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Design Thinking Approach to Fabrication of Meteorology Tracking CUBESAT

S. Suvitha[1*], S. Reepitha[2]
[1]B.E. Graduate, Department of Aeronautical Engineering, Hindustan College of Engineering and Technology, Coimbatore, India
[2]B.E. Student, Department of Aerospace Engineering, SNS College of Technology, Karur, India

***Abstract*: In the past decade's satellites played a crucial role in enabling global communication through TV, phone and internet transmission. Additionally, they were used for navigation, mapping, weather forecasting, disaster response and military intelligence. However, these traditional satellites are expensive to build, launch and maintain which can limit the number of satellites in orbit and the frequency of updates. The interest is to design an autonomous NANO satellite which can provide the information of weather from anywhere anytime. It is possible to provide an instant weather report which can be used to compare the data of a place with some different altitude as well as for different times. With the advancement of technology, especially Micro Electrical Mechanical Systems and Data acquisition systems, the problem of large set up area and cost has been reduced significantly. Nano satellites can be set up at home as well as in the atmosphere or in space which can provide accurate weather reports.**

***Keywords*: Nano satellite, Weather forecasting, Micro Electrical Mechanical Systems, Data acquisition systems.**

1. Introduction

A satellite is an object or device that can circle or orbit around the planet or star. There are two types of satellites 1. Natural satellites (earth revolves around the sun). 2.Artificial satellite (man-made one and launched into space by using rockets). These satellites can be used for a variety of purposes such as navigation, weather forecasting, communication, Earth observation etc. The technology has widely developed and satellites gain more importance. However, the cost of estimating the satellite is really high. Our aim is to design and implement a Nanosat based weather monitoring system. The system must be simple to construct, portable, cost efficient, less power consuming and reliable. Cube Satellite is an artificial miniature satellite with 10 cm in length. Scientists have gotten better satellites in the decades even though it would be better for weather forecasting if we had more satellites. However, launching these huge weather satellites take both time and hundreds of millions. These satellites can be used for a number of things, including communication, navigation, weather forecasting, and Earth observation. Technology has advanced greatly, and satellites are becoming increasingly significant. However, it is very expensive to estimate the satellite. Our aim is to design and implement a Nanosat based weather monitoring system. In low Earth orbit, CubeSats are currently often utilized for communications and remote sensing tasks. However, as engineers get more experience with the technology, CubeSats are starting to travel farther.

2. Methodology

A. Design Thinking

Design thinking is the way of solving problems creatively and innovatively by analysing consumer needs. It is a problem-solving approach that is widely used in various fields such as business, engineering, and social sciences. It involves understanding user needs, exploring possible solutions, and iteratively refining the ideas through prototyping and testing.

The origin of design thinking can be traced back to the early 1960s when the design consultancy firm IDEO was founded. However, the term "Design thinking" was not coined until the 1990s when David Kelley, one of the founders of IDEO, began using it to describe their approach to innovation. In the following years, design thinking gained popularity as a powerful tool for innovation and problem-solving, particularly in the field of product design. It has since been adopted by various industries and organisations to address a wide range of challenges and opportunities, from developing new products and services to improving business processes and creating social impact.

Today, design thinking is widely recognized as a human-centred and collaborative approach to problem-solving that emphasises empathy, creativity, experimentation, and continuous learning. Design thinking can be achieved through five stages 1. Empathy, 2. Define, 3. Ideate, 4. Prototype, 5. Test

B. Empathy

In the first stage of design thinking signers seek to understand the needs, wants, and perspectives of the people they are designing for. This involves conducting research, observing and interviewing people, and gathering data to gain insights into their experiences and behaviours.

The problem at hand is that the processing power of the Microsoft controller is weaker than that of many microcontrollers. Additionally, the resolution of the Microsoft controller is limited to only 10 bits, which may not be sufficient for some applications. This results in a need for more

*Corresponding author: suvithasubramani030@gmail.com

microcontrollers, which can be costly and complex to implement. Furthermore, the Microsoft controller has limited working memory, which can further limit its capabilities.

Moreover, the Microsoft controller's small size means that users have to work in a relatively tiny space, which can be challenging and frustrating. Finally, some errors remain persistent, and error messages may not be useful, leading to difficulty in troubleshooting and fixing issues. These limitations can hamper productivity and limit the effectiveness of the Microsoft controller in various applications.

C. Objective

In the case of companies that are deploying hundreds, or possibly even thousands of satellites in large-sized constellations, the objective is to achieve financial advantage through

- Mass production
- Minimizing testing and
- Validation and
- Adopting innovative manufacturing techniques such as additive manufacturing.

The objective of this project describes the following research objectives:

1) Survey and estimation of the potential of IU-CubeSat platform potential, reflecting how to design 2 Nickolay Zosimovych: IU CubeSat Platform Design more suitable platform for future CubeSats.
2) During CubeSat platform development, formulating concept of the design process and propose standard physical relationships due to find optimal design solutions.
3) Study CubeSat modular structure which allows to get flexible subsystems settlement.

D. Scope of the Project

CubeSats have appeared in the last 15 years and represent a new paradigm in the satellite industry. They are radically smaller than conventional satellites, resulting in lower costs, which offsets the reduced risk of failure and shorter useful life, which is nevertheless acceptable for numerous applications.

The special nature of nanosatellites does not prevent them from carrying out the same tasks as larger devices. The features naturally differ, but are sufficient for multiple industrial applications.

- Earth Observation
- Communication and IoT
- Geolocation and Logistics
- Signal Monitoring (SIGINT)
- Scientific Applications

In addition to commercial solutions, CubeSats can also be used for space observation programmes, interplanetary missions, systems testing in orbit or biomedical research. They also represent a gateway for the development of space programmes in those countries that have not yet joined the space race.

E. Define

In the second stage, designers use the insights they gained during the empathise stage to define the problem they are trying to solve. This involves synthesising the data they collected, identifying patterns and themes, and framing the problem in a way that can guide the design process.

Here, we improve the accuracy and reliability of weather forecasting, in order to provide more timely and useful information to individuals, businesses, and government agencies.

F. Ideate

In the third stage, designers generate a wide range of ideas and potential solutions to the problem they defined in the previous stage. This involves brainstorming, sketching, and using other techniques to encourage creative thinking and generate a diverse set of ideas.

G. Prototype

In the fourth stage, designers create physical or digital prototypes of their ideas to test and refine them. This involves building models, creating mock-ups, or developing simulations to explore the feasibility and effectiveness of different solution.

3. Design/Fabrication

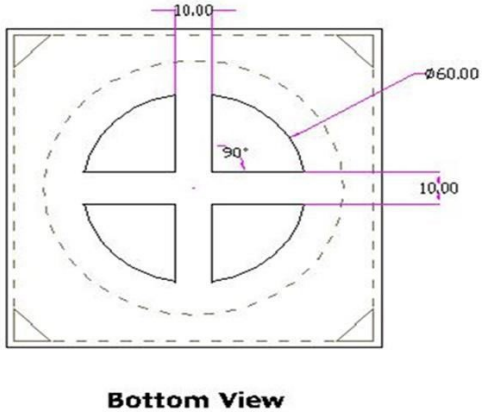


Fig. 1. Proposed 2D design

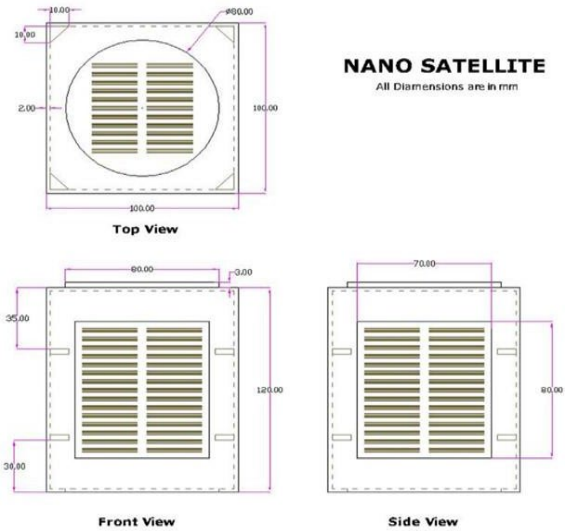
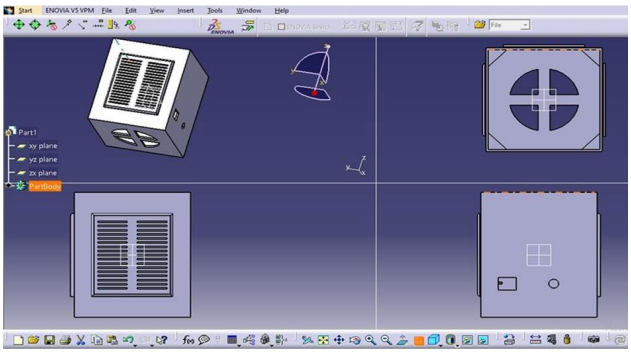


Fig. 2. 2D representation of NANO satellite using AUTOCAD

A. *Proposed 3D Design*



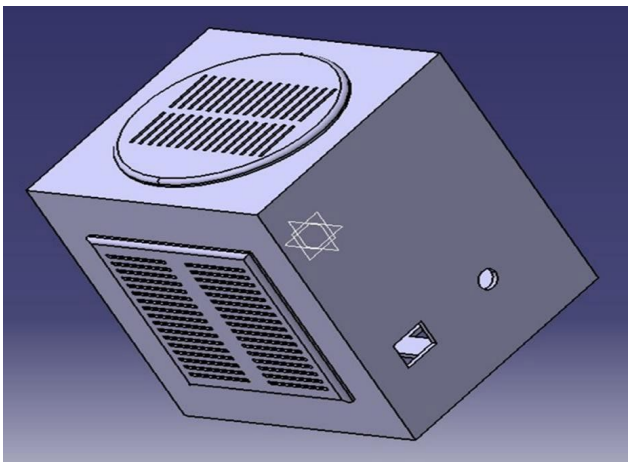


Fig. 3. 3D view using CATIA v5

B. *Components Used in Nano Satellite*

1. PLA (Polylactic acid) (10x10x12cm3)
2. Arduino Development Board
3. Temperature & Humidity Sensor
4. Gyro Sensor
5. WIFI/Bluetooth Module
6. Monoacrylate Solar Cells

1) *Main Control Board*

The ESP32 is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc.

Table 1

Developer	Arduino
Type	Single-board microcontroller
Minimum Power Required	5 Volts
Input Voltage	5 to 20 Volts
CPU	Microchip AVR (8-bit)
Memory	SRAM
Storage	Flash, EEPROM

2) *Temperature and Humidity Sensor*

DHT11 Module:

It consists of a capacitive humidity sensing element and a thermistor for sensing temperature. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form.

$$Absolute\ Humidity = \frac{Mass\ of\ Water\ Vapor}{Volume\ of\ air\ mixture}$$

C. *3-Axis Gyroscope Sensor*

GY-50 MPU6050 Module:

It has many functions over the single chip. It consists a MEMS accelerometer, a MEMS gyro, and temperature sensor. This module is very accurate while converting analog values to digital because it has a 16bit analog to digital converter hardware for each channel.

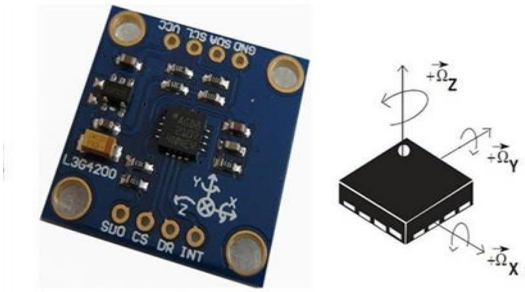


Fig. 4.

D. *GPS*

1) *GY-GPS6MV2 Module*

To calculate your 2-D position (latitude and longitude) and track movement, a GPS receiver must be locked on to the signal of at least 3 satellites. With 4 or more satellites in view, the receiver can determine your 3- D position (latitude, longitude and altitude). Generally, a GPS receiver will track 8 or more satellites, but that depends on the time of day and where you are on the earth.

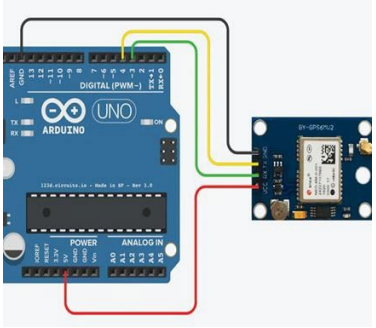


Fig. 5.

2) *Wi-Fi/Bluetooth Sensor*

HC-05 Module:

The HC-05 is a very cool module which can add two-way (full-duplex) wireless functionality to your projects. You can

use this module to communicate between two microcontrollers like Arduino or communicate with any device with WIFI/Bluetooth functionality like a Phone or Laptop.

Fig. 6.

3) PLA (Polylactic acid)

PLA withstands years of exposure to the elements and even corrosive atmosphere without losing its dimensional shape. They are highly relevant for their mechanical & thermal properties.

Fig. 7.

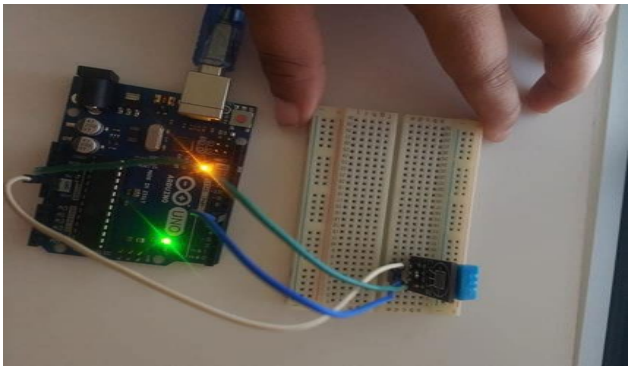


Fig. 8. Fabrication and assembling temperature and humidity sensor

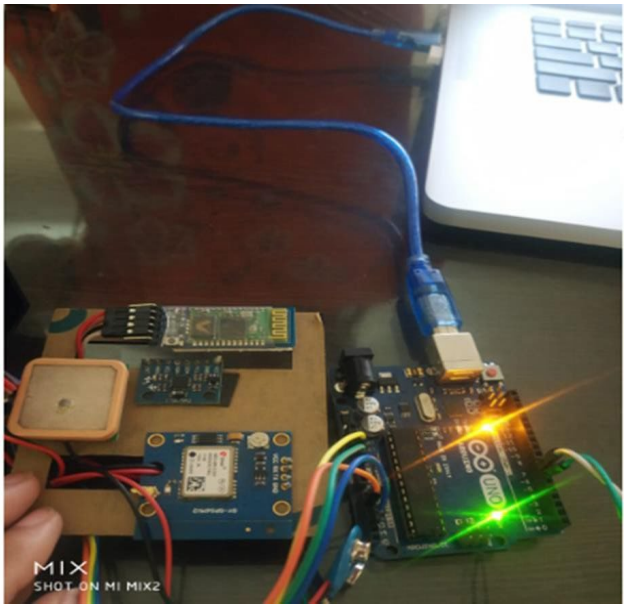


Fig. 9. 3-Axis gyroscope sensor

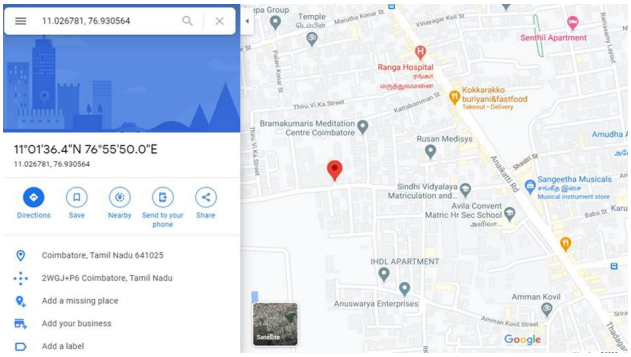


Fig. 10.

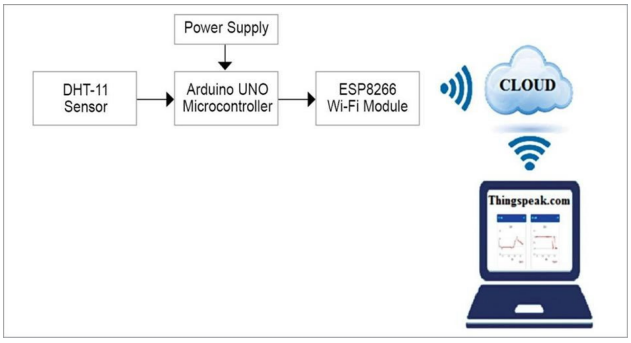


Fig. 11. Arduino control devices

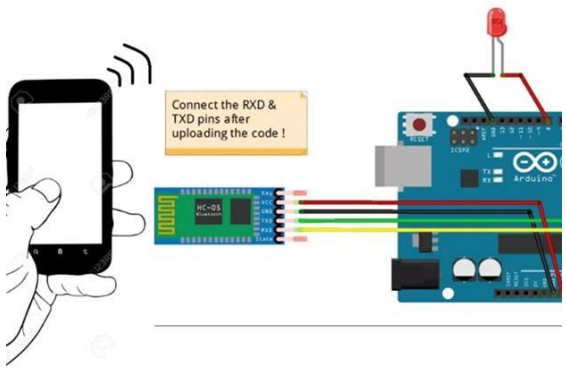


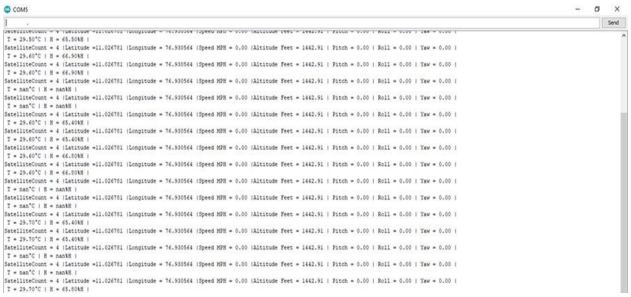
Fig. 12. WIFI/Bluetooth control via. android

E. Test

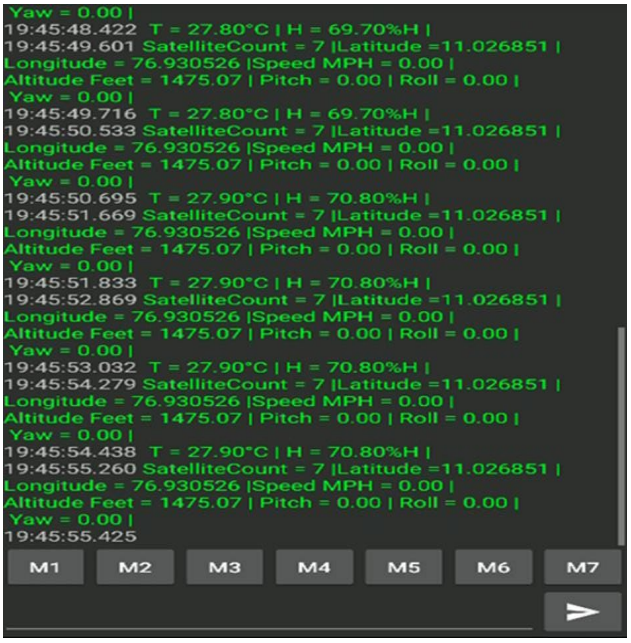
In the final stage, designers test their prototypes with the people they are designing for to gather feedback and insights. This involves conducting user testing, gathering data, and iterating on the design based on the results. The testing stage helps designers to refine and improve their solutions, ultimately leading to a better design outcome.

4. Results and Discussion

The results displayed by Arduino Integrated Development Environment Software in PC screen:



Average Temperature (T)	Relative Humidity (H)	Speed of the Object (MPH)	Altitude (ft)	Longitude	Latitude	Roll	Yaw	Pitch
29.60°C	66.9%	0	1442.91	11.026781	76.930564	0.00	0.00	0.00



Average Temperature (T)	Relative Humidity (H)	Speed of the Object (MPH)	Altitude (ft)	Longitude	Latitude
27.80°C	69.70%	0.00	1475.07	76.930526	11.026851

Fig. 13.

The result screen displayed in Serial Bluetooth Terminal app.

A. Serial Monitor

The Arduino IDE has a feature that can be a great help in debugging sketches or controlling Arduino from your computer's keyboard. The Serial Monitor is a separate pop-up window that acts as a separate terminal that communicates by receiving and sending Serial Data.

B. Serial Bluetooth Terminal

Serial Bluetooth Terminal' is a line-oriented terminal/console app for microcontrollers, Arduino and other devices with a serial/UART interface connected with a Bluetooth to serial converter to your android device.

5. Conclusion

Our aim is to design and implement a Nano-Sat based weather monitoring system. The system must be simple to construct, portable, cost efficient, less power consuming and reliable. We have demonstrated the hardware design and the data acquisition system theoretically.

And the fabrication of NANO Satellite with proper material Identification is done. Also, Pressure, humidity temperature against variation of altitude in a region is measured in given interval of time with the help of satellite. The comparison of humidity and temperature with respect to the variation of altitude is tabulated.

The future scope of the project is to develop propulsion unit for this specific nano satellite module which will utilize lipo battery power subsystem for the same.

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