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Lower Atmospheric Research Satellite for Environment: A Review

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Abstract: In the past couple of decades, there is rapid growth in the field of satellite technology. Different satellite systems have been developed in order to improve the space technology. A model, small and light weight satellite having power system, sensors and telecommunication system into its minimal volume that can perform some of the basic tasks that artificial satellites can do. This paper reviews some of these satellite systems and proposes an automatic environmental parameters measuring system by a model satellite using Arduino board, which may help to measure atmospheric parameters like temperature, humidity, pressure and acceleration.
Keywords: IoT, temperature sensor, humidity sensor, pressure sensor, accelerometer sensor, Lower Atmospheric Research Satellite for Environment (LARSE)

I. INTRODUCTION

The term satellite refers to a technology that is capable of rotating around a planet or around another satellite in a specific orbit. Natural satellite and Artificial satellite are the two types of satellite. The world needs such artificial satellites for a number of reasons, including surveillance, geographical area measurement, telecommunication, military and civilian Earth observation, navigation, weather, and space telescopes, scientific research satellites. These satellites work without breaks or any interrupts till its lifetime. All these mentioned satellites are major satellite having weight in the range of hundreds of kilograms. Also, all such satellites have specific missions and predefined task, so that satellite needs to escape the Earth's atmosphere and either stay at specific location or revolve around the Earth in space. But some of the satellites do not escape the Earth's atmosphere because of its particular mission. The maximum height range for such satellite is about 100m to 1000m from the surface of the Earth. A Lower Atmospheric Research Satellite for Environment (LARSE) is a type of sounding rocket payload used to teach space technology. It is similar to the technology used in miniaturized satellites. Neither LARSE ever left the atmosphere, nor orbited the Earth. A LARSE is a simulation of a real satellite, integrated within the small square box which is made of aluminium metal and it contains major subsystems found in a satellite, such as power, sensors and a telecommunication system, in this minimal volume.

It is the needed to develop a mini model satellite having the data acquisition system which consist of temperature, humidity, pressure and accelerometer sensors which are used as to measure parameters of the atmosphere respectively and send it to the ground station. The main purpose of measuring all these parameters is for artificial rain. All this measured data is compared with ideal parameters which are already stored at ground station. The LARSE may contain real time camera. It is like a surveillance camera to observe below satellite area. One of the most important parts of the LARSE is, this system totally based on the internet of things (IoT) by using Wi-Fi module. Information about atmosphere like temperature, humidity, pressure graphs are plotted on IoT. The LARSE is a combination of hardware and software. Hardware part consists of Arduino processor, temperature, pressure, humidity and accelerometer sensor, camera, stepper motor. Where software part consist of Arduino Integrated Development Environment (IDE). This paper has an introduction in first section is followed by previous related work of the topic. Third section describes the implementations done in given area. Fourth section briefly concludes the work.

II. RELATED WORK

Cihan, et al.[1] developed a mini model satellite that measures pressure, the temperature and its location. It was the first step to study and reach the space and its technology. This micro-satellite had various capabilities after adding electronic equipments, sensors and GPS. This micro-satellite measures temperature, pressure and location data and sent it to the central database. These capabilities provided with the sensors and GPS which were ready made. The sensors were sensing the data and GPS was tracking the exact location of the satellite in the space. The data collected by satellite was sent to the central database with the help of radio receiver which was installed to RF module to have a connection with the micro-satellite. The system was built up with the configuration as cylindrical body and tri-pod landing system with 200 mm in height, 81 mm in diameter and in weight. This project included electronic equipments, sensors, ground station, batteries for energy needs, camera and microcontroller for autonomous mobility and memory for data storage units. So, it indicates inexpensive equipments to model a satellite and gain experience. Normally the general satellite launched by a rocket, but in this project a mini-satellite was thrown from the top of a building. It landed with a help of a parachute which was also designed for this mission. While free-falling it records data to its memory. The drawback of this designed system was, it depends heavily on the software. Software control processor, sensor and receiver-transmitter were developed in C language. As a micro-controller had small size of memory (about 64 KB), it needs an external memory device to store the software program and measured data, it was resulting in bulky and heavy system. Also authors defined all the theory regarding the project, but not implemented it. Efrén et al.[2] developed the first step for developing a nanosatellite, the fundamental mission of the system was the collection of telemetry data in the Veracruz-Boca del Rio (a satellite development organisation in South Africa), with special emphasis on measuring air pollutants, the typical measured variables are temperature, relative air pressure, relative humidity, the development of the system architecture consists of a flight segment and ground station, which shows data through a desktop interface variables measured in real time and stored for later analysis. Authors tried to simulate the real satellite in the space, which took the volume of a soda tin of 355ml. As a result, the challenge of introducing all the systems that takes part in a satellite, such as the power subsystems, communication and sensors, linked to the correct working of the system. Its deployment in the air by a rocket of short distance, a balloon, an airplane with a radio control or from a high building, and its recovery after the launch, was the result of teamwork. This process or experiment had high impact on the building of the significant knowledge, so this experiment allows researcher the testing of theory by direct implementation. But the developer used the RF transmitter and RF receiver for data exchange purpose. This traditional method of data exchange requires antenna system which needs a heavy programming for efficient transmission and reception of data and a large size metallic antenna too which directly increases the weight of system. Mustafa et al.[3] presented, designed and implemented a PC based ground station for a nanosatellite. The ground station was developed from scratch by a high level language (C#). And was platform-free therefore it may operate with any mini-model satellite having different brand microcontrollers. The users may track several parameters and sent control commands simultaneously. For designing ground station, author used microcontroller, GPS sensor, XBEE RF modem and shield, and a pressure sensor on experimental conditions. Sultan et al.[4] designed and manufactured a model satellite named Vecihi that was able to perform some of the basic tasks that artificial satellites can perform. It had design constraints about budget, dimensions and weight; and having subsystems like: sensors, storage module, wireless transmission, control, and optional imaging subsystems. Sensors consist of pressure, temperature and direction. All the data acquired with sensors and had stored in a Micro SD storage device with an appropriate format and had to be sent to a ground station for processing. Here the model satellite started recording from separation, and keeps recording until landing. After landing, the satellite would be located with the help of buzzer device attached to it. For experimental purpose, the author implemented all subsystems in small 30g weighted cylindrical container. The electronics components used in nanosatellite were AtMega processor, temperature and pressure sensor, XBEE and SD card. But the experiment stores the acquired data first and until connect storage device the data was not accessible.

III.PROPOSED ALGORITHM

The main aim of designing the mini model satellite system is to increase the knowledge about space technology. Other systems may propose for the same reason. Different types of sensors like temperature, humidity, pressure, etc. will be deployed in small, lightweight, nanosatellite. These sensors will read the actual parameters from the environment. These random analog values will be first combined with the help of a high end processor like Arduino or Raspberry-Pi and then transmit this data to the ground station. The processor will transmit these values to the base station via traditional transmitter-receiver or by IoT. It will capture the real time values of sensor readings and send it for data analysis. The entire telemetry system for nanosatellite is divided into two parts those are transmission system and reception system. The most challenging task for the developer is to send the system vertically upward from the Earth surface. There are various methods to project the system, these methods are:

A. Using a nitro-bust (a cylinder containing compressed nitrogen gas)
B. Using a gas balloon (the gas can be Hydrogen or Helium)

By using one of these mentioned methods, the system can be send vertically upward. But here comes a second hurdle that is the system should start collecting the data during a descending movement. This is because; downward movement is slower than upward movement. During the descend, satellite starts collecting the data like temperature, pressure, humidity, acceleration from the surrounding atmosphere and environment. At the same time Arduino processor used in the satellite collects the environmental data from respective sensors and send it to the ground station with the help of Wi-Fi module interfaced with the Arduino. This Wi-Fi module contains in built TCP/IP protocol which assigns a specific IP address to it. This IP address is registered on ThingsSpeak (IoT). So by connecting PC to the created network, such collected environment is directly accessible to the user.

Then according to requirement of user, the graphs of temperature, pressure, humidity, acceleration are plotted. The data collected by sensors of the mini-model satellite is used to draw the graphs. These graphs are directly potted on the ThingsSpeak(IoT).

C. Transmission System of LARSE

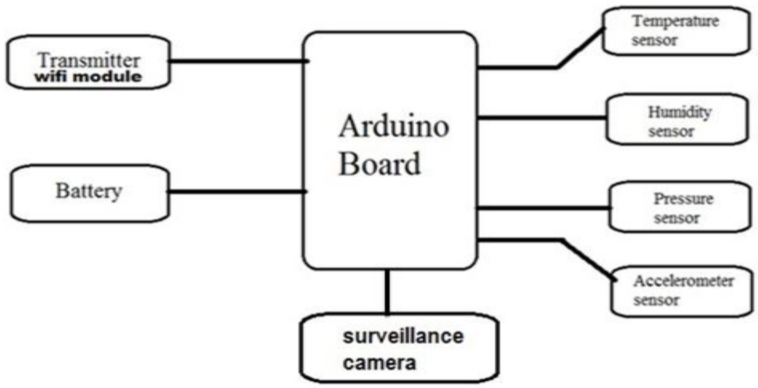

Fig. 1 LARSE Transmission System

Figure 1 show that all sensors like temperature, humidity, pressure and accelerometer are connected to the arduino with the help of software. Arduino collects the data form sensors and send it to the ground station by using Wi-Fi module. Also the video captured by surveillance camera is transmitted to ground station.

D. Receiving System of LARSE

The receiving system of LARSE consists of information or received data appearing on web server or Thingspeak IoT which contains temperature, humidity, pressure and acceleration values generated by sensors. All the acquired data can be read on the web application with proper graphs and tables. The data that are stored in ground station will be compared with the data that is stored by the satellite after landing.

IV. CONCLUSIONS

The improvement in engineering and technology over the last few decades has encouraged researchers to develop automatic measuring and controlling system for mini model satellites. To sum up, in every component of the model satellite; mechanical, electrical and software, familiar mechanisms with a proper artificial satellite are made available. It provides a beneficial study model for people who are willing to perform practical exercises in satellite design field.

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