

WIRELESS FLIGHT DATA RECORDER (FDR) FOR AIRPLANES

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Abstract. This paper is on the urgent need of today's *Aviation Sector* which comes smart materials in airplanes. We have made wireless system i.e. a real time Flight Data Recorder (FDR) in which the data(*Parameters like Engine Temperature ,Fuel Level, Speed ,Location (Latitude And Longitude)etc.*) getting stored in real time, in the plane's FDR(*commonly known as Black Box*), same data will get transferred to our Personal Computer(PC) which is at ground. The data will be transferred via XBEE-RF Module(*long range*). Also, the Global Positioning System (GPS) device will send the Position coordinates logged by the micro-controller at periodic intervals. After processing the data, the data will be uploaded to the server via the GPRS/Internet Connection. The program resident on the server will process the data and map the position on a digital map. The digital map view can be accessed through and other PC's using the Protocol, thus giving real time positioning and different parameters of the plane on ground.

“This paper focuses on sufficient data for analyzing the air disasters as short term application, and reduction of air disasters as long term goal.”

Introduction

Today there are hundreds of plane flying around the world. Some of the Airports have hundreds of plane landing in a very short span of time. Any mistakes at this point of time can mean accident. Sometimes weather can be foggy or it can rain heavily making the runway slippery. Which can lead to Pilot's nervousness and it is possible he can neglect any sign of any parameter being faulty.

In this Paper , we are logging the Plane's Parameter online ,parameters like Engine Temperature ,Fuel Level, Speed ,Location (Latitude And Longitude)etc. ,for this we have the respective sensors interfaced to the Micro-Controller through MUX and ADC and a On Board GPS to sense the exact location of the plane.

The plane sends this information online via XIGBEE to the Ground unit which keeps a track of hundreds of planes at one time.

Flight Data Recorder

A Flight Data Recorder (FDR) (also ADR, for accident data recorder) is a kind of flight recorder. It is a device used to record specific aircraft performance parameters. Another kind of flight recorder is the Cockpit Voice Recorder (CVR), which records conversation in the cockpit, radio communications between the cockpit crew and others (including conversation with air traffic control personnel), as well as ambient sounds. In some cases, both functions have been combined into a single unit.

Popularly referred to as a "BLACK BOX,"(in Fig 1) the data recorded by the FDR is used for accident investigation, as well as for analyzing air safety issues, material degradation and engine performance. Due to their importance in investigating accidents, these ICAO-regulated devices are carefully engineered and stoutly constructed to withstand the force of a high speed impact and the heat of an intense fire.

Following an accident, recovery of the "Black Boxes" is second in importance only to the rescue of survivors and recovery of human [5] remains.



Fig 1 An example of an FDR (Flight Data Recorder). (English translation: FLIGHT RECORDER DO NOT OPEN)

Identification

In this project we are trying to overcome the short-comings of FDR via

- 1) Data Recording : A Wireless FDR can record parameters (such as Fuel Level, Engine Temperature, Cabin Temperature, Location (latitude and longitude via GPS) of Airplane) same data of plane in our personal computer so that if the FDR gets lost or if because of some problem it stops working, we have the data with us.
- 2) Pilot can be informed : At any EMERGENCY, if due to some reason pilot didn't notices the malfunction in plane, pilot can be alerted, immediately. Such that we can save hundreds of lives and prevent many Air Disasters.
- 3) Prevent Pilots Error : As pilots send information to ATC ,a wrong information can lead to an accident, our system we can get rid of this procedure.
- 4) Prevent Future Accident : Also, via this project we can find the reason of accident, which could be rectified in future.

RECENT AIR DISASTER

AIR BLUE crash

Date: July 28 2010 Time: 09:45

Location: Islamabad, Pakistan

Operator: Air Blue Type: Airbus A321-231

Aboard: 152 Fatalities: 152 Ground: 0

Route: Karachi - Islamabad -The passenger plane crashed in the Margalla hills(Fig.2)while attempting to land at Benazir Bhutto International Airport. The tower lost contact with the plane as it was about to land in poor weather conditions. All 146 passengers and crew of 6 were killed. This is the 70th Worst Accident in aviation history. [11]

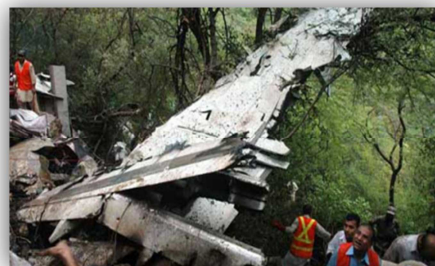


Figure 2 : Debris of AIR BLUE

Air India Express crash

Date : May 22, 2010

Time: 06:10

Location: Mangalore, India

Operator: Air India Express

Type: Boeing 737-8HG

Reg : VT-AXV

Aboard: 166

Fatalities: 158

Ground: 0

Route: Dubai, UAE - Mangalore, India

Details: While attempting to land at Mangalore Airport, the plane overran the runway, slid down a ravine into a wooded valley, and burst into flames.

Air France

Air France was also one of the disaster in which the requirement of online FDR came in thought. Air France crashed on June 1, 2009. [11]

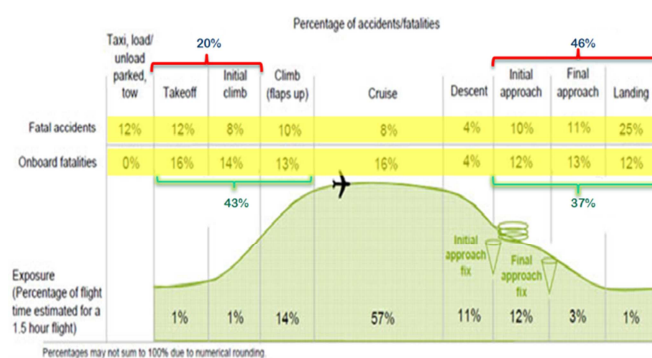


Figure 3: Statistical Summary of Commercial Airplane Accidents, 1959 - 2008, [11]

Accident Data

The data shows the Accident and Fatalities by the phase of flight i.e. while taking off, landing and cruise.

In Fig.3, we can see the maximum number of, approx. 70 % of accident is taking place while taking off and landing [1] and the maximum fatalities i.e. about 80% fatalities took place before or after cruise. Also, Dr. Krishna Kavi [1] has mentioned in his article the main worry regarding air accident is while taking off and landing.

Our paper is recording the data till the plane goes to cruise level and also, when it comes out from cruise. [7]

BLOCK DIAGRAM

The components shown in Fig.4, is explained below :

- 1) *GPS Unit* : The GPS unit continuously sends the co-ordinates to the micro-controller kit. These co-ordinates are received and stored in micro-controller memory [11][08]
- 2) *XBEE-PRO RF MODULES* : The XBee/XBee-PRO OEM 868 RF Modules interface to a host device through a logic-level asynchronous serial port. Through its serial port, the module can communicate through a level translator to any serial device. to our PC.
Here, in this paper we are using a pair of XBEE, one will be interfaced to microcontroller in AIRPLANE and other XBEE which will act as a receiver on ground, which will be interfaced to our personal computer. [6]
- 3) *LCD Section* : The micro-controller is interfaced with 16*2 LCD which used to display the readings of parameters which are being monitored and similar data will be seen on our PC on ground.
- 4) *Sensors* : Here we are using different types of sensors as per the availability. Since, a normal FDR in airplanes records approx 128 parameters. [10][9][7]

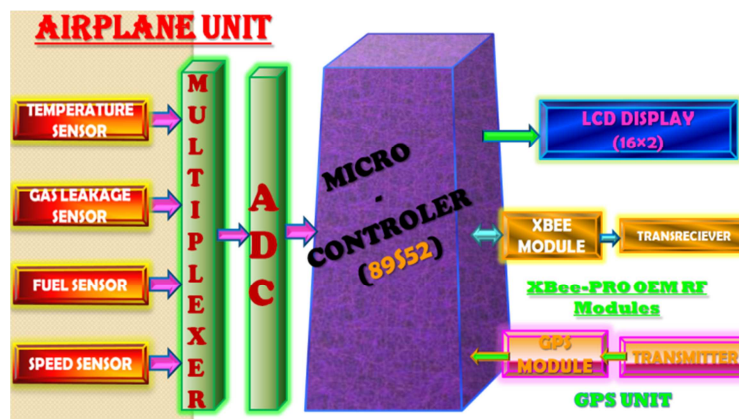


Figure 4. Block Diagram

Ground Unit

The base unit after receiving the co-ordinates displays them on the Visual Basic software on board the pc as shown in Fig.5. The position of the vehicle is then displayed on the map of VB software. Thus the people at the base unit can track the plane as well as monitor all the parameters of plane. In case of emergency it can warn the pilot.



Figure 5: Ground unit

Methodology

In this paper we are using four different sensors, fuel sensor, gas leakage sensor, temperature sensor, speed sensor (*these sensors are selected as per the availability*) and GPS will give the details of position of plane. These sensors will be applied to multiplexer to choose one of the sensor's data. As the sensors give the output in analog form it is converted into the digital form by analog to digital converter (ADC) and applied to the Micro-Controller. The micro-controller will store the data, and display the changes in plane sensors on the LCD. This LCD, we are using to display data like Flight No; Fuel Level (*also the other parameters*) etc. We are using LCD in order to show the correctness with the ground unit.

In the paper project we are going to use a pair on XBEE OEM PRO which acts as trans-receiver. In which one of the XBEE will be placed on plane and interfaced to micro-controller (act as Transmitter) and the other XBEE will be placed on ground interfaced with the CPU (act as Receiver). The data stored in the micro-controller will be send via XBEE on plane to the ground XBEE. The data can be seen on the VB designed window as shown in Fig.6. Which will display all the parameters of plane on our PC which will be in real time.

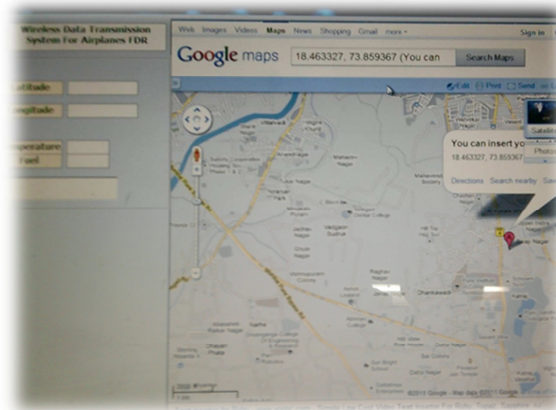


Figure 6. Visual Basic window

Result

In this paper we are trying to overcome the short-comings of FDR via

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The prototypes we have designed have following result shown in table 1.

TABLE 1	
Number of Parameters	5
Location of Airplane	GOOGLE MAP
Data Transfer rate	24 kbps
Data Transfer (5-25 km)	20 kbps
Frequency	868 Mhz
Receiver Sensitivity	-112 dbm

Conclusion

Dr. Krishna M. Kavi in *IEEE Spectrum-August 2010*, mentions in his article named "Beyond The Black Box" that there is an urgent need of a real time FDR[1]. So, that we are just trying to make a wireless data transmission system which can solve many problems related to FDR. Because air passengers safety is our main concern.

Through this paper, we are trying to over-come the problems faced by people working in air maintenance field. Through this paper we are not only trying to prevent the air disasters but also trying to solve the problem related to Black Box or FDR.

Since, today's FDR can't able to record the data for more than 17-25hrs. in Online FDR we can record data for more than the time limit. Also, as the FDR records the data of cabin camera too.

The future of the paper is for our aviation sector by this we will be able to controll many air disaster. In future we will be able to send many other parameters to ground unit. We are looking forward and doing research to make our system a peer-to-peer network.

Also, If we have online recording the data, At the time of HIJACK we can watch every step of hijackers, which would be helpful for investigators. They can then take fast action against the hijackers. [10][12][11] This could have helped the investigators in WTC attack investigation.

Important: The black box of both planes which attacked WTC is yet not found.

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