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Design and Development of a Real-Time Ground Station Software System and Small Satellite for Weather Monitoring Applications

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ABSTRACT: In the current scenario, weather monitoring is playing a very significant role. Every day around 800 satellites (Radiosonde) are being launched for weather sampling globally. The objective of this project is to design and develop ground station software system along with a cost effective small satellite. The software will be developed using JAVA as front end and SQL as backend; small satellite will be designed and developed from off shelf-materials and open source on board computer. The small satellite will be launched by a rocket which will carry sensor array to transmit information about the atmospheric pressure, temperature, humidity, altitude, Global Position System (GPS) and wind speed by means of small sensors, and Transistor-Transistor Logic (TTL) wireless data transmission. The collected data are preprocessed used data mining techniques.

KEYWORDS – GUI, Small Satellite, Ground Station, Sensors, GPS

I. INTRODUCTION

In the view of current technological developments Small Satellites are playing a very important role, they have been largely developed for education, earth observation and constellation operations. Over the last 50 years, more than 860 microsatellites (10–100 kg), 680 nanosatellites (1–10 kg), and 38 picosatellites (0.1–1 kg) have been launched worldwide. Small satellites have recorded data on the terrestrial and space environment near the moon and Earth, helped in the search for planets on other star systems, and demonstrated various telecommunications systems that we enjoy today. These satellites have served as test beds for the development of new space technologies, and as hands-on educational tools for countless students, scientists, and engineers. The architecture of small satellites being far simpler than large, long life spacecraft built by governmental space agencies provides room for commercial entities to pitch in for their construction. There is a large scope of using Commercial off the Shelf (COTS) components within such a small spacecraft, given that their designed lifetime is low. This change has the potential of transforming space technology within a very short period, considering the context of the history of satellite development. The research in small satellites has moved from using them in Low Earth Orbit (LEO) to extrapolating their uses in interplanetary travel. One of the key supporters for this movement within space is the United Nations Office for Outer Space Affairs (UNOOSA).

II. SYSTEM OVERVIEW

A. Mission

Mission definition is concluded as follows.

- Base Mission: The base missions are listed as the following, with priority order;

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(1) to read the values obtained via sensors,
(2) to design the interface of the ground station,
(3) to transmit the data properly to the ground station,
(4) to record the data into memory unit.
(5)to process the data using data mining techniques.

- Side Missions: The following missions are listed as Optional ;
  (1) to record a video of descent moment using camera sensor,
  (2) to designate the point of landing using a GPS module.

B. Small satellite and Subsytems

The subsystems of the Small satellite are developed under three separate topics.

1.Mechanical Parts:

Mechanical design's main mission is to provide a safe landing, protect the carrying all of the electrical and mechanical components safely and, be a safeguard against "g" forces. In this regard our design is an innovative, robust, and functional solution. The mass is limited with ±500 gms.

Mechanical design consists of two parts as depicted in Fig 1.

• Chassis
• Container

1.1 Chassis

The parachute is used for safe landing of the on-board computer. It is compulsory to construct a chasis that is capable of providing the protection of the components from the impact during landing. Inorder to provide protection a reliable material has to be chosen. Acrylics material is chosen for building the chasis, since it has high resistance to impact and protect the on-board components.

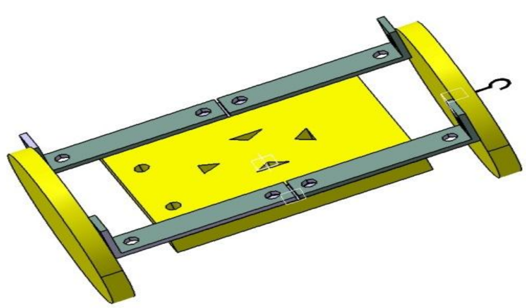

Figure1.Design of a small satellite chasis

1.2 Container

The container is made of aluminium foil to protect the internal components since the material is light and highly resistance to wear and tear.

2. Electrical Architecture

Electrical architecture is summed up in two divisions as follows.

2.1 Electrical Diagram

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The CanSat needs electrical system for communication and the internal components. In choosing electrical system, we considered requirements of mission. The electrical architecture includes sensors, microcontroller, battery, memory card, and other circuitry. We need to power up enough power to other subsystems. We choose Li-Ion batteries. The batteries connect to the sensors and the microcontroller. So, we got 5 V voltage level and a 5000 mAh current capacity. The sensors, microcontroller, distance sensor, camera, GPS, and the memory card supplied by 5 V. All sensors and transmitter/receiver modules are supported by 3.3V.

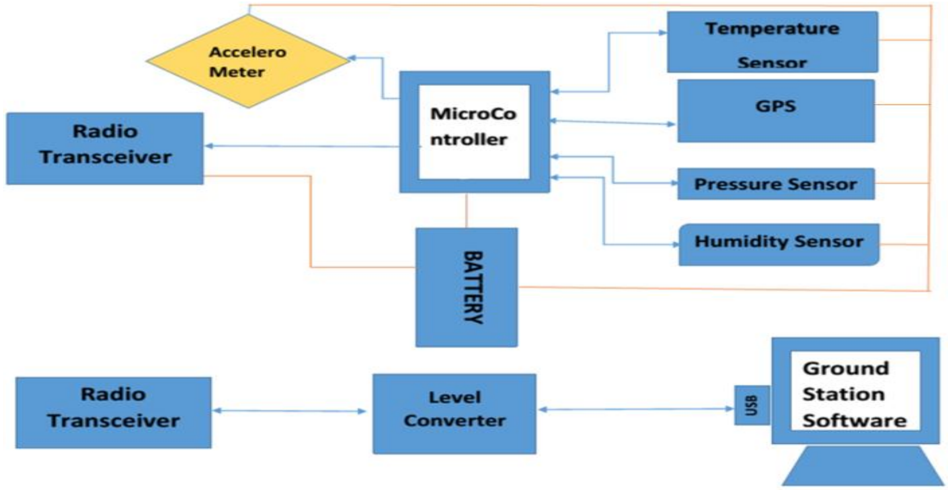


Figure2.Electrical architecture block diagram and ground station

2.2 ATMEGA32:

The high-performance, low-power Atmel 8-bit AVR RISC-based microcontroller combines 32KB of programmable flash memory, 2KB SRAM, 1KB EEPROM, an 8-channel 10-bit A/D converter, and a JTAG interface for on-chip debugging. The device supports throughput of 16 MIPS at 16 MHz and operates between 4.5-5.5 volts. By executing instructions in a single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed. The sensor shield includes accelerometer, gyroscope, barometer, temperatue sensor, ATMEGA32microcontroller.

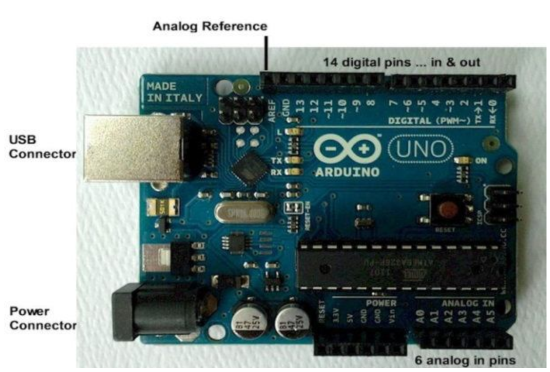


Figure3.ATMEGA32

3. Telemetry and Ground Station:

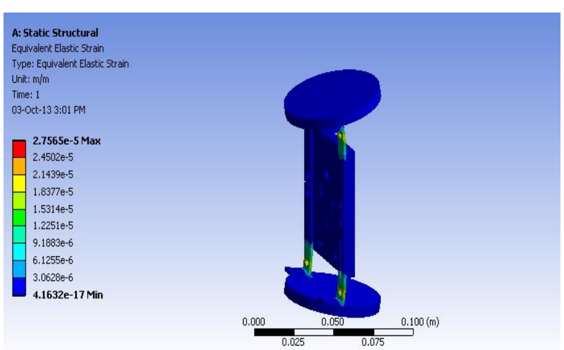
Telecommunication part of the system consists of a TTL network, which is peer to peer model communication type. Network is set up with one communication module attached to the satellite and another module that is connected to the terminal in ground station. Module on satellite receives all the sampled data via serial interface from microcontroller, and send it to the module on ground station via radio waves. Both modules work on 2.4 GHz frequency.On ground station terminal, a JAVA application is written specifically for this system. All the received data is prompted to the user in a grid view. Specific data types of temperature, voltage, and altitude are plotted to charts, except GPS data. For GPS data, Google Earth™ is used for plotting the real-time coordination of the satellite. Ground station application also shows RSSI (Received Signal Strength Indicator) information, which shows the quality of the received signal.

4. Data mining Using K-means Algorithm

K-means is a cluster based algorithm used for mining of the valid data from the data collected from the small satellite. It is a cluster based algorithm used for clustering of the respective data based on the value of the K given to the algorithm. The value of the K should be chosen in such a way so that it suits the amount of the data to be clustered. When the data is given to the algorithm random points are selected based on the k value given. The Euclidean distance between the nearby points calculated and the particular nearest centroid is taken as the master point of that cluster.

III. SYSTEM ANALYSIS

During the launching of the satellite all the components have to be protected. In order to ensure the required strength of the system, Structral analysis - for material to be withstand its weight in parachute have to be made.This structural testing and analysis is done using the Ansys software . A CAD model is developed for this purpose using the catia V5 software.



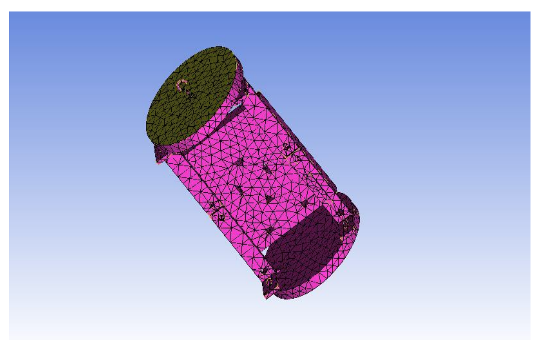


Figure4.Structural analysis using ansys

Figure5. Mesh Geometry in Ansys Software

IV. RESULTS AND DISCUSSION

The Graph of the atmospheric values that were plotted shows the change in the temperature, pressure and humidity.

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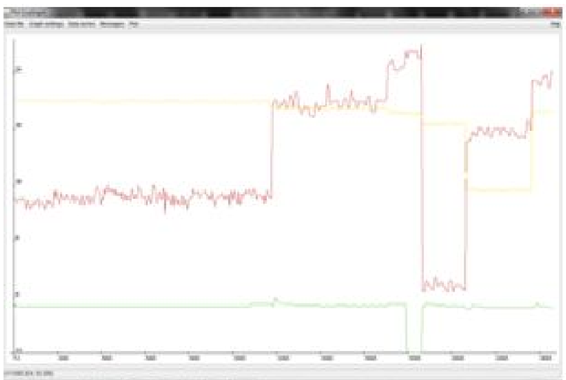

Figure6.Graphical representation of Temperature, Humidity

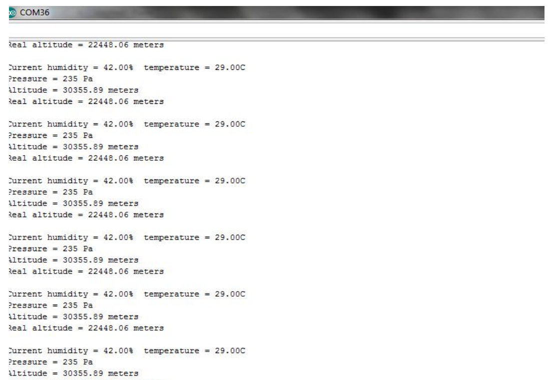

Figure7.Serial Monitor Collecting data Pressure values

V.CONCLUSION

The development of the Small Satellite involves steps such as designing a CAD model for the external body of the satellite, performing design iterations of the CAD model, Fabrication of sensors with the Arduino board and Development of sketch for the on-board computer. Developing an algorithm for the Graphical User Interface and interfacing the on-board computer with GUI. Initially, the CAD model of the body of the Satellite has been designed, stress analysis has been performed and the sketch for the Arduino Controller Board is developed. The fabrication of the electronic components is performed along with the Controller Board. In future, GUI based on java Platform and interfacing the On-Board Computer along with the GUI will be developed.

REFERENCES

1. Saburomalztnag, Keisuke Yoshiharpi, Yoshiki SUGIURA-Masato SEKIGUCHI, hirotakasawada, Shingo "Titech Micro-Satellite Model:cansat for Sub-orbital Flight".
2. Jack K. Kreng, Michelle M. Ardeshiri, Oscar C. Barbosa, and Yogi Y. Krikorian "Telemetry, Tracking, and Commanding (TT&C) Link Considerations for a LEO Sat123"
3. M. Hosseinsharifi, Senior Member, IEEE "A Centralized Multiple Satellite Network For Real Time Global Space, Land, And Mobile Communications".
4. Bastian Preindl from Institute of Analysis and Scientific Computing Vienna University of Technology, Austria; Lars Mehnen "Design of a Small Satellite for performing measurements in a Ground Station Network"
5. The CHASQUI team members from the J. Martín 1 Center for Technological Information and Communications, National University of Engineering (UNI), Lima, Peru; "Design of a Peruvian Small Satellite Network"
6. Shwetha Prasad, Core Leader, Communication System; Harish Ramavaram&Mamatha R.M, ADCS.Ka, Ground Station"STUDSAT: India's First Student Pico-Satellite Project".
7. Author Stileyrnan SOYER from Istanbul Technical University,Istanbul, TURKEY had published an IEE paper on the topic "Small Space Can: cansat"
8. Cihan,ABULOGLU, Hliseyin A YKIS, Resul Y APACAK, Erhan<;::ALISKAN,Orner AGIRBAS, Saban ABUR and Slileyman SOYER from the Turkish Air Force Academy Istanbul, "Mission Analysis and Planning of a CANSAT"
9. Mustafa emreaydemir from the Department of Electronics Engineering, Turkish Air Force Academy, Istanbul, Turkey; Mansur Celebi from the Department of Aerospace Engineering, "Design and Implementation of a Rover-Back CANSAT"