Design and fabrication of advance level CANSAT Used for measuring the atmospheric parameters And GPS tracking system

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Abstract- *Satellite communication is an advanced mode of communication in aerospace. Design, fabrication, launch of satellites is a complex task and very few countries have succeeded in this and the cost involved is very high. Design of these satellites at college level need a lot of research and expertise. Can Sat is one of the simplest design of satellites. The low cost of implementation, short preparation time and simplicity of design compared to other space projects make Can Sat concept an excellent practical opportunity for students to take their first steps in space. It gives students a first-hand experience on how a real time satellite will be as Can Sat faces same problems like a real time satellite. The Can Sat project aims to develop a can-sized satellite which measures atmospheric data and transmits the acquired data to a ground station. The Can Sat is launched using a rocket and safe landing is done using parachute. The main objective of the project is to conduct a case study about the variations in the temperature and humidity with respect to altitude in different places. The Can Sat is controlled by a micro controller. The main components are the humidity sensor, temperature sensor and GPS module. The data that is stored by the Can Sat during the mission is then read and plotted.*

Keywords- Can Sat, Satellite, Rocket, Launch, Navigation Control Algorithm

I. INTRODUCTION

Can sat is a functional model of a micro-satellite, in that all the systems are integrated into a volume of soda can. It is a type of sounding rocket payload. No can sat has ever left the atmosphere or even orbited earth. CanSat represent the next level of complexity in the student satellite program. In this case, the payloads fit inside a standard soda can (hence Can Sat) and are launched to an altitude of approximately 2 miles where they measure different parameters like pressure, temperature, humidity etc. The can sat's are deployed using small rockets. They are equipped with a recovery mechanism, usually a parachute, to limit damage upon recovery and to allow the can sat to be reused.

In 1998, Bob Twiggs, professor emeritus at the Stanford University, proposed the initial idea of what later would become the nanosatellite projects. The idea was to make a satellite with the size of a soda can into space. The volume was 350 ml and weighed about 500 grams. This led to the project called ARLISS in the year 1999, which involved mostly Japanese and American universities. The first launch took place on September 11, 1999.

Types of Cansat

There generally three type of CanSat with two mission types,

a) Data acquisition CanSat

These devices generally have a steering system consisting of threads that move asymmetrically so as to generate a difference in lift of the longitudinal axis so the CanSat rotates in one way or another. It uses fairly simple mechanics. These devices are difficult to govern due to the generally low rate of descent and the large surface area lifts it. They are used in first type of mission profile.

b) Fly-back CanSat

Mechanically more complex and less vulnerable to weather conditions than CanSat's with parachute or gliders. These kinds of gadgets are much harsher to govern and require an electronic system able to perform many more corrections per second due to its higher rate of descent.

c) Come back CanSat

The main task of these is to land in a controlled manner as close as possible to a target marked by GPS coordinates. These devices can be guided by GPS or by and Inertial Navigation System INS. The position is sent to the microprocessor which compares the position of the target from the analysis of these data to calculate the angle at which it should turn to address the target and gives appropriate instructions to the steering system. This process is repeated continuously to make corrections. Such devices also store data on the flight but since the number of sensors that accompany them is less, information is scarcer than in the previous type. A Come-back CanSat always carries a steering system that allows it to manoeuvre, to orient and to move towards the target. Normally such a mechanism is actuated by one or more actuator controlled by the microprocessor so that the servomotor rotates to one side or the other and so rotating CanSat. There are two main types depending on whether CanSat incorporates a parachute or glider or a rotor and wings.

II. RESEARCH AND COLLECT IDEA

Margad-Erdene Jargalsaikhan, Munkh-Erdene Zorigbold, Sukhbuyan Galc [1], has designed a CANSAT that has been implemented during the CANSAT leadership training program at the Wakayama University in Japan. The program has allowed all of the participants to get the knowledge of two full CANSAT experiences. Starting with the initial course about a very flexible computer, the MBED system, and discussion of the project idea, the design, the development (hardware and software), the validation, and the correction of mistakes, the conduction of the projects, the launching process, the digestion of learned lessons, the interaction with international colleagues.In this study, a CanSat with capability of returning back to target is designed and implemented. The device is a part of project that has been implemented during the CLTP (CanSat Leadership Training Program) in Wakayama University. The CanSat is controlled by a state-of-the-art MBED 32-bit microcontroller. The main components are the pressure, ultrasonic, GPS sensors and the 2.4 GHZ transmitter. The mission is planned for two stages which are flight back to the target by a paraglider and rovering on the ground on wheels. The process will be monitored on the ground station via the Google Earth software. The electronics & hardware design and the control algorithm is discussed.

Hiraoki AKIYAMA, Shusaku YAMAURA [2], presented the design and navigation control of an advanced level comeback CanSat which is going to be launched to an altitude of about 400 m using an amateur rocket from ground level. The CanSat uses advanced and ultra-light microcontroller, pressure and temperature sensors, 3-axis accelerometer, 3-axis gyro, camera, GPS, IR distance measuring sensor, and RF communication module to communicate with the ground station PC. Three actuators are considered in this work for flight and ground segments control. They are the motor driven propeller, elevator and rudder. For the flight segment, parachute and attitude control are used to control the CanSat descent rate, attitude and heading. For the ground segment control; both the propeller and the rear landing gear of the CanSat is used for heading toward a predefined location on the ground. The rear landing gear is connected to the rudder rotational axis. An indigenous navigation control and electronic circuit design with the test results also are presented in this paper. Risk analysis was performed to identify the most critical element and path for whole mission. Both launching and parachute deployment was successful. However due to strong wind both rocket and cansat drifted away.

Cabuloglu C [3], described a CanSat that measures pressure, temperature and its location. The Cansat is provided to take a certain altitude by a RC aircraft and it can land on ground with the help of a parachute. The main mission objectives are temperature, pressure, and altitude and humidity measurement, landing to the desired point. The paper describes about all the electronic and mechanical systems involved for the launch of satellite.

Serder Ay, Mansur Celebi [4], describes about the CanSat which is controlled by a state-of-the-art MBED 32-bit microcontroller. The main components in this CanSat are the pressure, temperature and altitude sensor. It also consist of ultrasonic, GPS sensors and the 2.4 GHZ transmitter. The mission is planned for two stages. One stage is flight back to the target by a paraglider and other stage is rovering on the ground on wheels. The process is monitored on the ground station via the Google Earth software. The electronics and hardware design and the control algorithm is discussed in this paper.

III. OBJECTIVE

Our first primary objective is to design and build a Can Sat with the specifications mentioned below and it should be able to sense humidity and temperature readings send it to ground station and withstand minor shocks.

Our second primary objective is to take the readings in the atmosphere a few metres above the ground level using a Rocket.

IV. ADVANCE DESIGN OF CANSAT

Project Specifications:

The requirements and restrictions of the mission are as follows:

- The size of Can Sat should be equal to or less than a 0.5liter can.

- The weight should be less than 0.5kg.
- The CanSat should be able to measure the atmospheric temperature and humidity
- The module to measure temperature is LM35 & for humidity measurement is DTH11.

Hardware Requirements:

- Micro controller board- Arduino UNO
- Temperature sensor- LM35
- Humidity sensor- DTH11
- Battery

Software Requirements:

- Arduino software
- MS Excel

Mission Profile and System Development

Mission type

The mission type can basically divide into two categories:

- Data acquisition Mission (include imaging, sensors data acquisition).
- Come-back or fly back mission

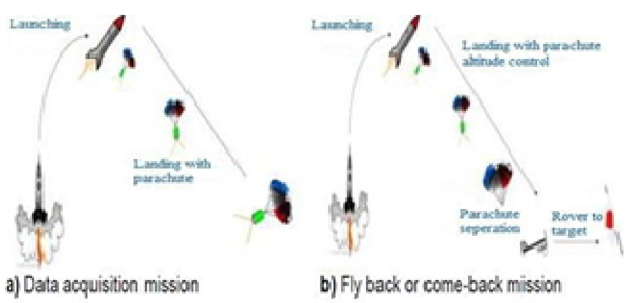

Figure 1. Can Sat mission type

Parachutes and Attachments

When the Can Sat is deployed from the rocket, it is possible the rocket is still moving quickly. The container parachute will open up almost immediately after the Can Sat exists the payload section and open up. There will be a significant jerk force on the parachute and the attachment point.

Parachutes

It is best to purchase a commercial parachute. It is simpler and a time saver. There are multiple sources and multiple designs. There are designs specific for high velocity deployments. If you must make your own parachute, use strong cord and have the cord sewed into the parachute material. High performance parachutes secure the cord across the parachute. A major weak point is the attachment point of the cord and parachute material. Do not use fish line.There are numerous types of parachutes, the simplest is a the flat circular sheet, then there is spherical parachute. The problem with these parachutes is they fill with air and will tilt to the side to spill out air. It is highly recommended to get a parachute with a spill hole. An x-form parachute will also work.Also include a one to 2 foot length of cord between the parachute and CanSat. The length of cord will dampen any swaying from the parachute to the CanSat. I use kelvar cord and a know that tightens when pulling the cord. There are numerous websites and a book on knots.For parachute material, use rip stop nylon. Do not use Quest or Estes plastic parachutes.

Attachment Points

The best way to attach is an eye-bolt. The bent wire eye-bolt with an 8-32 threading is sufficient. A forged eye-bolt is better but most likely over kill. You want the attachment point to be very strong. Use a fender washer on both sides of the eye-bolt when securing with a nut. The fender washer distributes the load over a larger portion of the material. This configuration is used in the construction of the rockets. Where the eye-bolt attaches to the Can Sat structure is important. Make sure the material is strong enough. 1/8 inch thick micro-plywood is strong. Some printed plastics may not have the strength. Testing needs to be performed to verify the strength. If using a bent wire eye-bolt makes sure the cord cannot slip through any gap

V. DESIGN AND FABRICATION

Electronics System Design

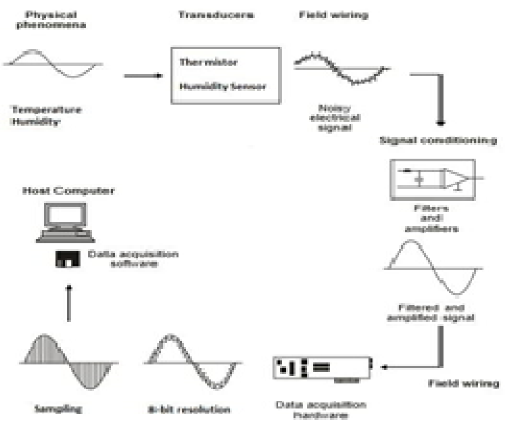

Figure 2.

Electronic System Design

Transducers and sensors provide the actual interface between the real world and the data acquisition system by converting physical phenomena into electrical signals that the signal conditioning and/or data acquisition hardware can accept. Field wiring represents the physical connection from the transducers and sensors to the signal conditioning hardware and/or data acquisition hardware. Electrical signals generated by transducers often need to be converted to a form acceptable to the data acquisition hardware, particularly the A/D converter which converts the signal data to the required digital format. Data acquisition and control (DAQ) hardware can be defined as that component of a complete data acquisition and control system, which takes the input signal, processes it and coverts it to digital format using ADC. Data acquisition software runs on the computer that transforms the system into a complete data acquisition, analysis, display, and control system.

Microcontroller Unit

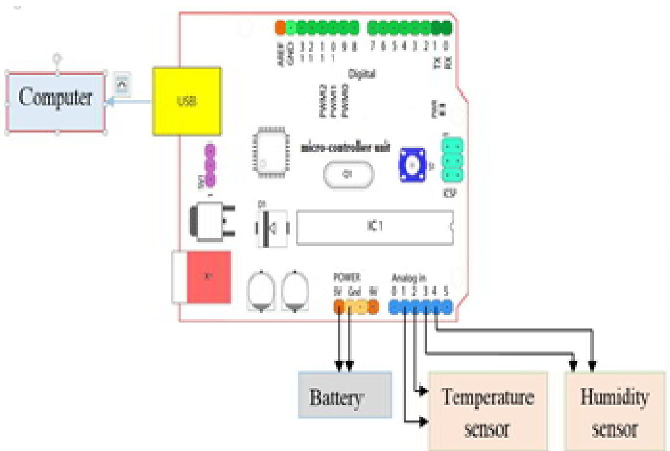

Figure 3.

Schematic representation of Arduino board

An Arduino UNO is an open-source microcontroller development board. This allows you to upload programs to this board which can then interact with things in the real world. With this, you can make devices which respond and react to the world at large

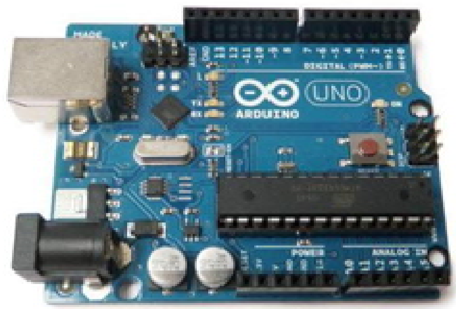

Figure 4.

Arduino Uno
Sensors

Temperature Sensor –LM35

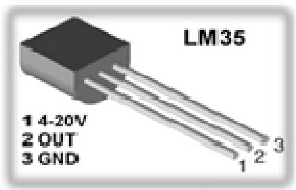

Figure 5.

The LM35 does not require additional circuitry to calibrate externally. The low output impedance, the output and precise linear calibration enables this to be easily installed integrated in a control circuit. Due to low supply current of self-heating effect is produced greatly reduced. It is found in different types of encapsulation, the most common is the TO-92 , used by low-power transistors. Also this sensor if it is connected to one but get general and output gain.

Humidity sensor

The LM35 does not require additional circuitry to calibrate externally. The low output impedance, the output and precise linear calibration enables this to be easily installed integrated in a control circuit. Due to low supply current of self-heating effect is produced greatly reduced. It is found in different types of encapsulation, the most common is the TO-92 , used by low-power transistors. Also this sensor if it is connected to one but get general and output gain.

Humidity sensor

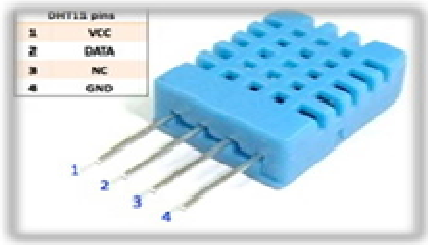

Figure 6.

This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high-performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness. Each DHT11 element is strictly calibrated in the laboratory that is extremely accurate on humidity calibration. The calibration coefficients are stored as programmes in the OTP memory, which are used by the sensor's internal signal detecting process.

VI. DESIGN OF CANSAT

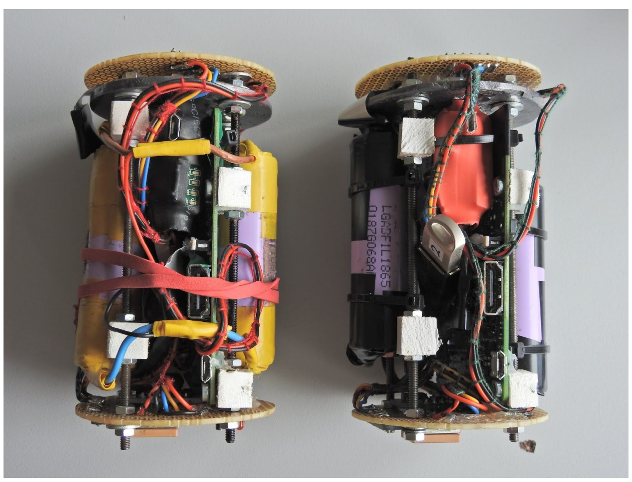

Figure 7.

Rocket- Satellite Release Mechanism

Door opening mechanism of rocket

Cansat along with parachute which acts as a payload is placed inside the project in a compressed state with help of a spring .The payload ejection is done with a servo mechanism. When the rocket reaches the required altitude, the signal is sent through the transmitter, this signal is received by the receiver installed in the rocket. Now the servo motor rotates and releases the rubber band attached to it. Door is closed by the rubber band. Once the rubber band is released by servo motor the door opens. The spring in the compressed state pushes the parachute or deploys the parachute at the instant the door is opened.

Figure 8. Receiver& Transmitter

MISSION PLAN OF OUR DESIGN

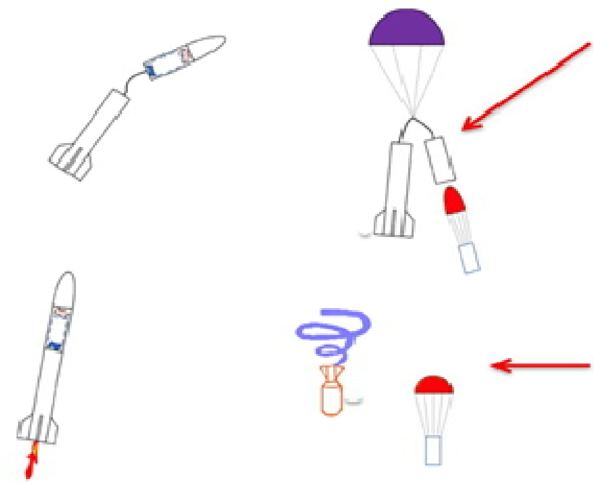

Figure 9.

VII. CONCLUSION

During this period we have made our cansat model successfully And we have launched in excel engineering college.At 30 deg of Sea Level altitude we have used rocket boosters to launch and it Have launched successfully the tem and hum values are noted

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