CanSat And Laser Communication Project

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***Abstract*– The Can Sat or the Can Satellite is named after this name due to its tiny size (comparable to Drink Cans), its primary objective to educate the individuals how to design a mission and know its requirements, then. Programming it, and manufacture it and finally, launching it successfully. So, the CanSat is called to be an educational satellite that make the individuals apply all the parts of the Space Mission.**

Our project contains of 5 subsystems, it has the major subsystems found in a satellite; like Coding subsystem to select its mission, integrate the sensors, PCB subsystem to design the boards that contain all the sensors, Structure subsystem for designing the Can Sat and testing, Ground Station subsystem to analyze the data and Recovery subsystem to prepare for launch.

The second part of the project is the laser communication technology in which we send the cansat data by means of pulses in the laser beam to simulate the transmission of data in space.

Keywords-- Can Sat – Laser Communication – Satellite – Prototyping – Space technology – broadcasting - Ground Station.

I. Introduction

Our research that talks about the CanSat (mini-satellite) and laser data transmission technology, and at the end we present our experience in implementing a real project for them into one integrated project, which is a merger between the CanSat project and the laser pulses communication project

A. Intro to Satellites

Meaning of the word (Satellite), is to have something that revolve around another one (e.g., Moon goes around earth).
The satellites are having Various kinds as its mission is different, here we'll learn about their types and their sub-systems and the CanSat example.
Satellites are revolving around the earth by the effect of the Gravity, the equation that master the effect is

$$F_g = G \times \frac{M_1 M_2}{r^2} \quad where\ G = 6.67 \times 10^{-11}\ \frac{m^3}{kg \times s^2}$$

B. Intro to laser communication

Laser communication in space is a new technology that is currently used to increase the speed of communication with satellites and to solve the problem of interruption of broadcasting when they walk in an orbit far from the Ground Station

C. Intro to CanSat project

The Can Sat or the Can Satellite is named after this name due to its tiny size (comparable to Drink Cans), its primary objective to educate the individuals how to design a mission and know its requirements, then.
Programming it, and manufacture it and finally, launching it successfully.
So, the CanSat is called to be an educational satellite that make the individuals apply all the parts of the Space Mission.

II. CanSat

CanSat is an educational satellite that make the individuals apply some parts of the Space Mission Concept, its primary objective is to have a good knowledge of how to design a mission and understand its requirements.
Our CanSat Mission is to determine:

1- Temperature
2- Pressure
3- Acceleration & Orientation
4- Position (Longitude and Latitude)
5- Humidity
6- Air Quality
7- Altitude
8- Magnetic Field (compass)

And all these data stored in SD Card & transmit wirelessly to the ground station throw RF module.
We worked on four subsystems (four teams) and integrated them together to achieve CanSat, those are:

A. Coding Team

To measure each parameter we have mentioned before, we used a combination of sensors and electrical devices, Selection of this combination undergoes some limitations:

- Availability in Egypt
- Impact on total budget

We used OOP to create library for each sensor to make writing the main program sketch easy and manageable.
These Sensors and Electrical devices are:

- **ATMEGA 328p** microcontroller as the brain of CanSat.
- **GPS NEO 6M** to Determine CanSat Location (Longitude, Latitude and Altitude).
- **10 DOF-IMU** to detect Acceleration, Orientation, Magnetic Field and Pressure
- **433 MHz RF** for wireless communication.

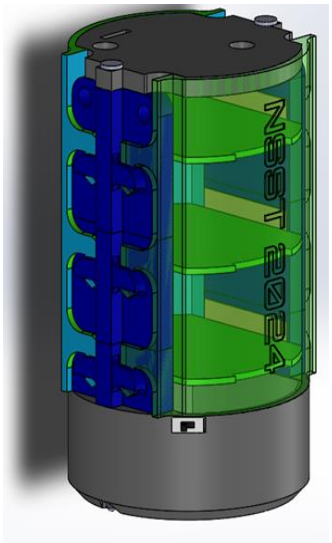
- **MQ-7** to measure Air Quality.
- **DHT-11** to detect surrounding environment of the humidity and temperature.
- **SD-Card Module** to store all data from all sensors periodically

B. PCB Team

First of all, we used bred board to check all sensor and electrical devices together, we make sure that all of them works very well, the desired voltage have been achieved and reads from sensors are acceptable.
You can imagine how complex this process is, the huge number of wires used make it so difficult to go behind any problems, so we used PCB to hold up all components together. We started with designing schematic then PCB design using Diptrace program and finally manual manufacturing.

C. Structure Team

To hold up all PCB boards together we designed a STRUCTURE which will be 3D printed latter. The Desigen goes under the national requirements like size and weight
The design has been changed many times tell reaching the current one.



D. Ground Station Team

In the ground station, we aim to design a friendly GUI that enables end-user to read and good understand for Data we get from the CanSat.

For More Data you can see that video:https://www.facebook.com/100008139365535/videos/904062850252610/

III- LASER COMMUNICATION

a) Introduction to Space Communication problem

In Current satellite communications systems have specifications that must be met for transmissions to reach their intended sender/recipient. The power and antennae gain must allow for coherent communication with an acceptable level of signal loss over the required distance for satellite communication to be successful. They present what is known as a communication window when all these parameters are met.

b) Solving Space Communication Problem (Laser Communication)

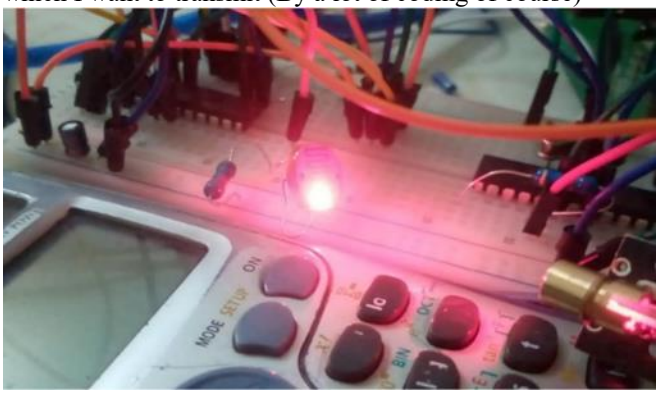
Because of the much higher bandwidth, laser communications can carry a lot more data. The disadvantage of laser communications is that it requires a straight line of sight between the two network nodes, which is possible in outer space but necessitates very agile, quick, and precise laser pointing. Electromagnetic waves bounce and bend around things, requiring no line of sight or exact pointing, but they are slower and carry less information.

For more information you can this video to better imagination of Space Communication problem:
https://www.youtube.com/watch?v=kZZ8SXhfsaw

c) Prototyping Space Laser communication in our project

In our project we used the same idea to transmit data throw the laser beam and after hard effort with coding it finally worked
There are 2 main components in these project

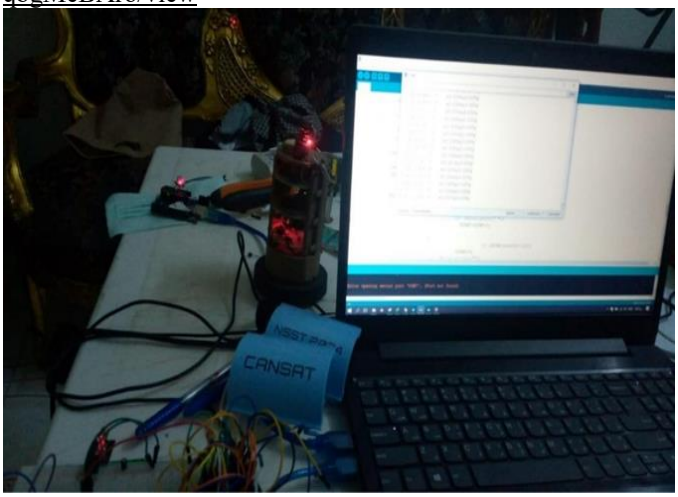
1) First one is the laser module which we can control it with code to make certain pulses in laser beam depending on the sequence of data I sent
2) Second module is the LDR which is light sensor can receive laser beam and convert pulses in the laser beam into data which I want to transmit (By a lot of coding of course)



d) Integration Between Laser communication & Can Sat Project

We had the opportunity to improve laser project by integrate it with can sat project. As instead of transmitting random data, we transmit real data from sensors of almost real satellite can sat, and it was more challenging more and more

For more imagination of how the integration done you can see these video
https://drive.google.com/file/d/1f5ZS0zxXVBBfsuCudGBflDhqbgMeBAro/view



THE BENEFIT OF OUR PROJECT & ITS IMPORTANCE

a. Benefits on us as students in these field space technology

- To make real satellite we need make it in small scale first as CanSat is small idea of real satellite, and these is the principle that most of student' s project (to learn something make a project in it, even in small scale which available in your ability)
- This Project opens to us the ability to make another enormous number of projects we could make it all alone (remote cars, rover, robotics, and more and more). Or to implement our idea in real, like laser communication in real project not just an idea
- Employment requirement in our field need strong skills in programs that we thought in this project like SolidWorks, ANSYS, Arduino (Embedded), LabView, PCB…
- The ability to make cansat for student is available for even first year engineer student as it just need the basics skills in 4 subsystems to make these, and its sensors are available in Egypt, and the cost of project within reach budget student cause its cost is relatively small but its benefit is enormous in your skills
- The safety to accomplish cansat project is relatively high as most of hard work is done by 3D Printer and CNC router

b. Benefits on Egyptian society

The Egyptian society is in strong need for cultural awareness with the importance and gravity of space technology field, as the western societies are light years ahead of us by their support of these projects or any project in space field, so our society needs this project and need to support and implement more and more studies and projects like these to keep pace with western progress in space technology.

c. Benefits on our country Egypt and market needs for these project

Now in Egypt there are huge demand for projects in these field as Egyptian government decided to begin the Egyptian space program with high support and enormous budget and support, and mainly there are 3 places in Egypt need to contain these projects (Egyptian Space Agency, National Authority for Remote Sensing & Space Sciences, African Space Agency)

4. FUTURE PLAN TO IMPROVE AND DEVELOP THE PROJECT

To improve our project, we would develop it in 3 main stages, first one is to improve the cansat to the next level which is CubeSat, secondly we would improve the range of laser by using more powerful laser module to transmit data in large distance, finally we would make an automatic mechanical

structure which could direct the laser berm to the target accurately automatically