AN INTELLIGENT REAL TIME FLIGHTDATA ACQUISITION SYSTEM

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Abstract

This paper presents the feasibility of acquiring the transmitting data from an aircraft to ground stations in real time through Flight Area Network (FANET). Instead of waiting for a prolonged time for locating the black box, the valuable information can be recovered instantly via the receiving earth stations. The system overcomes all disadvantages of existing system, such as time delay in getting the black box, cost of dispatching search teams etc. It includes the division of area into segments and the subsequent communication between the plane and earth station of particular segment. A set of shortest path algorithms (SPA) is developed to packetize the flight data, transmit it to the servers in ground stations and integrate the transmitted data to recover the flight information. This flight tracker system will contribute towards saving human lives and improving the safety and reliability of aircrafts.This system is On-mould black box with dynamic routing in which, instead of storing flight data on board, it also transmit the information in real time to the ground. The status of flightlike last problem reported was detected and paves possibility to identify deeper problems of the sensor system on board with live data monitoring in the Data Processing Unit (DPU). Thus the monitoring system can take steps to prevent problems immediately and also in the future. This system is designed to transmit the flight data continuously in real time to the ground station to improve safety and prevent flight accidents.

Key Words: Black box, Data Acquisition unit, FANET, SPA, DPU.

I. INTRODUCTION

The aircraft investigation is basically relying on the black box recorders to investigate accidents. Several researches were performed to monitor and improvise to acquire information on the cause of accidents. The authors have logged the Plane's Parameter online, parameters like Engine Temperature, Fuel Level, Speed, Location (Latitude And Longitude) etc., using 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 [1].

The authors have explained how to detect and collect the information from the vehicle and how to present the data to the user in a simplified way. This paper presents how it collects the status of the sensors and stores it intothe micro controller EEPROM[2] .The usage of acoustic pingers following AODC standards whose signal output frequency is 37.5 kHz, resistance to water depths up to 6096 meters and minimum battery life of 30 days is reported [3]. Flight maneuver evaluation is achieved based on flight maneuver recognition. Quantitative evaluation of flight maneuvers will provide an impersonal remark relate to one pilot or pilot team. Currently, flight maneuver evaluation methods are mainly focus on parameters identification for Equivalent System. This method usually implement by using Maximum Likelihood in Frequency Domain approach and Least Squares approach [4] .The application based on the long-term experience database, Advanced PHM systems adopt the advanced sensor technologies and advanced algorithms, structure an integrated PHM system, which is filled with automatic functions [5]. The authors have achieved the system for accident analysis by objectively tracking what occurs in vehicles [6].Another method proposed a study on a program to convert the data into binary, split and merge data and data compression [7].Authors have contributed the effective development of science to optimize access of information [8]. A study reveal the result got by enrolling 25 randomly selected CVR recordings, efficiency of the proposed algorithm was indicated with high accuracy [9].A detailed analysis is presented to recover data in which corrupted, lost or damaged data is recovered or retrieved from storage devices [10].Most people are aware that large commercial aircraft and some smaller commercial, corporate, and private aircraft are required by the Federal Aviation Administration (FAA) to be equipped with two "Black Boxes", which record information about a flight. Here a simple system that can monitor and record the data continuously to eliminate the need of search operations to track and aviation accident issue.

II.ON-MOULD BLACK BOX SYSTEM

On-mould black box system is a great challenge to the black box in flight safety engineering. It stores all flight data at the ground station in real time. Initially the fight data are displayed on PC using embedded system.

Next, the data are transmitted to the ground stations through Flight Area Network (FANET) as shown in Figure 1.

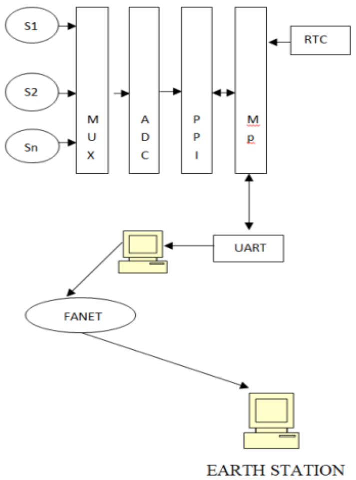

Figure 1 On-mould Black Box

In this black box, embedded system is used for data storage on flight. Shortest Path Algorithm is used to send data to the earth stations. It is based on the distance between the flight and the earth station and when the distance increases, the maximum link time decreases. Maximum link time is the amount of time during which the link between the fight and the current earth station exists. The earth station which having highest link time will be the current earth station of the flight.The proposed shortest path routing algorithm is to route the flight data to the respective ground station used in this system which processes the data acquired in the Data Processing Unit of the Earth Station Server.

III. PROPOSED SYSTEM

A flight tracer system in which the flight data is transmitted in real-time to the ground in addition to being saved in the black box, so that the data would be available instantly in case of a crash. This work also investigates the feasibility of transmission, retrieval and analysis of flight data in real-time when the flight is in progress. A distributed data transmission scheme is developed and a protocol is defined for reliable and efficient transmission of flight data. This idea has been explored in the literature. The flight tracer system includes a distributed fault tolerant handshaking, data transmission protocol and header formats for communication between plane and ground servers. This idea has a strong resemblance with the idea presented here. The system is called "glass box", which replaces the black box. Using glass box, the air craft could easily send the information in real-time to ground, instead of storing flight data on board. Various communication medium alternatives are discussed and difficulties in arriving at a standard are outlined.

In the same intelligent agent based system design in which ground based intelligent agents would collect and analyze the flight data for identification of unsafe conditions. The unsafe conditions refer to those flight conditions when engine temperature, fuel pressure, heading direction, altitude and other data values exceeds their safety thresholds. The proposed intelligent agent based system alerts pilots of such conditions, by developing data mining techniques. Such solutions are not scalable and not targeted towards the global aviation and safety mechanisms. In order to connect selected planes to ground for monitoring or fuel efficiency research, these modules can be added by the airlines to their planes.

A. Flight Data Storage

Each flight data is sensed by their respective sensor, which outputs the flight datum in the form of electrical signals. Each signal is selected one by one by the multiplexer and converted into digital signal using Analog to Digital Converter (ADC).The digital datum from the ADC is directed to the Microcontroller through PPI (Programmable Peripheral Device). Because of limited I/O pins in Microcontroller, PPI is used to get more Digital I/O pins. The microcontroller processed all data and data are locally displayed in LCD of Microcontroller. All parallel data from Microcontroller are directed to the UART (Universal Asynchronous Receiver and Transmitter) which is used to send data serially to PC on board and also used for speed synchronization.

IV. SHORTEST DISTANCE ALGORITHM

If two or more stations are present in any area then shortest distance formula is used to find the shortest distance from the aircraft. The mathematical formula for shortest distance is

Start:

1. Get Latitude and Longitude coordinate of the flight and the ground stations using the GPS

a. Assign $(x_1,$ = (latitude, Longitude) of flight

b. Assign $(x_2,$ = (latitude, Longitude) of origin ground server 1

c. Assign $(x_3,$ = (Latitude, Longitude) of ground server 2

d. Assign $(x_4,$ = (Latitude, Longitude) of ground server 3

2. Find the distance between flight and each ground server using distance formula, D= $\sqrt{(x_2}$ –)2 + ($y_2 - y$

3. a. Assign = Distance between flight server and ground server at origin of flight

b. Assign = Distance between flight server and ground server 2

c. Assign = Distance between flight server and ground server 3

4. a. If $(D_1 <$ then

If $(D_1 <$ then

Transmit flight data to ground server which is at distance from the flight

b. else

If $(D_2 <$ then

If $(D_2 <$ then

Transmit flight data to ground server which is at distance from the flight

c. else

If $(D_3 <$ then

If $(D_3 <$ then

Transmit flight data to ground server which is at distance from the flight

End.

Here D is the distance x_1 and x_2are the latitude of flight and origin ground server while y_1 and y_2 are the longitudes of flight and ground server. The position of ground server gets varied with the flight according to area. If two or more servers are under coverage area of the flight then the one with shortest distance is transferred. This distance is most important in mechanism of the flight tracer system. At the successful reaching of each flight the data from various servers are encoded and a text file is transmitted at the destination of the flight. Thus, the whole data is accumulated in the database of the flight. It is very much uncluttered that, using this system the flight data can be obtained instantly after a crash, with which the exact cause of the crash can be determined without much delay.

V. CIRCUIT EXPLANATION

The circuit diagram of the system is shown in Figure 2. Transducers are used to sense the physical quantities like temperature, RPM etc. These physical changes are converted into electrical energy. These electrical signals will be in analog voltages. Since analog voltage cannot be understandable by the microcontrollers an analog to digital convertor is used to convert the analog signals to digital.

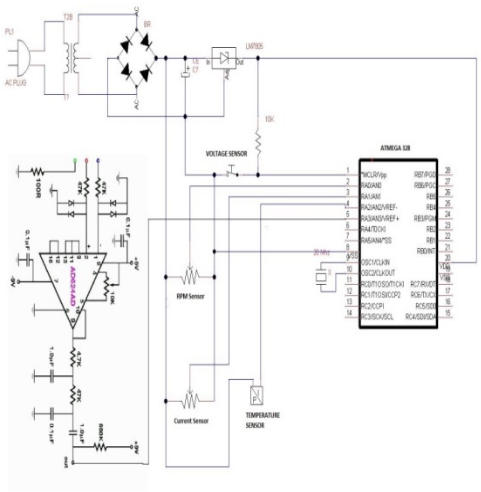

Figure 2 Circuit diagram of Data Acquisition system.

Since more than one analog signals are received from different transducers a multiplex is used to multiplex multiple analog signals into one selected output. The microcontroller At Mega 328 has 8 channel, 10 bit analog to digital converter. The converted digital data is further processed and serially transmitted through RS-232 protocol using built-in UART. The order to differentiate the continuous data received from the transducer, a header and a footer key is added in front and back of each parameters. These headers are further decrypted and decoded at the receiving and then stored it into computer memory for further investigation. A baud rate of 9600 bps is set in the microcontroller as well as in the computer to receive the sensed data. These data is concatenated with the flight unique ID and data and time stamp and retransmitted to the calculated shortest earth station using a secured TCP/IP protocol.

VI. VISUALIZATION OF ON-MOULD BLACK BOX SYSTEM

A. Output 1

One of the stored data within the flight using embedded system is shown below in Figure 3.

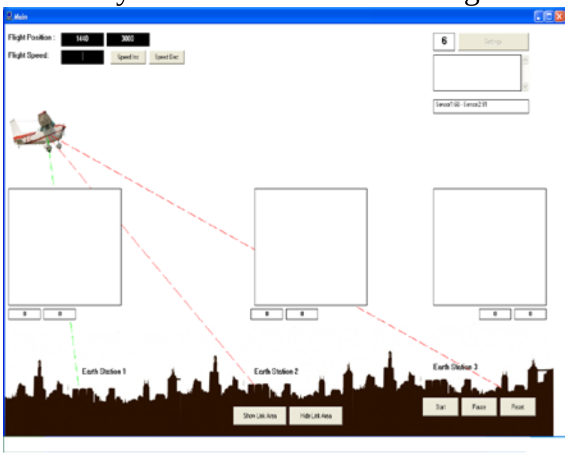

Figure 3 Flight Data Storage Output

In Figure 3, the data from sensor1 and sensor2 are displayed in the text box at the right corner. The sensor values are 68 and 91 respectively. The datum are displayed from the embedded system using wired connection to the system.

B. Output 2

If SP algorithm routing of Earth Station 1 is greater than others, output is shown below in Figure 4.

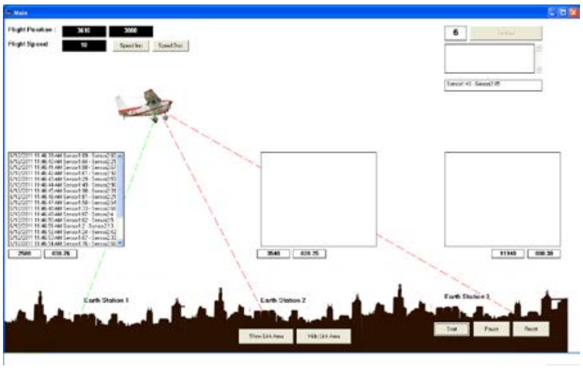

Figure4 Link with Earth Station 1(L1>L2 and L1>L3)

In the Figure 4, the SP algorithm routing of station 1, station 2 and station 3 are 38.76, 28.75 and 8.38 respectively. It is very clear that the earth station1 has maximum LL time (38.76). So, that the communication link exists with the station1. It is represented by the green link between flight and earth station1. There is no communication with the other station is represented by the red links.

C. Output 3

If SP algorithm routing of Earth Station 2 is greater than others, output is shown below in Figure 5.

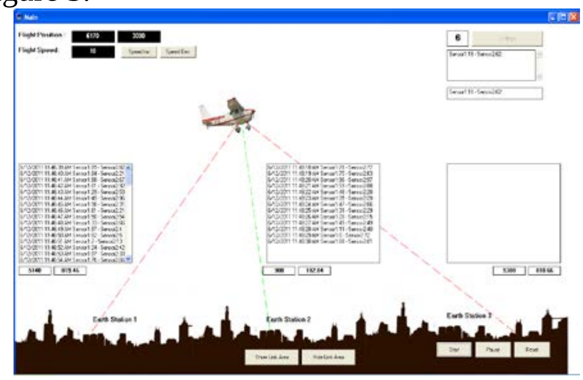

Figure 5 Link with Earth Station 2(L2>L1 and L2>L3)

In the Figure 5, the SP algorithm routing of station 1, station 2 and station 3 are 19.26, 102.4 and 10.66 respectively. It is very clear that the earth station2 has maximum LL time (102.4). So, that the communication link exists with the station2. It is represented by the green link between flight and earth station2. There is no communication with the other station is represented by the red links.

D. Output 4

If SP algorithm routing of Earth Station 3 is greater than others, output is shown below in Figure 6.

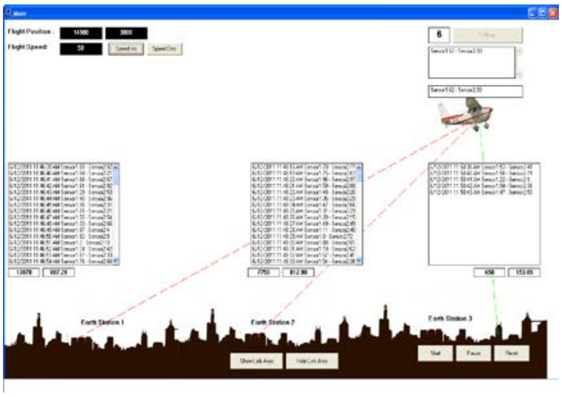

Figure 6 Link with Earth Station 2(L3>L1and L3>L2)

In the Figure 6, the LL time of station 1, station 2 and station 3 are 7.21, 12.90 and 153.85 respectively. It is very clear that the earth station3 has maximum LL time (153.85). So, that the communication link exists with the station3. It is represented by the green link between flight and earth station 3. There is no communication with the other station is represented by the red links.

VII. CONCLUSION

The On-mould Black Box system will be the greatest development in the flight safety engineering. The cause of the crash is identified within a second. It is possible to loss of stored data in On-flight Black box or loss of On-flight Black Box. No steps can be taken to prevent similar in the future. But this is not possible in On-mould Black Box system. A Shortest path algorithm is generated to prevent same kind of accident in the future. The black box is only suitable, if it is immersed in the water. But, this black box is suitable for when crash occurs above the sea or land.

A. Future Scope

In this system the aircraft is been shown in stimulation and only few parameters are used. This will be more useful when this On-mould Black Box system is been implemented in an aircraft and all the parameters id recorded.

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