International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 10 | Oct 2018 www.irjet.net p-ISSN: 2395-0072

Miniature Satellite

Yashaswi Rahut[1], Aditya Rohan Das[2], Ashu Kumar[3]

[1,2,3] *Student, Department of Computer Science, SRM Institute of Science and Technology, Ramapuram, Chennai, India*

Abstract - *The proposed project is a miniature satellite that uses Machine Learning to perform analysis. The main purpose of this satellite is to measure the pressure using the BMP180 sensor (barometer), temperature using the MPU6050 and UV radiation levels using the GYML8511 at every layer of the atmosphere right up till the Karman line or the point of minimum gravity. The components such as the sensors and the Arduino pro mini (the microcontroller) will be held within a 4 cm wide 3-D printed nylon fiber cube which will act as the primary exoskeleton of the satellite and will serve as protection from harsh weather conditions and any sort of impact. The data recorded by these sensors will be stored in a 16GB SD card and can be retrieved when ever the satellite lands on the surface. The satellite will use a MPU6050, this device will act as a triple axis accelerometer and a gyroscope. This sensor will help measure the trajectory and record the projectile motion of the satellite as it rises and descends with the help of the helium weather balloon. The Satellite will be powered by a 12V Lipo battery. Using the multiple linear regression feature of machine learning we can predict the trajectory and nature of motion of other similar objects that may enter our orbit and fall. The satellite is designed to constantly record data right from the time of take-off till its battery dies. During this time period not only will the satellite record and store the recorded data in the SD card but it will use this data as test data to compare it to its reference data which the satellite will obtain from its previous launch. Using the multiple linear regression algorithm the satellite will be able to predict future data and accordingly forecast the weather accurately. This satellite is extremely light and inexpensive making it easy to deploy it.*

Key Words: **Machine learning, development boards, embedded systems, Arduino pro mini, multiple linear regression, sensors, cube, Arduino IDE.**

1. INTRODUCTION

This Every weather forecast from daily weather conditions to natural disastors like cyclone, everything is possible only using the satellites. Everyone from government agencies to small farmers, depend on these predictions.

Weather satellites are very bulky and costly and they take a long time to build. So the main aim of our satellite is to cut down on cost, size, and time required to manufacture these satellites there allowing them to be launched more frequently.

The main aim of the proposed design for a miniature satellite is to not only drastically cut down on the cost and size of the satellite but to also introduce machine learning to cube satellites allowing the satellite itself to make make weather predictions. The satellite does this through the multiple linear regression algorithm. Multiple linear regression is one of the most common form of linear regressions. It is type of predictive analysis. It is used to explain the relationship between one continuous dependent variable with two or more independent variables. The independent variables is either of two types continuous and descrete. Multiple linear regression forms the relationship between two or more input variables and an output variable by fitting a linear equation to the dataset observed. Each value of the independent variable x i.e. the input variable is associated with a value of the dependent variable y.

The satellite is designed to constantly record data right from the time of take-off till its battery dies. During this time period not only will the satellite record and store the recorded data in the SD card but it will use this data as test data to compare it to its reference data which the satellite will obtain from its previous launch. At first the satellite may make a few errors in the predictions but as the satellite begins to gather more data and draw more comparisons between the test and reference data the multiple linear regression algorithm will help reduce this margin of error and will eventually give us an accurate result.

One of the main parts of the architecture of any satellite are the sensors. A sensor is a device that records or measures a physical quantity and responds to the values in different ways.

The various types of sensors that the proposed miniature satellite uses are

1) BMP180 sensor (barometer) for measuring atmospheric pressure.
2) MPU6050 for measuring temperature, this sensor will act as a triple axis accelerometer and a gyroscope. This sensor will help measure the trajectory and record the projectile motion of the satellite as it rises and descends with the help of the helium weather balloon.
3) GYML8511 for measuring UV radiation intensity at every level of the atmosphere.

All of this recorded data that we will obtain from the sensors will be stored within a 16GB SD card that will be retrieved on landing.

2. EXISTING SYSTEM

A lot of satellites exist which are used for multiple purpose such as research and monitoring. Most of these satellites are quite large, hence making it difficult and expensive to deploy them. Satellite that exist within the Karman line are usually referred to as microgravity satellite, mostly used for research studies.

Example:

1. Shijian -10, which carries 20 experiments covering fluid physics, material science and the effects of radiation and microgravity on various biological system.
2. Jai hind 1s: This particular satellite was developed by the students of Hindustan University. The internal system of the satellite is held within a 4 cm wide cube. The main purpose of this satellite is to measure atmospheric parameters such as temperature, pressure and gas composition.

3. PROPOSED SYSTEM

The proposed system is a miniature microgravity satellite. The main purpose of this satellite is to measure the pressure using the BMP180 sensor (barometer), temperature using the MPU6050, UV radiation levels using the GYML8511 and at every level or layer of the atmosphere right up till the point of minimum gravity while ascending and descending. The components such as the sensors and the Arduino pro mini(the microcontroller) will be held within a 4 cm wide 3-D printed nylon fiber cube which will act as the primary exoskeleton of the satellite which will protect from harsh weather conditions and any sort of impact.

The MPU6050 will act as a gyroscope and will record the trajectory of the satellite along with temperature and triple axes acceleration. The pressure will be measured using the BMP180 sensor (barometer), the satellite will record UV radiation levels using the GYML8511.

The satellite will store the recorded data within a SD card
The satellite uses Machine learning with the help of Multiple Linear Regression Algorithm for analyzing and predicting similar data. The Multiple Linear Regression Algorithm is specifically designed to make comparisons between test and reference data and accordingly predict the most possible outcome. The more trials the algorithm takes the more accurate its predictions become over time.
The satellite will be suspended from a helium weather balloon which is capable of carrying it to great heights. Right from the start of the launch uptill the point where its battery dies the satellite will keep recording data and will keep feeding it to the algorithm.

4. SYSTEM ARCHITECTURE

The entire system architecture for the miniature satellite can be divided into three parts data collection, storage and analysis.

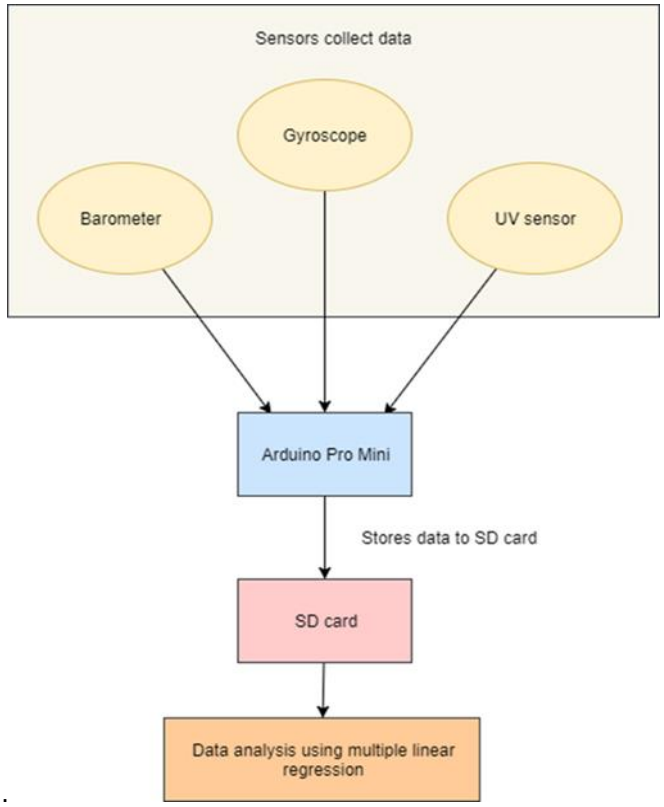

Fig -1: System Architecture

4.1 Data collection

The sole purpose of the sensors are to collect data from your surrounding environment. In this case the data we record are pressure, temperature, UV radiation intensity, speed, acceleration and the trajectory of the satellite. The sensors used are analog sensors and hence they are interfaced with the ADC (analog to digital conversion) pins of the Arduino pro mini. The satellite consists of sensors used to measure the pressure using the BMP180 sensor (barometer), temperature using the MPU6050, UV radiation levels using the GYML8511 and at every level or layer of the atmosphere right up till the point of minimum gravity while ascending and descending.

4.2 Processing and Storage

The main development board that is used in the miniature satellite is the Arduino Pro Mini microcontroller which serves as an embedded system for the the satellite.

The Arduino Pro Mini is a microcontroller board, it is also based on the ATmega328 like Arduino UNO. It has 14 digital pins which can be used as both input and output (of which 6 can be used as PWM outputs), an on-board resonator, 6 analog inputs, a reset button, and pin holes for soldering pins. A six pin header can be connected to Sparkfun breakout

board or an FTDI cable to provide USB power and communication with the Arduino Pro Mini development board.

All the sensors that are put to use are interfaced with the ADC pins of the Arduino Pro Mini. The Pro Mini has 8 analog inputs, each analog pin provide 10 bits of resolution (i.e. 2^10 = 1024 different values).

The data that is received from the sensors is stored in a 16GB SD card. This is done using a SD card module. The Arduino uses the SD library to create a file in an SD card for writing and saving data recorded by the sensor. The data from the sensors of the satellite is stored in the SD card. This data is in CSV (Comma Separated Values) format making it easier and more convenient to segregate the data. The csv format also makes it easier to per-form machine learning on the data.

4.3 Data analysis using multiple linear regression

The data that is retrieved from the SD card as a training model for machine learning. This data is fed into the Python script which uses the multiple linear regression algorithm. Multiple linear regression is one of the most common form of linear regressions. It is type of predictive analysis. It is used to explain the relationship between one continuous dependent variable with two or more independent variables. The independent variables is either of two types continuous and descrete. Multiple linear regression forms the relationship between two or more input variables and an output variable by fitting a linear equation to the dataset observed. Each value of the independent variable x i.e. the input variable is associated with a value of the dependent variable y.

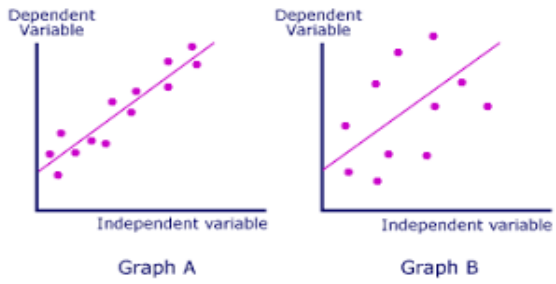

Fig – 2: Linear Regression

Mathematical Equations:

Formally, the model for multiple linear regression, given n observations, is

Yi = A0 + A1Xi1 + A2Xi2 + ... ApXip + Ei for i = 1, 2 ... n. Multiple regression is derived from simple linear regression. It is used to predict the value based on the value of two or more other variables. The variable which is predicted is known the dependent variable. The variables we use to predict the value of the dependent variable are called the independent variables (or regressor variables). Multiple regression also allows you to determine the overall fit of the model and the relative contribution of each of the predictors to the total variance explained.

5. IMPLEMENTATION

The primary use of the miniature satellite is to monitor the atmospheric conditions in the edge of the Mesosphere (70-80 km above sea level); this includes Pressure, Temperature, and Ultraviolet radiation intensity. Besides atmospheric conditions the satellite is also designed to measure its altitude, acceleration and rotation (Pitch, yaw, roll) along the triple axis plane. The satellite does this using the GYML8511 sensor which also acts as a gyroscope. This data is used to measure the trajectory of the satellite. Using multiple linear regression in the proposed system we can predict future data based on the test data we obtain from the satellite. This data is useful for meteorological research on the atmosphere and the study of the trajectory of cube satellites in the mesosphere. The satellite can be launched using a helium weather balloon that can carry it to heights upto 100km above sea level.

The satellite will also use a secondary parachute incase there is any damage inflicted to the weather balloon or if the balloon looses pressure. The entire system will be held within a 4cm wide 3D printed nylon fibre cube which will act as its main exoskeleton. The power will be supplied to the satellite by a 12V lipo battery.

4. CONCLUSION

The proposed project is a miniature satellite that uses Machine Learning to perform analysis. The primary use of the miniature satellite is to monitor the atmospheric conditions in the edge of the Mesosphere and accordingly use this data to predict changes and forcecast atmospheric conditions using multiple linear regression. The main aim of the proposed design for a miniature satellite is to not only drastically cut down on the cost and size of the satellite but to also intro-duce machine learning to cube satellites allowing the satellite itself to make make weather predictions.

5. REFERENCES

Arduino website: https://www.arduino.cc/

NASA: https://www.nasa.gov/

CubeSat: www.cubesat.org/