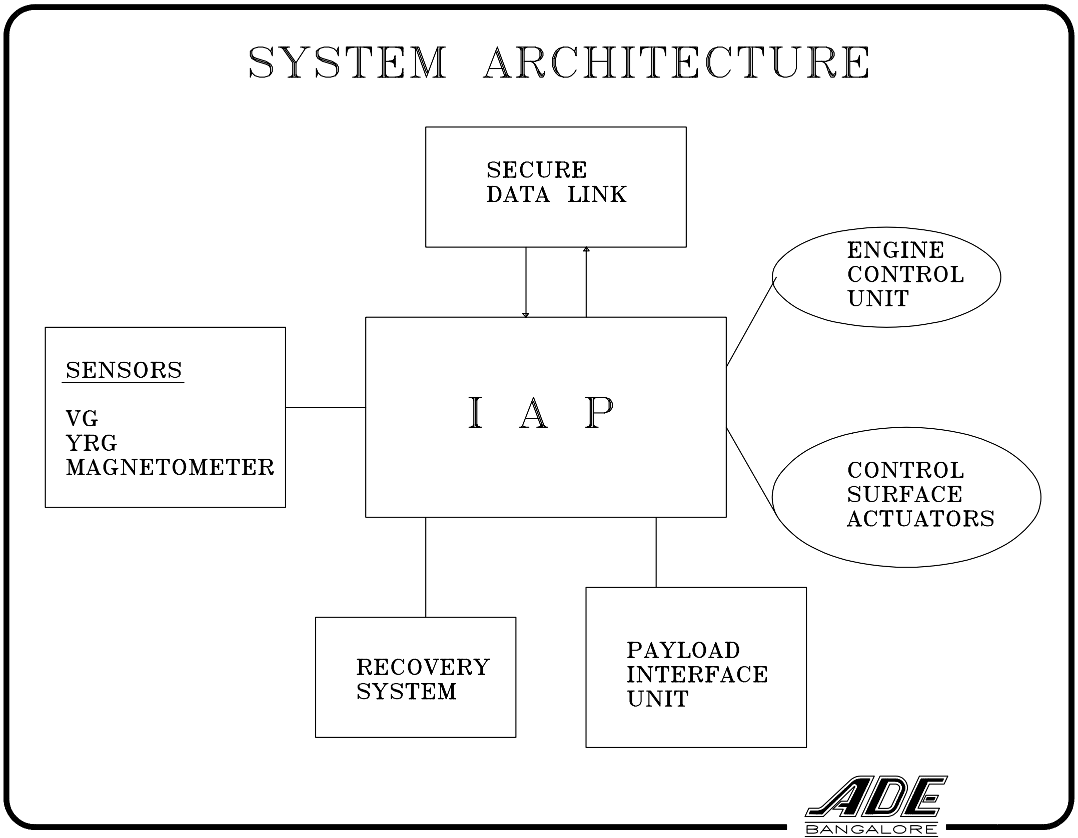


The Secure data link is implemented by an RF package operating in C-Band and a SSM package which provides jam resistance to the Uplink and Downlink data using spread spectrum coding. The remainder of the avionics functions are combined in a single LRU called the Integrated Avionics Package (IAP).

The IAP contains the air data sensors, a control and navigation processor based on the Zilog 8002 processor , an encoder/decoder for the Uplink and Downlink data based on an Intel 80186 processor , a built in GPS kernel, an Intel 8051 based interface processor for handling the GPS data and RS232 data from an external wing mounted magnetic heading sensor. It provides also an analog backup for the basic flight control functions in case of failure of the control and navigation processor.

SYSTEM ARCHITECTURE

The IAP is interfaced to the SSM package via a two way RS 422 link , it is hard-wired to the basic flight control sensors , the Vertical Gyro and Yaw rate gyro which provide the inertial reference for Roll and Pitch and a damping signal for Dutch roll. The magnetometer is connected to the IAP by a RS232 link.



The Control and navigation processor obtains data from the encoder/decoder , the flight control sensors and the GPS receiver and provides demand outputs to the engine control system and control surface actuators so as to provide basic airvehicle stability and control and implement the navigation modes of flight. The IAP provides data and commands to the Payload Interface unit which controls all the hard mounted and gimbal mounted sensors on the airvehicle. All data transfer between the processors contained in the IAP and between the IAP and the Payload interface unit is through dual-port RAMs.

The airvehicle is recovered using a two stage para recovery system and the ground impact is contained using an air-bag system. The recovery sequence is controlled primarily by the IAP.

The IAP therefore forms the most important subsystem in the Avionics system as it implements the major modules of command data decoding, downlink data encoding, the Flight control system functions, Navigation, payload control and the recovery functions.

SOFTWARE

The IAP architecture primarily being processor based all the functionality is obtained through extensive software. To illustrate the complexity of the software implemented in the IAP an overview of the software modules of the flight control and navigation are presented.

FLIGHT CONTROL AND NAVIGATION SOFTWARE MODULES

1. SCHEDULER
2. COMMAND DESTRUCT
3. PARA RECOVERY
4. PROGRAM
5. NET RECOVERY
6. GET–U–HOME
7. WAY POINT NAVIGATION
8. LATERAL CONTROL
9. LONGITUDINAL CONTROL
10. THROTTLE CONTROL
11. ADDR
12. BIT
13. SENSOR COMPUTATION
14. LAUNCH
15. COMMAND LOSS
16. ALTITUDE HOLD
17. IAS HOLD
18. HEADING HOLD

ADE BANGALORE

The basic flight control and navigation processor runs at a frame time of 10 ms. at which rate the essential digital flight control system is implemented. The scheduler is an extremely important module which permits implementation of other software modules at larger multiples of the basic frame time.

The modules of Lateral control, Longitudinal control and Throttle control implement the stability and control of the airvehicle. The hold modes that is; altitude hold, heading hold and IAS hold are functions available to the controller for ease of maintaining a planned flight. These modes are automatically engaged in the way-point navigation mode so as to fly the airvehicle along a set of preprogrammed way-points. The air data dead reckoning module with pseudo-wind correction forms the basic navigation mode and is updated either by GPS data or tracker data from the ground control system. The program modes implement certain fixed flight patterns at selected way-points. The get-u-home mode is an extension of the navigation mode and is primarily a safety feature in case of link failure. The net recovery guidance mode is an alternative method of recovering the air- vehicle. Commanded destruct and recovery are modes of recovery either over enemy territory or in friendly territory.

ENHANCED ARCHITECTURE

The IAP design facilitates enhancement of its capabilities as and when additional hardware is added to the airvehicle. The possibilities of both hardware and software enhancement are indicated below:

ENHANCED ARCHITECTURE

HARDWARE	SOFTWARE
INERTIAL MEASUREMENT UNIT (IMU)	KALMAN FILTERING
DOPPLER RADAR	HLL
CONCEALED ANTENNAS	RISC PROCESSORS
AWACS DATA	
ALTERNATE TO GPS ?	

ADE BANGALORE

CONCLUSION

INTEGRATE H/W, S/W, MULTIPLE SENSOR DATA AND PROCESSORS SUPPORTING AUTOPILOT, NAV, GUIDANCE AND DATA COMMUNI- CATION KEEPING IN MIND FUNCTIONAL MODULARITY

ADE BANGALORE

CONCLUSION

In conclusion it can be stated that the aim of to-day's avionics systems for unmanned airvehicles is to integrate the hardware and software and use a multi-sensor concept using a modular approach to implement the functions of Navigation , Guidance, Autopilot and Data Link.

REFERENCES

1. "Modular Avionic System for UAVs ", Marvin Silver, Proceedings of the Eighteenth Annual AUVS Technical Symposium , Aug 13-15, 1991.