CHAPTER 1

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.

Here we are logging the Plane's Parameter online, parameters like Engine Temperature, Fuel Level, Speed, Location (Latitude and Longitude) etc., for this we have used respective sensors interfaced to the Micro-Controller through Multiplexer and ADC and a On Board GPS to sense the exact location of the plane. The plane sends this information online via ZIGBEE to the Ground unit which keeps a track of hundreds of planes at one time.

1.1 FLIGHT RECORDER:

A flight recorder is an electronic recording device placed in an aircraft for the purpose of facilitating the investigation of aviation accidents and incidents.

There are two different flight recorder devices: the flight data recorder (FDR) preserves the recent history of the flight through the recording of dozens of parameters collected several times per second; the cockpit voice recorder (CVR) preserves the recent history of the sounds in the cockpit, including the conversation of the pilots.

In some cases, both functions have been combined into a single unit. Popularly referred to as a "BLACK BOX" (in Fig.1.1) the data recorded by the FDR is used for accident investigation, as well as for analysing 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 remains.

Modern day FDRs receive inputs via specific data frames from the Flight Data Acquisition Units (FDAU). They record significant flight parameters, including the control and actuator positions, engine information and time of day.

Fig.1.1: An example of an FDR (Flight Data Recorder)

1.2 RADAR:

Radar is an object detection system which uses radio waves to determine the range, altitude, direction, or speed of objects. Radar systems come in variety of sizes and have different performance specifications. Some radar systems are used for air-traffic control at airports and others are used for long range surveillance and early warning systems. A radar system is the heart of a missile guidance system. Small portable radar systems that can be maintained and operated by one person are available as well as systems that occupy several large rooms.

The modern uses of radar are highly diverse, including air traffic control, radar astronomy, air-defence systems, anti-missile systems, marine radars to locate landmarks and other shifts, aircraft anti-collision systems, ocean surveillance systems, outer space surveillance, meteorological precipitation monitoring, altimetry and flight control systems, guided missile target locating systems and ground penetrating radar for geological observations. High tech radar systems are associated with digital signal processing and are capable of extracting useful information from very high noise levels.

1.3 OBJECTIVES:

- To record specific aircraft performance parameters.
- To alert the pilot about the fuel level and gas leakage level.
- To measure the temperature within the cabin.
- To alert the pilot about the over speed.
- To detect the presence of any object within the specified range using radar.

CHAPTER 2

WORK CARRIED OUT

The design of simple Radar application using Arduino UNO is done. Radar is a long range object detection system that uses radio waves to establish certain parameters of an object like its range, speed and position. Radar technology is used in aircrafts, missiles, marine, weather predictions and automobiles.

Further, it deals with logging the Plane's Parameter online, parameters like Engine Temperature, Fuel Level, Speed, Location (Latitude and Longitude) etc., for this we have used respective sensors interfaced to the Micro-Controller through Multiplexer and ADC and a On Board GPS to sense the exact location of the plane. The plane sends this information online via ZIGBEE to the Ground unit which keeps a track of hundreds of planes at one time.

2.1 IDENTIFICATION:

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

- Data Recording: A Wireless FDR can record parameters such as Fuel Level, Engine Temperature, Cabin Temperature, Location (latitude and longitude) and display same data of plane in our personal computer so that if the FDR gets lost or if because of some problem it stops working but data will be stored in our PC.
- Pilot can be informed: At any EMERGENCY, if due to some reason pilot didn't notices the malfunction in plan e, pilot can be alerted immediately. Such that we can save hundreds of lives and prevent many Air Disasters.
- Prevent Pilots Error: As pilot send information to Air Traffic Controller, a wrong information can lead to an accident, our system can get rid of this type of errors.

2.2 BLOCK DIAGRAM:

2.2.1 WIRELESS FLIGHT DATA RECORDER:

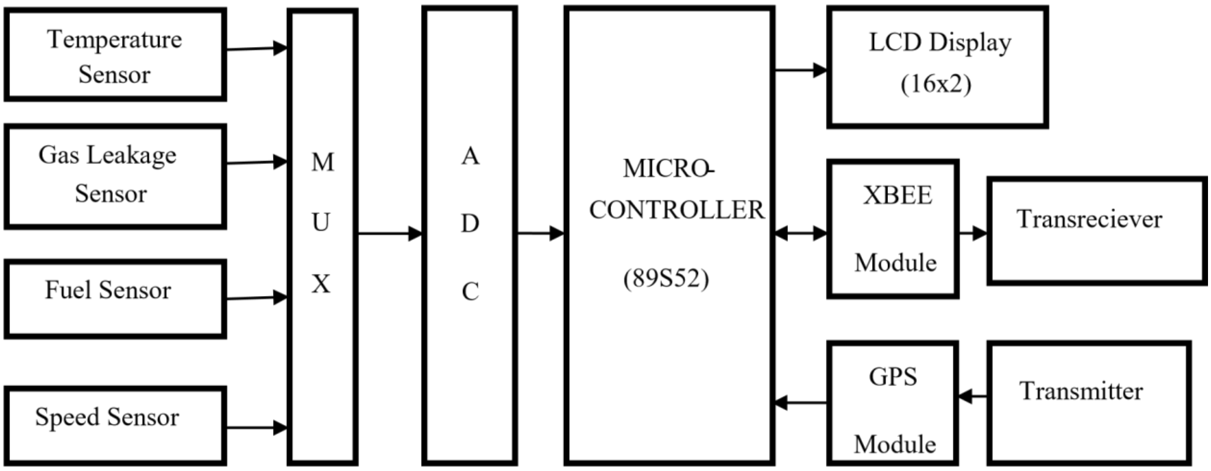

Fig.2.1: Block diagram of wireless flight data recorder.

The block diagram shown in the Fig.2.1 includes the following:

1. Temperature Sensor: A temperature sensor is a device, typically, a thermocouple or RTD, that provides for temperature measurement through an electrical signal. A thermocouple (T/C) is made from two dissimilar metals that generate electrical voltage in direct proportion to changes in temperature.

Fig. 2.2: Temperature Sensor

2. Gas Leakage Sensor: Gas leakage sensor detects the leakage of gas and alerts the user through audio-visual indications.

Fig.2.3: Gas Leakage sensor

3. Speed Sensor: It measures transmission/transaxle output or wheel speed. This information is used to modify engine functions such as ignition timing, air/fuel ratio, transmission shift points, and to initiate diagnostic routines.

Fig.2.4: Speed Sensor

4. Fuel level Sensor: Fuel level sensors are used for accurate fuel level and volume measurement in tanks of vehicles and stationary units. It allows to determine current fuel volume and change in volume of fuel in the tank.

5. GPS Unit: This unit contains GPS module and transmitter. The GPS unit continuously sends the co-ordinates to the micro-controller kit. These co-ordinates are received and stored in micro-controller memory.

6. Multiplexer: A multiplexer (or mux), also known as a data selector, is a device that selects between several analog or digital input signals and forwards it to a single output line.

7. ADC: Analog to digital converter also known as ADC is a system that converts an analog signal, such as a sound picked up by a microphone or light entering a digital camera, into a digital signal.

8. XBEE-PRO OEM RF MODULES: This module contains XBEE module and transreceiever. 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. A pair of XBEE is used, one will be interfaced to microcontroller in airplane and other XBEE which will act as a receiver on ground, which will be interfaced to personal computer.

9. LCD Display: The micro-controller is interfaced with 16*2 LCD which is used to display the readings of parameters which are being monitored and similar data will be seen on Personal computer.

Ground Unit:

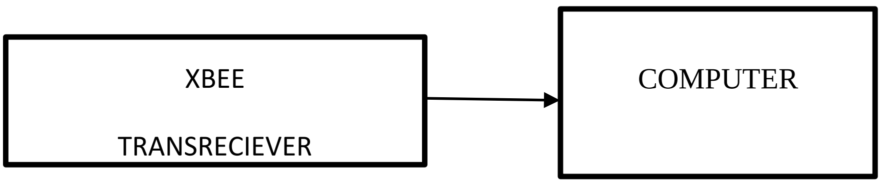

Fig.2.5: Ground Unit

The base unit after receiving the co-ordinates displays them on the Visual Basic software on board the pc as shown in Fig1.42. 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.

2.2.2 TEMPERATURE DETECTION USING RADAR:

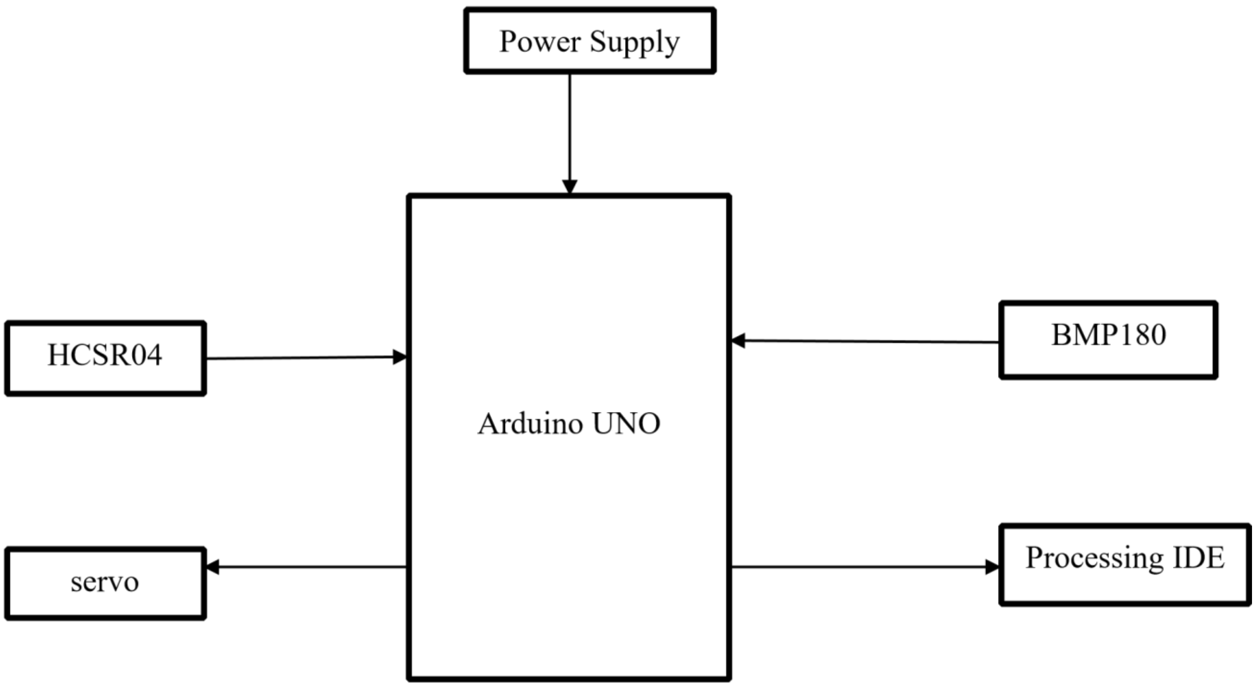

Fig.2.6: Block Diagram of Temperature Detection using radar.

The block diagram shown in Fig.2.6 includes the following:

1. Arduino UNO

The Arduino UNO is a widely used open-source microcontroller board based on the ATmega328P microcontroller and developed by Arduino.cc The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board features 14 Digital pins and 6 Analog pins. It is programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 v battery, though it accepts voltages between 7 and 20 volts.

- Microcontroller: ATmega328P
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V
- In-out Voltage (limit): 6-20V

- Digital I/O Pins: 14 (of which 6 provide PWM output)
- PWM Digital I/O Pins: 6
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB (ATmega328P) of which 0.5 KB used by bootloader
- SRAM: 2 KB (ATmega328P)
- EEPROM: 1 KB (ATmega328P)
- Clock Speed: 16 MHz
- LED_BUILTIN: 13
- Length: 68.6 mm
- Width: 58.4 mm
- Weight: 25 g

The General Pin functions are,

- LED: There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- VIN: The input voltage to the Arduino/Genuino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
- 3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND: Ground pins.
- IOREF: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin

voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.

- RESET: Typically used to add a reset button to shields which block the one on the board.

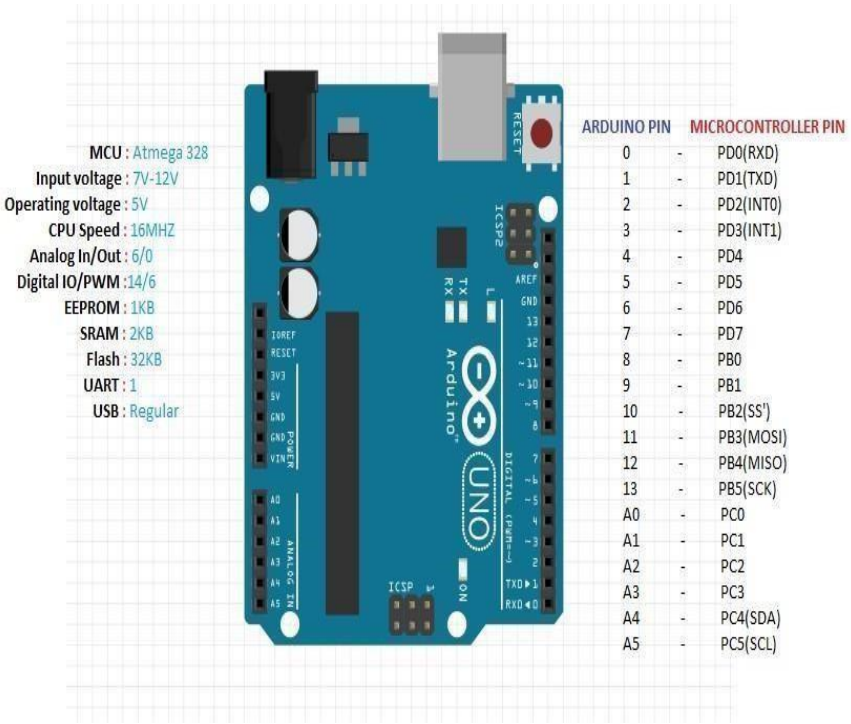

Fig.2.7: Arduino UNO

2. Ultrasonic Sensor

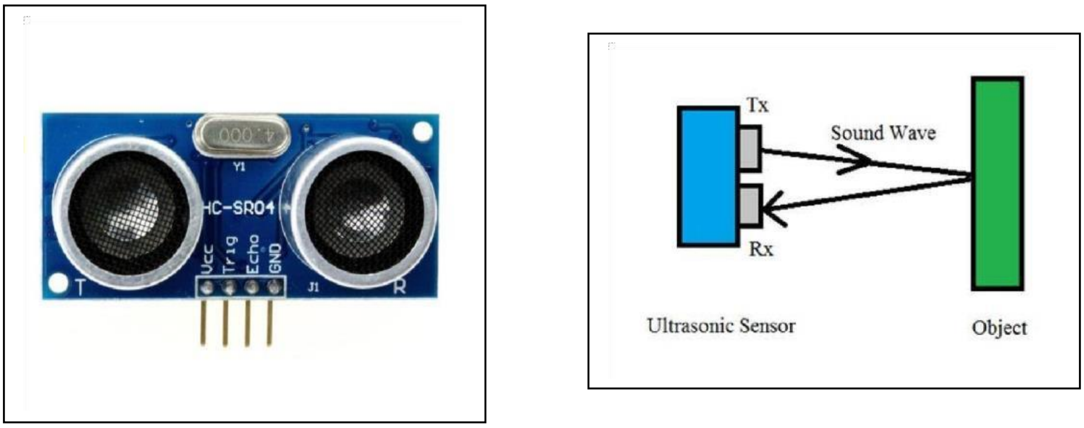

Fig.2.8: Ultrasonic sensor

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.

The working of an ultrasonic sensor is a pulse sent out at 40kHz which travels through the air and if there is an obstacle or object, it will bounce back to the sensor. By calculating the travel time and the speed of sound, the distance can be calculated.

Electric Parameters:

- Working Voltage: DC 5 V
- Working Current: 15mA
- Working Frequency: 40Hz
- Max Range: 4m
- Min Range: 2cm
- Measuring Angle: 15 degree
- Trigger Input Signal: 10uS TTL pulse
- Echo Output Signal: Input TTL lever signal and the range in proportion ➢ Dimension: 45*20*15mm

3. Servo Motor

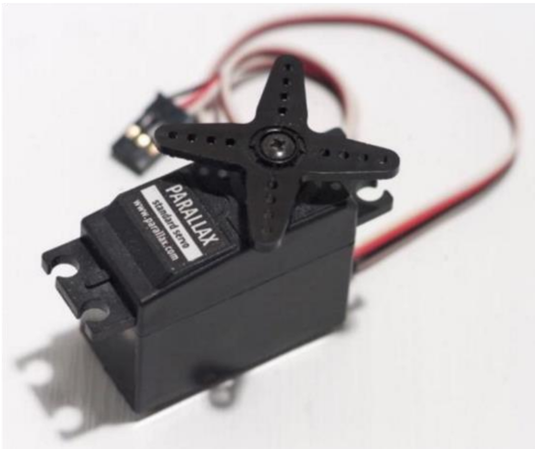

Fig.2.9: Servo Motor

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear positions, velocity and acceleration. The main reason behind using a servo is that it provides angular precision, i.e. it will only rotate as much we want and then stop and wait for next signal to take further action. The servo motor is unlike a standard electric motor which starts turning as when we apply power to it, and the rotation continues until we switch off the power. We cannot control the rotational progress of electrical motor, but we can only control the speed of rotation and can turn it ON and OFF.

4. BMP180 Sensor

BMP180 is one of sensor of BMP XXX series. They are all designed to measure Barometric Pressure or Atmospheric pressure. BMP180 is a high precision sensor designed for consumer applications. Barometric Pressure is nothing but weight of air applied on everything. The air has weight and wherever there is air its pressure is felt. BMP180 sensor senses that pressure and provides that information in digital output. Also the temperature affects the pressure and so we need temperature compensated pressure reading. To compensate, the BM180 also has good temperature sensor.

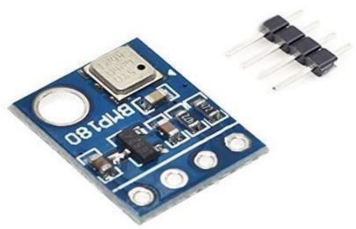

Fig2.10: BMP180 sensor

Key features:

a. Pressure range: 300 ... 1100hPa (+9000m ... -500m relating to sea level)
b. Supply voltage: 1.8 ... 3.6V (VDD)
c. 1.62V ... 3.6V (VDDIO)
d. Package: LGA package with metal lid
e. Small footprint: 3.6mm x 3.8mm
f. Super-flat: 0.93mm height
g. Low power: 5µA at 1 sample / sec. in standard mode
h. Low noise: 0.06hPa (0.5m) in ultra-low power mode ➢ 0.02hPa (0.17m) advanced resolution mode.

CHAPTER 3

METHODOLOGY

3.1. DATA RECORDER:

In this project, four different sensors such as fuel sensor, gas leakage sensor, temperature sensor, speed sensor are used 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 sensors on the LCD. This LCD, we are using to display data like Fuel, speed, gas leakage, temperature level. We are using LCD in order to show the correctness with the ground unit.

A pair of XBEE OEM PRO which acts as trans-receiver is used, in which one of the XBEE will be placed on plane and interfaced to micro-Controller(act as Transmitter) and the other XBEE swill 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, which will display all the parameters of plane on our PC which will be in real time.

3.2. TEMPERATURE DETECTION USING RADAR:

The basic objective of our design is to ascertain the distance position and speed of the obstacle set at some distance from the sensor. Ultrasonic sensor sends the ultrasonic wave in various ways by rotating with help of servo motors. This wave goes in air and gets reflected back subsequent to striking some object.

This wave is again detected by the sensor and its qualities is analyzed and output is shown in screen indicating parameters, for example, distance and position of object. Arduino IDE is utilized to compose code and transfer coding in Arduino and causes us to detect position or angle of servo motor and it is communicated through the serial port alongside the covered distance of the nearest object in its way.

Output of all of this working is shown in the software called Processing, it will display the input/output and the range of the object. Implementations of the sensors are done in such a way that ultra-sonic sensor is attached on top of the servo motor because it has to detect the object and its distance. Arduino (micro-controller) will control the ultra-sonic sensor and servo motor and also powered will be given to both of them through micro-controller.

Based on the rotation of ultrasonic sensor, the graphical representation of the data is shown in red colour. During the period of rotation, if the presence of any object is detected, the graphical representation in green turns red colour.

3.2.1 FLOW DIAGRAM:

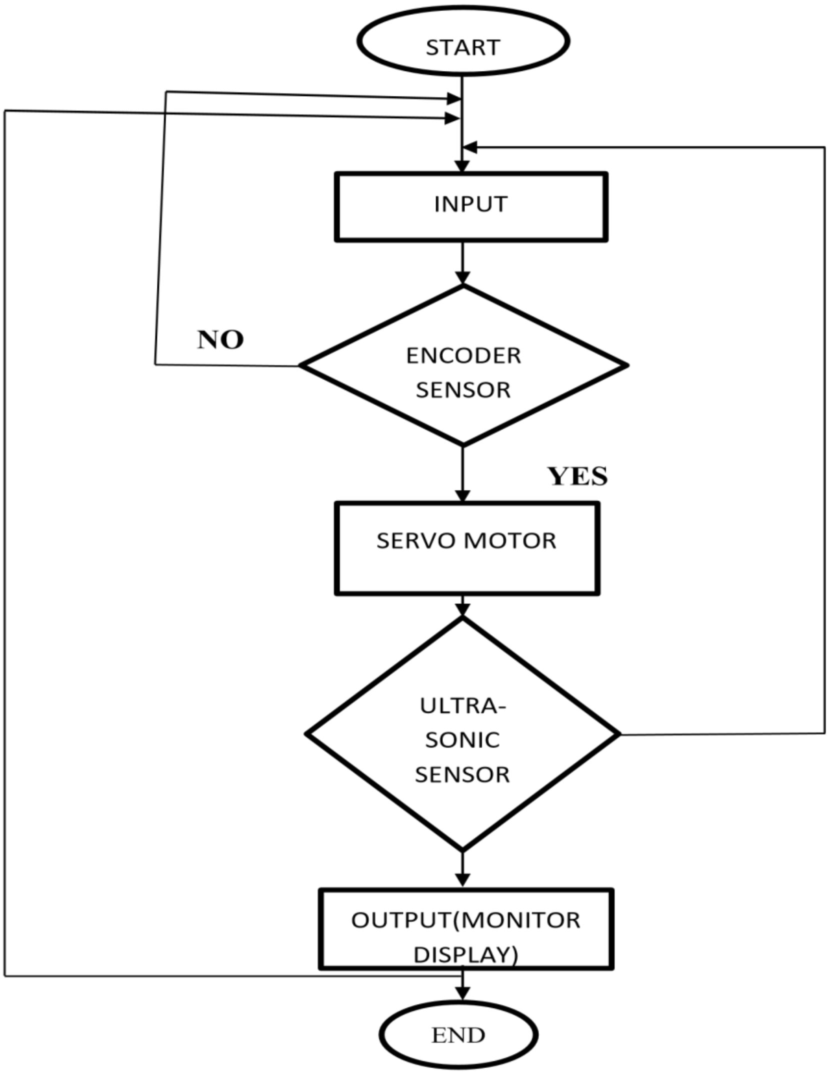

Fig.3.1: Flow chart of radar system

The flow chart shown in the Fig.3.1 explains the working and the decision flow of this framework. As it can be seen the system starts with an input i.e. when the ultrasonic sensor detects an object, or does not detects any object, at any condition the encoder feeds the information in the controller while the servo keeps constantly rotating.

As soon as any obstacle/objet is detected by the ultrasonic sensor the data is immediately processed by the controller and is fed to the IDE which shows it on the display screen. Here the process ends with an estimated distance of the object from the system with the angle at which it is placed.

CHAPTER 4

RESULTS AND FUTURE SCOPE

4.1. FLIGHT DATA RECORDER:

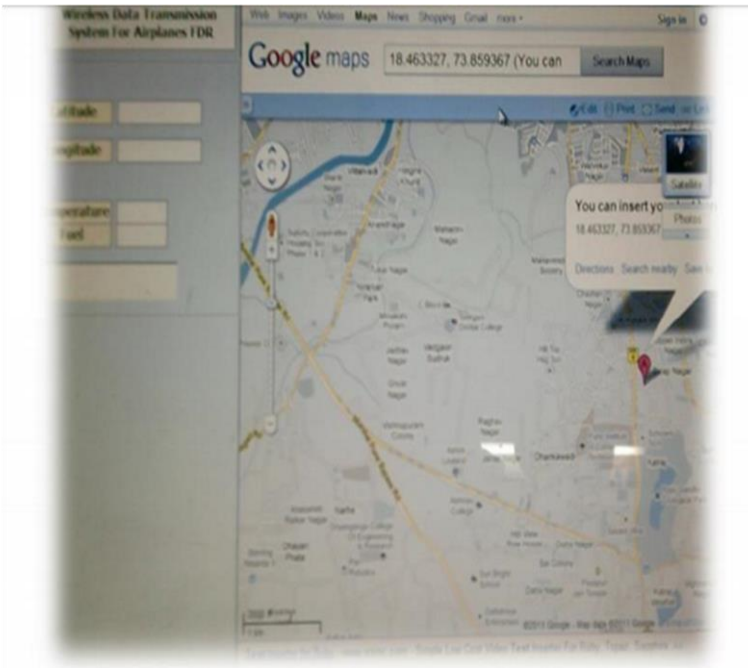

Fig.4.1: Visual basic window

Here, the wireless data transmission system can solve many problems related to FDR, because air passenger’s safety is our main concern. Through this project, we are trying to over-come the problems faced by people working in air maintenance field. Here, 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 cannot able to record the data for more than 17-25hrs. In Online FDR we can record data for more than the time limit. Also, FDR records the data of cabin camera too.

4.2 ARDUINO RADAR TECHNOLOGY CIRCUIT:

If you look at the circuit diagram, the design of the circuit for this project is very simple. The control pin of the servo is connected to Pin 11 of the Arduino while the TRIG and ECHO Pins of the Ultrasonic Sensor are connected to Pins 9 & 10 of Arduino respectively.

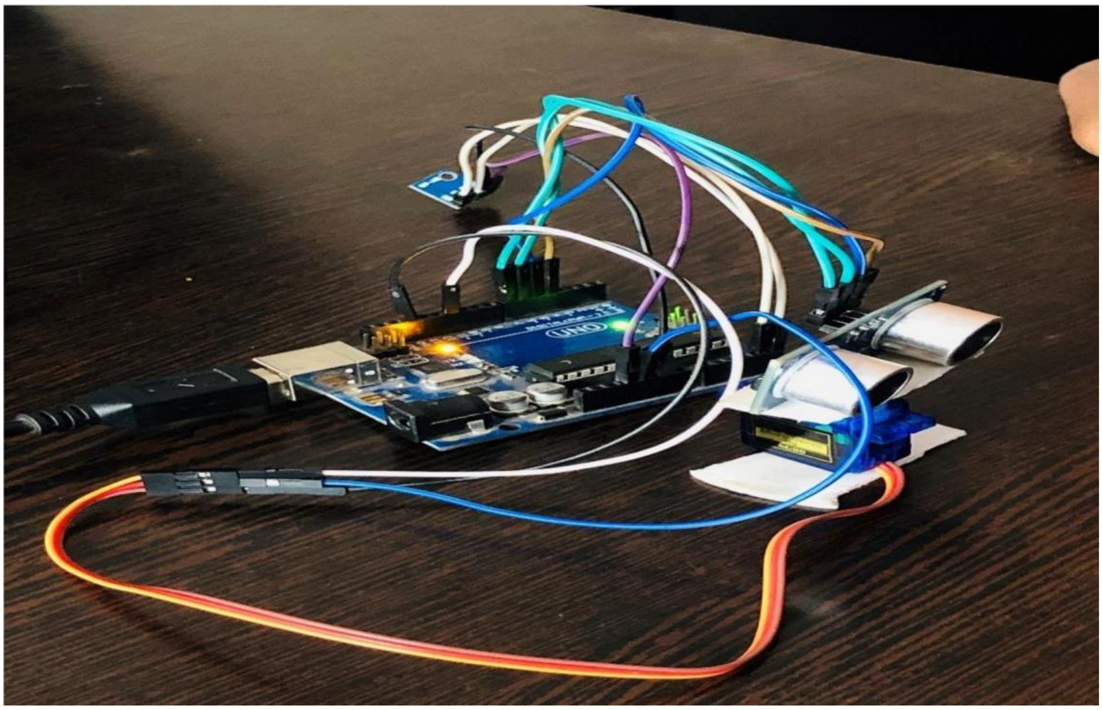

Fig.4.2: Radar and weather detection using Arduino UNO in helicopter

A separate 5V power supply (with common GND) is given to the Servo Motor and the Ultrasonic Sensor.

4.2.1 OUTPUT WINDOW:

A Graphical representation of the data from the Ultrasonic Sensor is represented in a Radar type display. Here the output shown in Fig.4.3 demonstrates the sensor’s output, before the detection of any objects within its range. Hence the graphical representation is shown in green colour.

The output shown in Fig.4.4 demonstrates the sensor’s output, after the detection of any object within its range. Hence the graphical representation is shown in red colour.

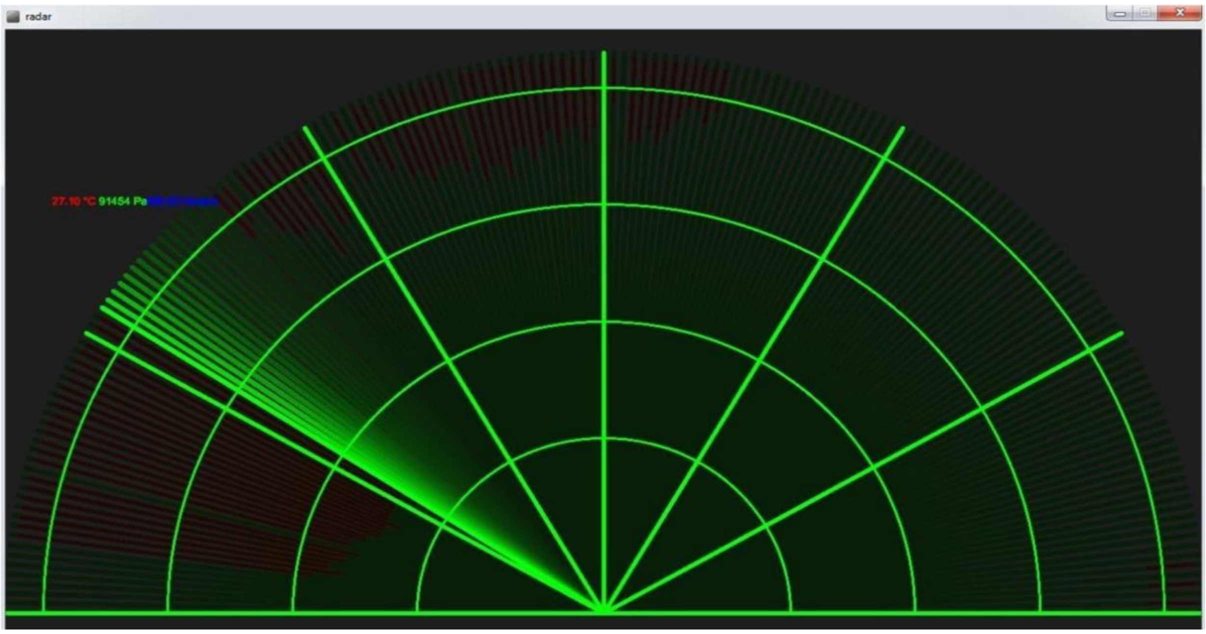

Fig.4.3: Graphical representation (Before the detection of an obstacle)

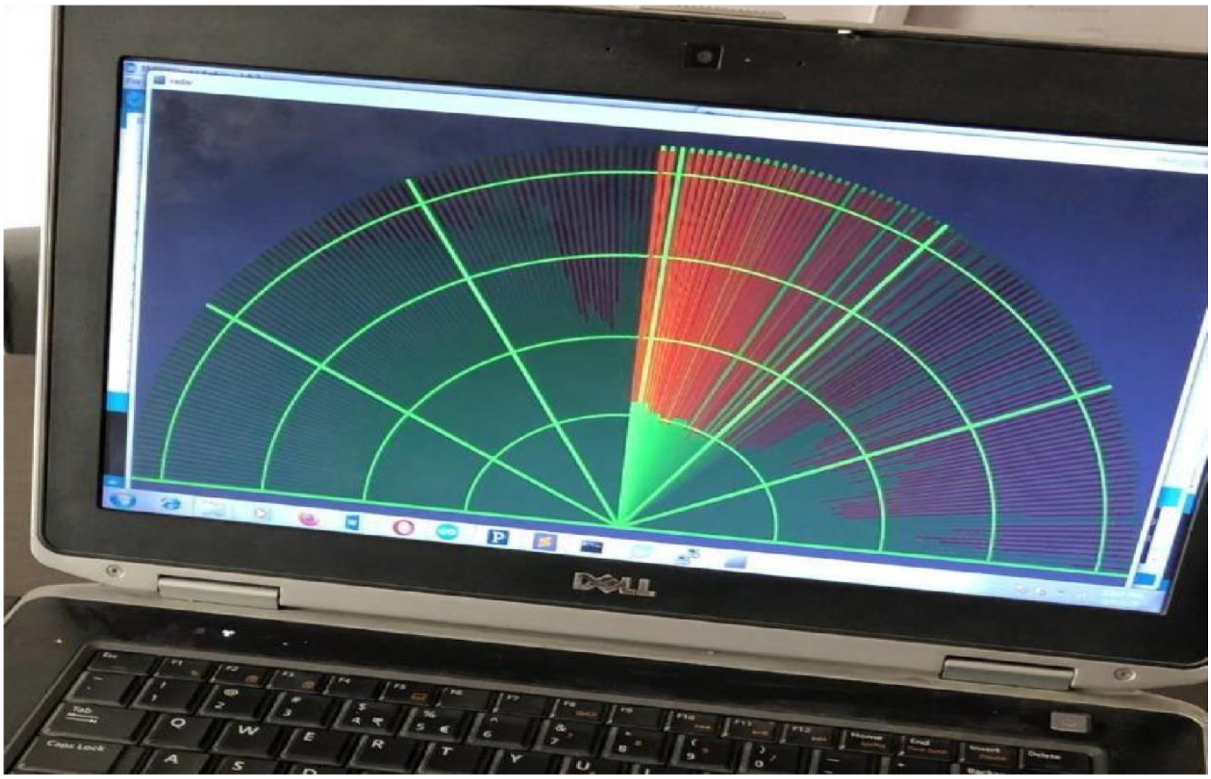

Fig.4.4: Graphical Representation (after the detection of the obstacle)

4.2.2 COMMAND WINDOW:

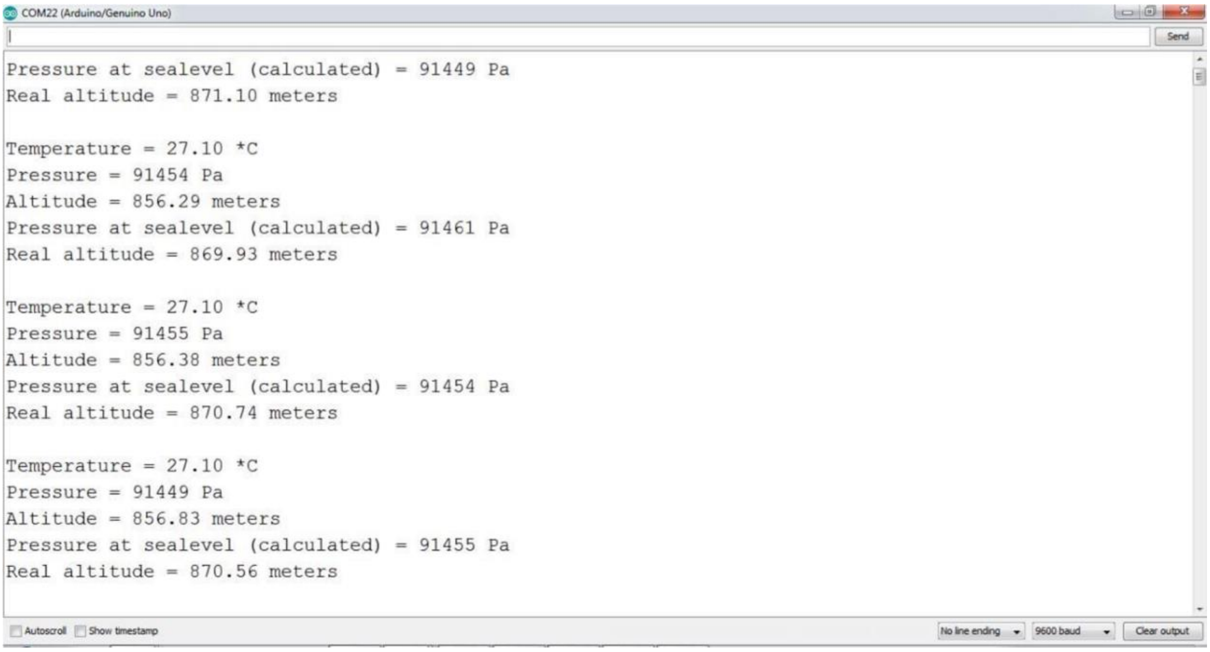

Fig.4.5: Output of BMP180.

In the command window, the calculated temperature, pressure, altitude and pressure at sealevel, based on the resolution is displayed.

4.3 FUTURE SCOPE:

- More aircraft's types will be required to carry FDR and more stringent environment tests will be added.
- Mandatory storage of images of the cockpit and instruments will be required. The privacy and integrity of FDR data for civilian aircraft will also be gathered.
- Collecting structural health data. With wireless technologies in the future, perhaps the need of Block Box may be eliminated.

CONCLUSION

In internship, it helped us to understand the working principle of wireless flight data recorder and measurement of temperature, pressure using radar and evaluated the performance of flight. Also got an opportunity to interact with the team members and found that the parameters from sensor's output of aircraft are acquired and desired parameter is stored in the data recorder. To track the distance and angle of the object and to represent this information graphically, means its output should be in graphical form which will be represented through processing software. We can have an idea of an efficiency of this radar by testing objects at different levels and observe how faster or smoothly it detects an object that it finds in a way and gives us an expected range of the obstacle. The red area indicates the presence of obstacle and below the angle of incident and distance is being displayed.

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