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RESEARCH ARTICLE

UAV FOR ATMOSPHERIC RESEARCH

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ABSTRACT

As we know the Earth's atmosphere is a thin blanket of gases and tiny particles together called air. We are most aware about the air when it moves and creates wind. Earth's atmosphere, along with the abundant liquid water at Earth's surface, is the keys to our planet's unique place in the solar system. Much of what make Earth exceptional depends on the atmosphere. For example, all living things need some gases in air for life support. Without an environment, Earth would seemingly be simply another lifeless rock. The previous method or currently method used for the collection of Atmospheric Data (i.e. Temperature, Humidity, and Pressure at different Altitude) is Balloon tracking system, in this system a radiosonde is a portable weather station lifted by a balloon and Sends observations back by radio, some of them are temperature, humidity and pressure and different position. In this project, we designed Unmanned Ariel Vehicle for the data collection in that we integrated the Data Logger which locks the different data at a different height with regular time interval with time stamp and the altitude. This will be helpful for the atmospheric research. This project represents low cost UAV (Quadcopter) who carry weight of data logger and go for a maximum height as possible. This quadcopter includes APM 2.8 as controller, BLDC motors to generate air thrust and drone can fly, ESC for the speed control of the motors, receiver and transmitter for the controlling of the UAV, It also includes the data logger for the data collection which is designed by using Arduino, DHT11 (Temperature and Humidity sensor), BMP180 (Pressure and Altitude) sensors, RTC module for real time stamp and memory module for memory card. After successful completion of this project we can come to know the different parameter of atmosphere at a different height and different position and by using this data we can do different types of study from this data.

Keywords- : UAV(Unmanned Aerial Vehicle), ESC (Electronics Speed Controller),RTC (Real Time Clock) etc.

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INTRODUCTION

Rapid development of unmanned aerial vehicles (UAVs) opens wide opportunities for meteorological measurements in the ABL. The quadcopters are very useful in understanding the process of surface and atmospheric interaction. However, the measurements over some meters on top of the bottom need the usage of masts, that area unit serious, expensive, restricted tall and inflexible with relation to the changes in location. The remote sensing instrumentality (e.g. SODARs, LIDARs or temperature profiles) is additionally costly and incorporates a ton of limitations [3–5]. There are two main types of the UAVs: fixed-wind aircraft and multi rotor aircraft (usually quadcopters or octocopters, further called as multi copters). The key advantages of the multi copters in comparison to fixed-wing UAVs are the maneuverability and abilities to hang in a fixed point and to takeoff or land in a confined space. Their disadvantages are the short flight time (usually no more than 30 minutes) and limited vertical and horizontal ranges of the operation. We have been used temperature, humidity sensor (DHT11) and Pressure sensor (BMP 180). The DHT11 temperature sensor has resolution of one degree Celsius and humidity of 1%. The altitude we will be estimated Based on pressure data. We have done total five experimental tests, and we got vertical profiles of the temperature humidity and pressure. We have connected the temperature, humidity and pressure sensor to data logger with real time clock. The sampling rate is every one second. The total weight of this data logger is around 100gms. We are able to reach maximum of 300 meter height with the drone.

METHOD AND DESIGN

The quadcoptor UAV is a small to medium-sized UAV having multi rotor that is lifted and propelled by four rotors. Rotors are situated in the end of a cross which are symmetric about the center of gravity. Quadcopters generally use two pairs of identical fixed pitched or variable pitched, two clockwise and two counter-clockwise, propellers. The control can be achieved by varying the speed of each rotor. These rotors provide the aerodynamic forces act on the rotorcraft, and are modelled using momentum theory and blade element theory. From this, expected payload capacity and lift the performance of the rotorcraft can be determined. The six degree of freedom system can be defined by equations using the Euler-Lagrange method. By changing the speed of every rotor it's doable to specifically generate a desired total thrust, to locate for the center of thrust both laterally and longitudinally; and to create a desired total torque, or turning force [4]. A typical quad rotor has a frame, 4 motors, 4 propellers, microcontroller and battery. Also, there are some electronic components that like ESCs, transmitter, receiver etc. The structure ought to be rigid and isobilateral and light-weight in weight. There are mainly two coordinate reference frames considered while studying flight dynamics. The first is the earth fixed frame. The other is body reference system rotating coordinate frame with the origin, placed at the center of gravity (CG) of the rotorcraft.

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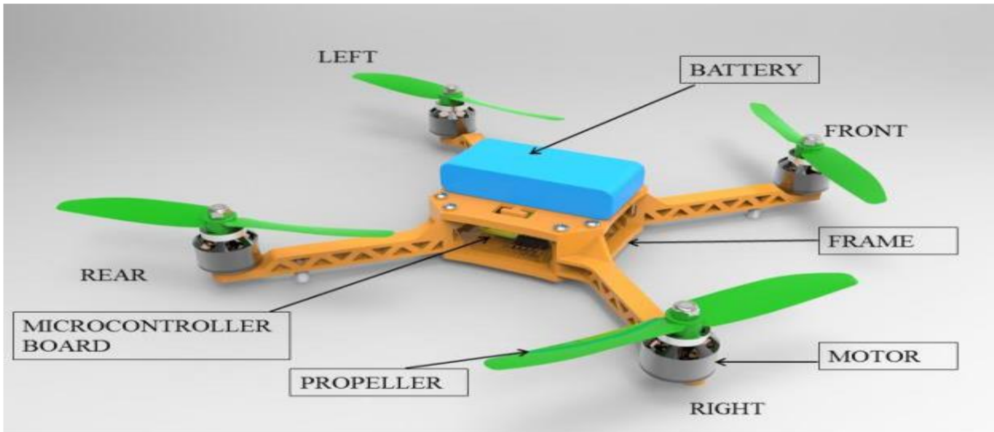

Figure 1: Quad Copter Drone Structure

Figure 2: Assembly of UAV

3.1 Sensor Specification

For the measurement of temperature, humidity and pressure interfaced to the data logger. The RTC is interfaced to the data logger for real time data sampling. The sensor specification is shown in below

Sr No	Paramater	Temperature Sensor (DHT11)	Humidity Sensor (DHT11)	Pressure Sensor(BMP180)
1	Resolution	1 Degrre Celcius	1%	0.01 hpa
2	Accuracy	+-2 Degree Celcius	+-5 %	+-0.12 hpa
3	Measurement Range	0-50 Degree Celcius	10%-90%	300-1100 hpa

Table No.1

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3.2 Data logger Specification

The Arduino mega controller is used as data logger, and we have interfaced real time clock (DS1307). The Arduino mega microcontroller is having 256 KB of flash memory and SRAM is about 8 KB and it has 54 digital I/O pins. The data logger programming is done in the Arduino IDE.

Atmega microcontroller is used in APM 2.8 controller. It is having 3-axis gyro, accelerometer and magnetometer, along with a high-performance barometer. **Atmel's ATMEGA2560 and ATMEGA32U-2 chips for process and USB functions respectively.** We have used the 11.1 volt lithium polymer battery of 2300mAH capacity. We have used the Auto Pilot software to configure the APM 2.8 controller and Remote Control is used to control the apm 2.8 controller.

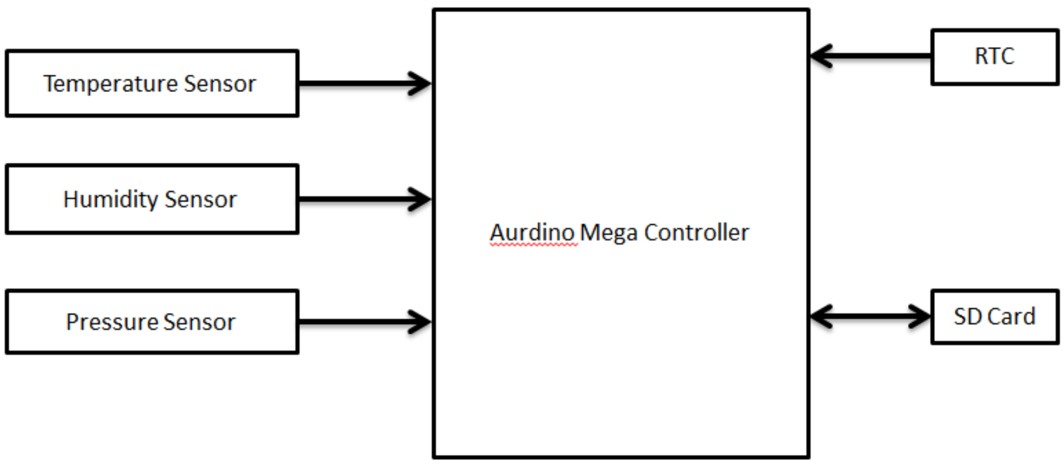

Figure 3: Block Diagram of data logger

The data will be sampled at every one second from this entire sensor and will be stored in SD card interfaced to data logger. The 9 V rechargeable batteries are used to power the data logger. We have more than ten trials with this system, and we got the some of the results.

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Figure 4: UAV with Data Logger

SOFTWARE DESIGN

Data logger programming is done in Arduino IDE. We have used the sensors which will be initialized, and then we will see if the sensors, and data logger are communicating. If sensors and data logger initialized well then we will store the data in the data logger SD card. We have used the below flow chart for the software development.

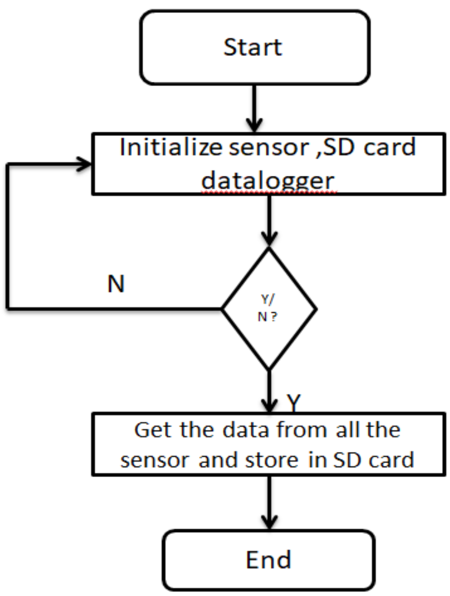

Figure 5: Flow Chart

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ESTIMATION OF ALTITUDE

We calculate it using an iterative method and used pressure values to estimate the altitude of the sensor

$$z_i = z_{i-1} - (\Delta p / g \cdot \rho_i)$$

Where Δp=0.5 hPa is the step of the vertical grid, $\rho i = pi/R \cdot Ti$ is air density, pi and Ti are the pressure and air temperature (in K) for ith level, R=287.058 is specific gas constant for dry air. The average vertical temperature profile (Ti=1…n) is obtained based on the readings of the temperature sensor.

RESULT AND DISCUSSION

We have plotted the vertical profile of temperature, humidity and pressure with respect to height. The data collected was at every second, and we had total five experiment. We got up to maximize height of 300 meters. The RTC is used for real time log. We have plotted the result from 07th March, 2020 15:12 hrs experiment and day was with cloud.

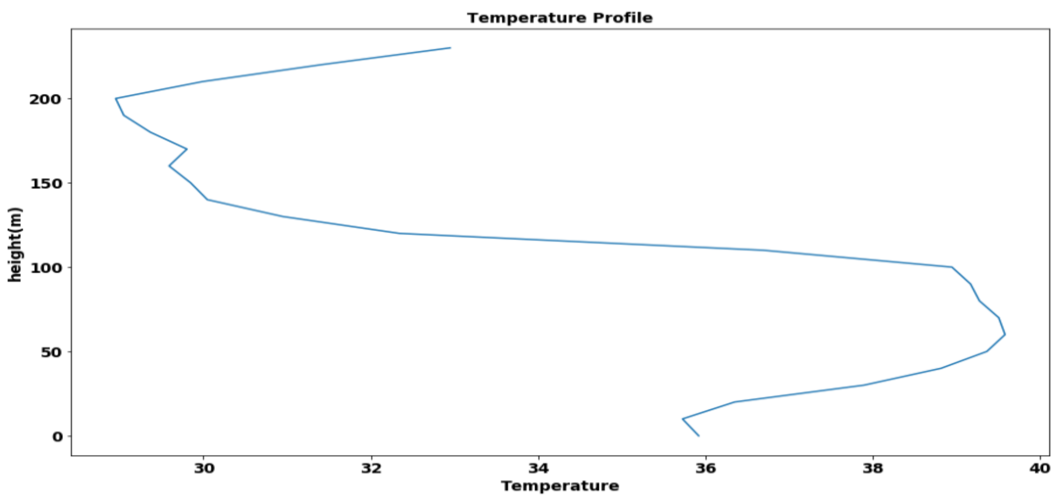

Figure 6: Temperature Profile

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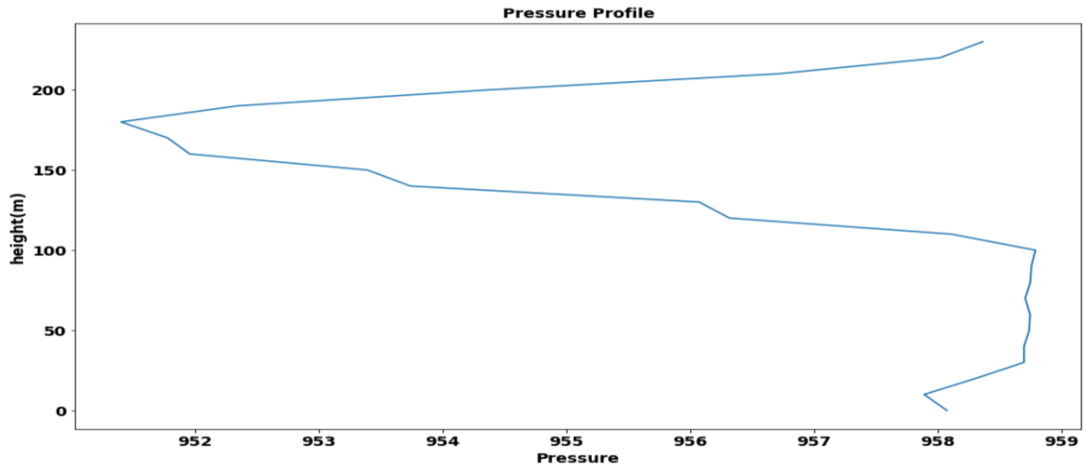

Figure 7: Pressure Profile

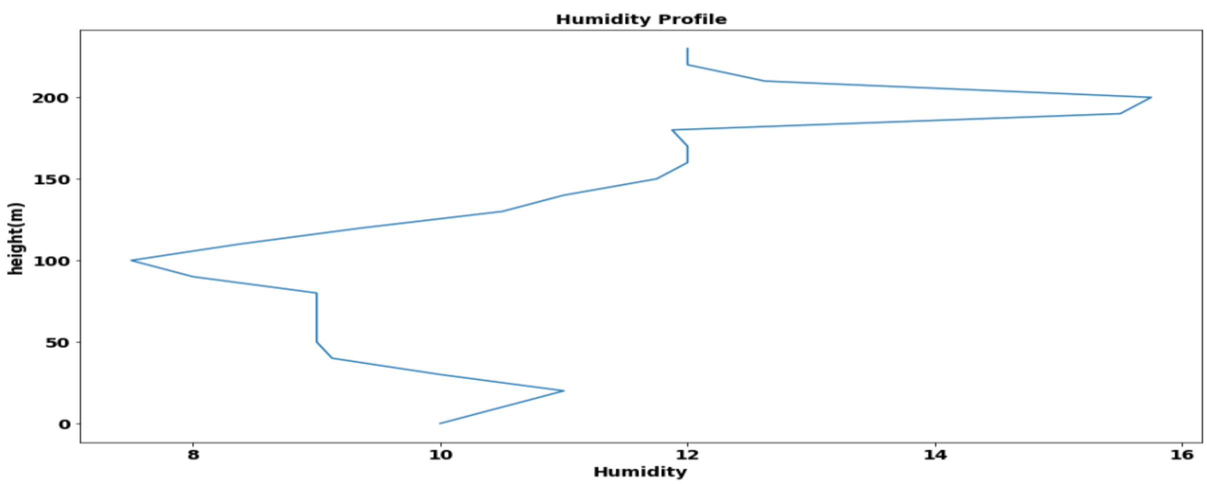

Figure 8: Humidity Profile

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CONCLUSION AND FUTURE PROSPECT

We can explore the meteorological research by using The proposed system framework just considers some fundamental requirements, and still needs other improvements. And the system we have developed is still a prototype with few payloads attached. The vertical profile of temperature, pressure and humidity will be further used to study the atmospheric thermodynamics, and the same data can be used in weather prediction. Real Time vertical structure of the atmosphere can be used in the now casting. In future, we can extend this framework like attaching more sensors as an payload for meteorological research such as Air Quality studies, PM2.5, PM10 monitoring, and also with IR sensor for vertical profiling.

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