Design of Solar Powered Subscale Glider for CanSat Competition

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***Abstract*— This paper briefly describes glider designed by IQRASAT Team from Yildiz Technical University for CanSat Competition 2017. CanSat competition is a design-build-launch competition that provide teams with hand on experience. The paper mainly focuses on the design of an innovative science glider. Hardware and software subsystem of CanSat is presented in detail as well as ground station for telemetry reception. The design procedure is described with the preliminarily designed complete system satisfies the rules of CanSat 2017**

Keywords—Model Satellite; Deltawing Glider; Energy Harvester; CanSat; CanSat2017

I. INTRODUCTION

As humanity rises up and technology evolves, interest on space technology has been significantly increased. As resources on earth runs out, mankind tended more to the sky. Several different space administration of countries has been researching and developing spacecrafts. But developing spacecrafts, rockets and satellites requires a tremendous cost. Connecting the world, teaching space technology to more people will cause coming of new ideas which could save potential amount of expenses. CanSat competition fulfills this requirement. Its aim is to make worldwide students design, build and launch their nanosatellites so they can compete against each other.

The history of nanosatellite idea originates to 1998's. The idea was what would be to launch into space in size of a soda can and mass of max 500 gram. Finally in 1999, mostly involving American and Japanese universities began to study about this problem. The result would be a rocket capable of moving 1.8 kilos and of reaching to nearly 4000 meters, opening the door to low cost space flights -about $400. The competition is carried out every year without interruption. In 2001, the ComeBack category was added which means the satellite should be directed to a particular target. After this mission was successfully achieved, University of Tokyo placed into orbit two satellites CubeSat. CubeSats are larger than CanSats and also cube shaped.

CanSat competition is organized in several countries. The biggest one is the one that carried out by American Astronautical Society (AAS). It is also supported by NASA and AIAA. It is a prestigious competition all over the world. In addition, CanSat training programs are also organized in order to teach high school students about the concepts.

CanSat designs should have below significant features

- Innovative solutions
- Affordability
- Feasibility

The international CanSat competition is a design-build-launch competition that provides teams with an opportunity to experience the design life-cycle of an aerospace system. The competition includes all aspects of an aerospace program from preliminary design to post mission review and teams are scored according to those aspects' performance. The mission and its requirements varies every year. CanSat mission reflects various aspects of real world missions including telemetry requirements, aerodynamics, mechanisms,communications and autonomous operations.

The overall CanSat system is composed of two primary components, a payload/science vehicle and a re-entry container that protects the science vehicle during ascent, "near-apogee" deployment and initial reentry/descent.

The mission of CanSat2017 is to design solar powered science glider travelling through a planetary atmosphere while gathering atmospheric composition. In this study, the innovative solution of IQRASAT Team from Yildiz Technical University for this year's mission is explained briefly. Hardware and software system of the model satellite and ground station for data reception is discussed respectively. The paper ends with concluding remarks.

II. SYSTEM OVERVIEW

This section briefly describe the design of model satellite designed by IQRASAT Team from Yildiz Technical University. A practical approach is applied for designing of the system. 3D printing for fast prototyping is used. The system was designed in SolidWorks program by reviewing aerodynamic structure of glider shapes. The researches were carried out in order to obtain the solution on how to fit the best design into cylindrical shape container with size of 300mm in height and 115mm in diameter.

According to CanSat2017 rules, CanSat payload, which is supposed to be glider shape, must separate at 400meter from its glider. Right after separation, it must start to harvest energy from sunshine as a result start its mission. The mission is to sample atmospheric pressure, temperature, relative altitude, speed and compass direction. For gaining better score from competition bonus mission which is taking 20 picture of ground during flight was chosen. Mission requires also to transmit gathered sensor data to ground station in real time and saving in SD card. Pictures are supposed to be saved at SD card. It is obvious that separation from container must be executed by container that is why container houses mechanism for ejection of science glider. Fig.1, Fig.2 and Fig.3 shows the physical layouts of science glider, container and overall system respectively.

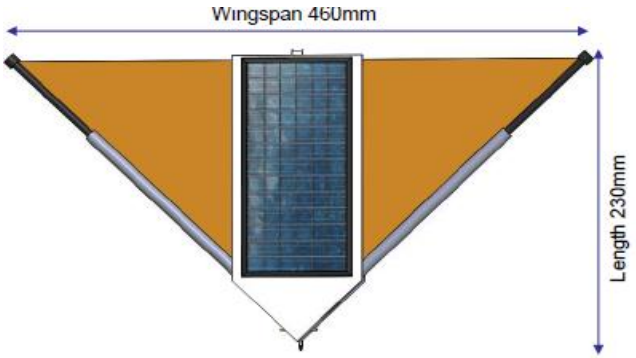

Fig. 1. Physical Layout of Science Glider

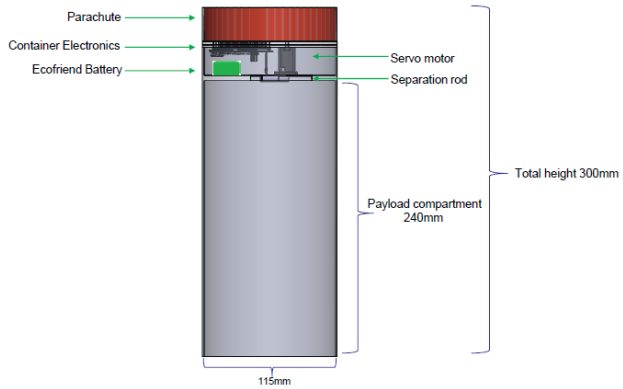

Fig. 2. Physical Layout of Container

After making final decisions on the design, durability analysis was conducted. Crucial points of system was detected. The system is planned to be produced from mostly ABS material. But for some crucial points composite materials will be used. Fig.4 shows the components layouts of science glider.

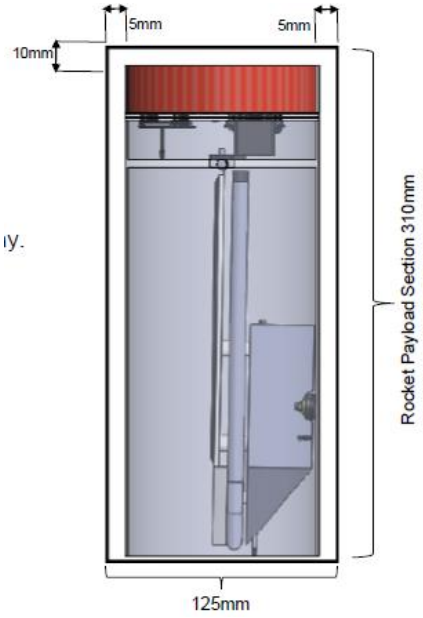

Fig. 3 Physical Layout of Overall System

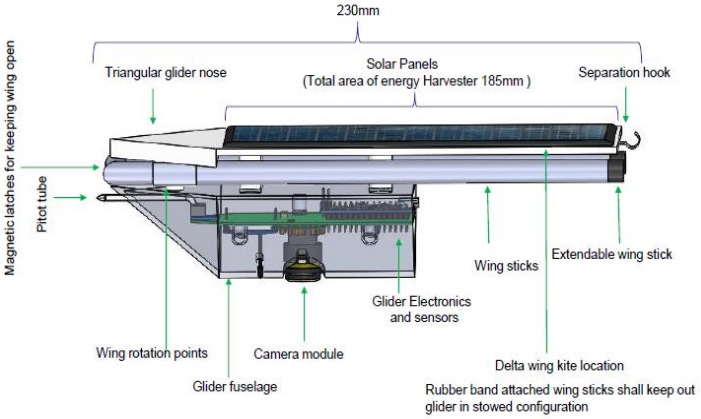

Fig. 4. Component Layouts of Science Glider

III. Flight Hardware System

Flight electronics of the science glider consist of sensor subsystem for data collection, XBee module for telemetry transmission and SD card for telemetry saving. Solar panels are used as source of energy.

The block diagram of the whole system is given in Fig.5. When solar panel is exposed to the sunshine it immediately starts to feed the electronic system. Meanwhile supercapacitors are tolerating the voltage drops in various glider positions. The Arduino microcontroller reads the sensor data and forwards to the ground station using XBee modules.

The list of science glider components are provided in Table I. Each component is depicted in Figs. 6-10.

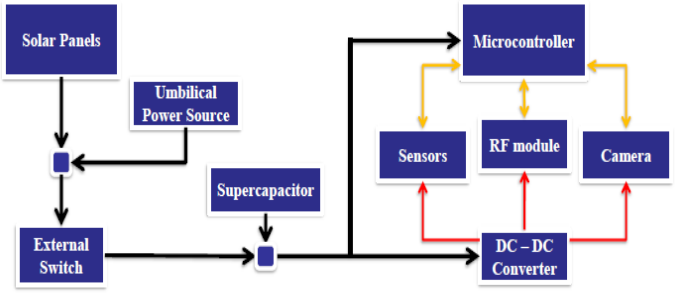

Fig. 5. The Science Glider Electrical Block Diagram

TABLE I. LIST OF SCIENCE GLIDER COMPONENTS

No	Component Name
1	Arduino Pro Mini (3.3V, 8Mhz)
2	BMP280 Ulltimate Bosch Pressure Sensor
3	MPU9250 9DOF Sensor (Magnetometer included)
5	XBee S2C RF communication module
6	SanDisk 8Gb SD card
7	Seed Studio 2W SKU- 313 Solar Panel

Fig. 6. Arduino Pro Mini (3.3V, 8Mhz) – Flight Computer

Fig. 7. XBee S2C - Communication Module

Fig. 8. SD Card – Telemetry Data Retrieval

Fig. 9. Solar Penel – Science Glider Energy Source

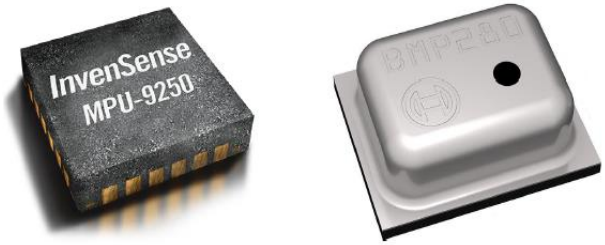

Fig. 10. MPU920 & BMP280 - Sensor Subsystem

IV. FLIGHT SOFTWARE

Flight Software of the Science Glider and Container should carry out below operations. It has been developed in Arduino IDE using C/C++ languages. It is also capable of taking remote commands. Flowcharts of the flight software of Science glider and container are provided in Fig. 11 and Fig.12, respectively.

- Read sensor data at rate of 5Hz.
- Calculate average value of sensor data
- Transmit collected data to ground station
- Write data packets to SD card
- Initiate glider separation (container only)
- Capture image of ground and write to SD card
- Activate buzzer when landed.

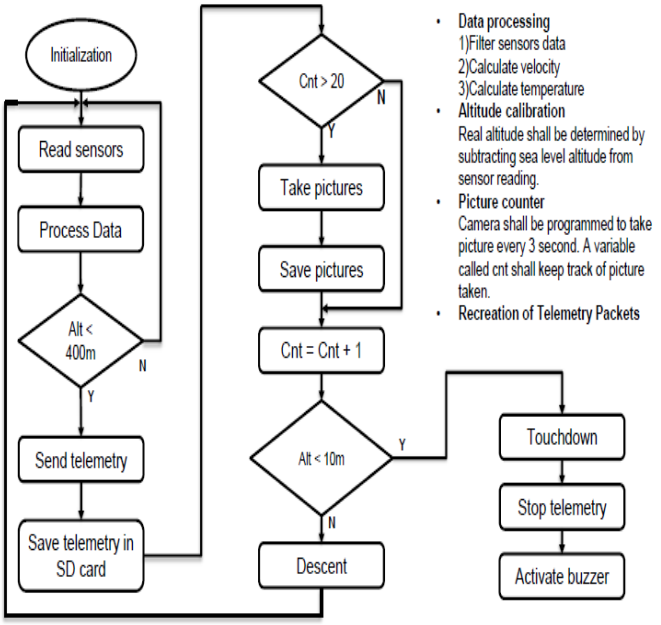

Fig. 11. Flowchart of Science Glider Flight Software

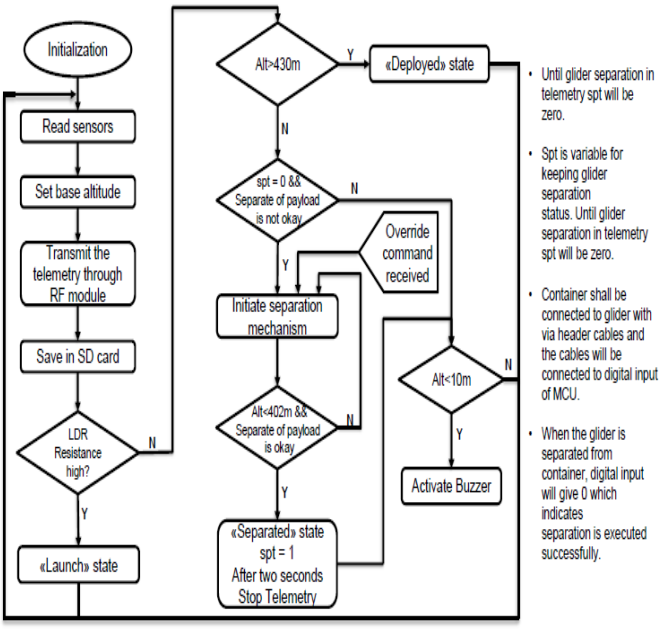

Fig. 12.Flowchart of Container Flight Software

V. GROUND STATION

The ground station of CanSat is receiving the incoming telemetry data and displaying the real time data. There is an application developed in MATLAB. For development of the application many languages like C#, python, java and ruby was reviewed and finally Matlab is chosen in order to ensure the robustness of events that are used in the application. The GUI/Application initiates displaying/plotting and saving operations whenever it receives any incoming data. The ground station also includes an 2.4Ghz Directional panel antenna for a receiving signal an XBEE module for data forwarding to PC. Fig. 13 shows the ground station design of IQRASAT team. The designed application is given in Fig. 14.

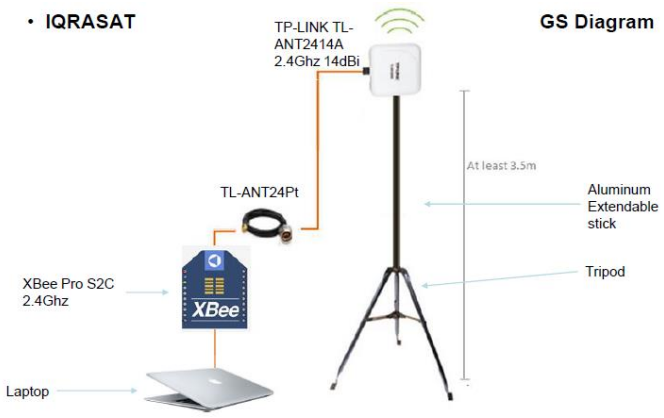

Fig. 13. The Ground Station Design

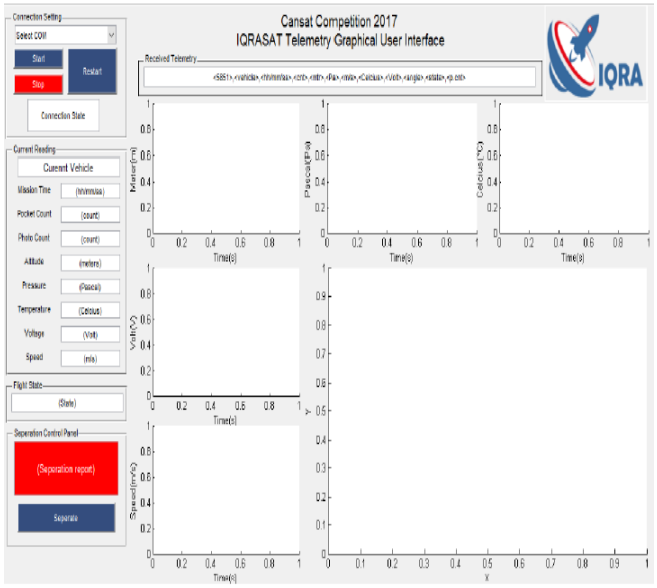

Fig. 14. Ground Station Application

The GUI is performing the required operations given below:

- Display full telemetry
- Plot some parameters
- Save in .CSV file
- Plots two dimensional Glider Trajectory
- Sending remote command to Glider.

VI. Conclusion

To sum up, an innovative solution, model satellite, was designed that meets the CanSat Competition 2017 requirements. Our CanSat several innovative features such as folding wing glider, energy harvesting system and real time environmental data collection and transmission. As world more tend to solar energy recently, the competition includes energy harvesting properties from teams. The design of the science glider is adapted from conventional deltawing gliders. These shapes are the most stable glider and also they have enough area for solar panel. A georgous aerodynamic sturucture of deltawing gliders enables them to slide in air. Team's goal is to produce the final design and perform an integrated system test till the competition.

Acknowledgment

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