



UYARI Team: The first model satellite team in Turkey

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Abstract–For the all missions have a separately design, and for all missions we make a CanSat. After the design finished, we bring them together in one CanSat. Finally its design finished, we start to test our CanSat, and if there is a problem, we have a meeting and argue that what we can do. Fabrication event occurred in İstanbul Technical University’s workshop. We test our CanSat various computer programs like Catia, Autocad, Unigraphics.

I. INTRODUCTION

UYARI Team which was the first CanSat team in Turkey participated to competitions two times. U1 was the first design, and it challenged in Spain on 8-11 April 2010. Its original design was awarded with “MERIT award” by the ESA engineers’ jury. The second design was U2. It challenged in CanSat competition organized by AIAA and AAS in America on 11-13 June 2010. UYARI 2.0 has the landing system which has the two propellers rotating in the opposite direction at the same axis. Third design was U3 which was designed for competition which occurred in France but it could not accomplish to challenge because of the lack of sponsor. The next design is U4 and it will be challenge in America on 12 June 2011. U5 is the last design of UYARI Team. It will challenge with nine French four international teams in France between on the days 21-25 August 2011. U5 has designed as a CanSat which could accomplish the five main missions and one bonus mission. The first mission is atmospheric sounding. U5 acquire sending hygrometry and altitude data to land system at least every five seconds. The second mission is deployment of a RF antenna after landing. Then, RF module sends altitude data, humidity data and photos taken to the land station by using RF antenna which is on CanSat. The third

mission is taking a photo. Camera sends photos to RF module by using SPI serial communication protocol. The fourth mission is airbag landing. U5’s landing be accomplished thanks to these airbags. The fifth mission is that Terraforming. After U5 lands, it drills a small hole in the ground and lay down a crop seed. The bonus mission is come back that aims at autonomously steering the CanSat onto a target on ground defined by GPS coordinates. [1]

II. CONTEXT OF DEVELOPMENT

A. Club

The first studies related to CanSat in Turkey were begun by students of Faculty of Aeronautics and Astronautics at İstanbul Technical University in September of 2009. These students who recognize the imperfection of this subject in Turkey establish UYARI Model Satellite Team for the purpose of immediately starting to work on the subject. In the same year it was established UYARI Team participated to international competitions in America and Spain. Because of the expense of satellites excess finding sponsors became the most important problematic. Therefore the sponsor crew set up. This crew is responsible for finding sponsors. For the purposes of help this crew, also two crews set up. One of them is responsible for advertise the team on media, and the other crew is responsible for researching the fair and diet major companies of aviation sector attend. Also İstanbul Technical University covers some expenses such as round-trip costs. Süleyman SOYER studies astronautical engineering. He is in the second class. He is the captain of UYARI Team and responsible for terraforming mission. Veysel Yağmur SAKA studies

aeronautical engineering and he is in the second class. He is the leader of France crew of UYARI Team. He is responsible for RF deployment and financial crew, and also material order. Çağlar ÜNAL studies aeronautical engineering and he is in the second class. He is responsible for social events crew and airbag landing. He works on this mission with Muhammed SÖZER. Muhammed SÖZER studies electronic communication technologies in vocational school. He is in the second class. Metehan ÇETİN studies electronic engineering and he is in the third class. He is responsible for humidity sensor and ground station. Deniz Gezmiş TAŞ studies electronic engineering and he is also third class. He is responsible for communication with RF, and taking a photo missions. [2]

B. Work plan

In collaboration with experience gained competition which UYARI Team taken part, it is easier that complete all the design, test and fabrication in a one school year. Instantaneously the competition rules determined, UYARI Team meets in council and according to team members request it is specified that who is the responsible for which rules. It is very important that the distribution of tasks must be done erewhile. After it is specified, the members must be determined that what are the materials needed and how long does it take design, tests and fabrication. After members who responsible for missions have an idea to how it will be done all members have a meeting and argue that how the CanSat which is made all the missions and should be the cheapest and most reliable. Team members must be done the missions with not forgetting the team budgets. There are three team's crews for the responsible to team budget. One crew is responsible for finding a sponsor and other crew is responsible for materials ordering and other crew is responsible for the distribution money in the team. All crews are informed each other and when one of them decides make something, it should be make in consultation with other crews.

III. DEFINITION OF THE MISSIONS

A. Scientific Mission

In collaboration with the determined competitions rules, UYARI Team decided to which missions it can do successfully. After our decision, thorough to agency of made meeting now we know that which missions how they are done thanks to our electronic and mechanical equipments determined for these missions. Our solution for missions one by one is written on the below.

a. Atmospheric sounding

We choose SHT75 humidity sensor for hygrometry mission. Humidity sensor sends digital data of humidity one time in 5 seconds to RF module which was chosen as CC1100EMK433 by using a converter that converts analog data to digital data and a serial interface circuit. Also we decided to send altitude data by GPS which is chosen as

LS20031 to RF module. And RF module sent it to ground station.

$$RH_{\text{linear}} = c_1 + c_2 * SO_{RH} + c_3 * SO_{RH}^2 (\% RH)$$

TABLE.1 SO_{RH} : HUMIDITY READOUT

SO_{RH}	c1	c2	c3
12 bit	-2.0468	0.0367	-1.5955E-6
8 bit	-2.0468	0.5872	-4.0845E-4

(1)

b. RF deployment

RF antenna which is compressed by spring after a signal which is came from PIC the servo motor which on keeps tabs turn and RF antenna and its module release. After its disentanglement, RF module sends altitude data, humidity data and photos to the land station by using RF antenna.

c. Photo

Chosen sensor for that mission is CMOS Camera Module. Thanks to it, it sent photos taken in the air to RF module.

d. Airbag landing;

Compressed air into the tube goes to airbags. While it happens, Solenoid valve, where is between tube and airbags, opens with electrical current. Tubes made of polyurethane are used for air passage. To sum up air goes to airbags quickly. We decided to use two or four airbags for Cansat. As a result of tests, we achieved flow of air using solenoid valve. Solenoid valve is an electromechanical valve that is used to control the flow of gases. 12V or 6V DC voltage is given to Solenoid valve from battery. We preferred solenoid valve, because it has quick taking command, high reliability materials adaption, using low energy and compact design. [3]

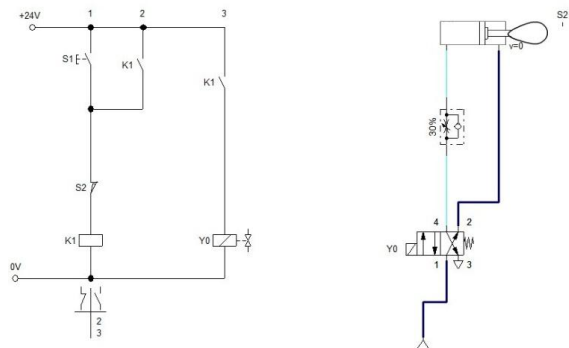


Fig. 2 One of simulation examples [4]

e. Terraforming

In this system, one Dc motor, one servo motor, one gear system and hand-made mechanism used. This solution for this mission is that thanks to backhoe stick's left-right movement checked up with DC motor soil excavation and leaving the seed and irrigation of the soil.

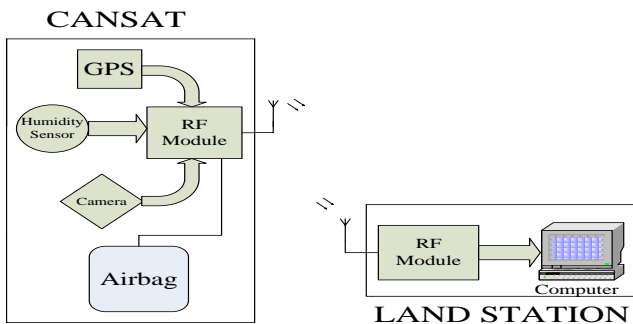
B. Free Mission

The free mission for UYARI Team is that come back. DC motor's differential driving which placed in below the satellite CanSat can be moved to requested area. We choose that solution because thanks to it, CanSat can be moved right and left. If the CanSat have to move back, apply a voltage to motor and satellite can be moved back.

IV. CANSAT ARCHITECTURE

A. Electrical architecture

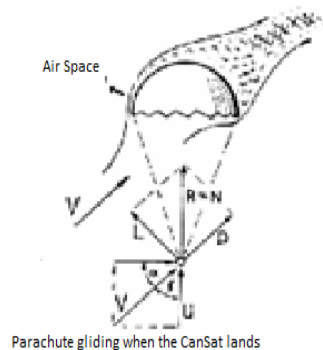
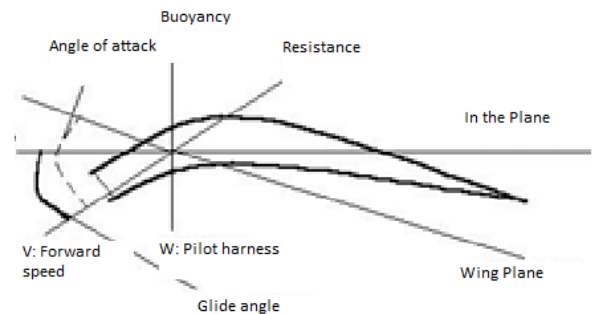
Electrical architecture consists of two sections in this project. First part is an electrical architecture which is on CANSAT. Second part is a land station. First part includes five parts: GPS, humidity sensor, camera, RF module and RF antenna. GPS sends altitude data to RF module by using UART serial communication protocol. Humidity sensor sends digital data of humidity to RF module by using a serial interface circuit and a converter that converts analog data to digital data. This converter works by using Equation 1. A CMOS camera sends photos to RF module by using SPI serial communication protocol. Then, RF module sends altitude data, humidity data and photos to the land station by using RF antenna which is on CANSAT. RF Module also sends a signal to airbag when altitude data shows four meters distance between CANSAT and ground. RF antenna which is on the land station receives data and photos and then sends them to RF module. At last, RF module sends them to the computer. All electrical parts of CANSAT and land station, GPS, humidity sensor, CMOS camera and RF module, are commercial products. More information about RF module is given in "Telemetry" chapter.



[5]

B. Mechanical parts

Aiming to develop an autonomous landing system for comeback mission, we thought it'd be a more appropriate structure to produce parafoil parachute and our production is done in this way. Parafoil parachutes, more effective performance than other types of wing and its going forward rates are higher than the others. These two features are the most important factors to be preferred. Our parachute, a parafoil parachutes with the help of one-to-modeled. Its sized is $40 * 105 * 10$ cm. It was designed as a seven-cell and mouth of cell width of approximately 16 cm. its sink rate is approximately 3.6 m mined as approximately $\frac{1}{4}$. These rates are without the effect of wind and thermal values. To be parachute in small size it will be much more sensitive to the wind. We avoid it for a piece of the wing's performance strengthened in various calculations. For example, to reduce the vortex impact on wingtips and to make it a more stable structure the Aspect ratio of it was kept high. This ratio was 2.6. As the type of fabric, low permeability, with more than conservatism, polyamide-polyester blend fabric is used. For autonomous landing, we were added one guidance servo on our landing system. With this servo, by routing the form of parachute left and right turns, provide orientation to the target. This servo always tries to turn toward the target from the direction of parachute. The last four seconds before approaching the ground, parachute, separated from the satellite with the help of separation servo. The aim of this departing to prevent affects of parachute for other systems after the landing.



Parachute gliding when the CanSat lands

[6]

C. Telemetry

The data of sensors will be sent through a RF module. We use CC1110; a commercial product of Texas Instruments. The CC1110 is a low-cost true System-on-Chip (SoC) device designed for low-power and low voltage wireless communication applications. The CC1110 combines the excellent performance of the state-of-the-art CC1100 RF transceiver with an industry-standard enhanced 8051 MCU, 32 KB of in-system programmable flash memory, 4 KB of RAM and many other powerful features. CC1110 ensures the frequency band-width and output power which is written in the competition rules. But the most important the reason we choose CC1110 is the simplicity of the software provided by Texas Instruments for CC1110. It is easy to send data and easy to receive data. [7]

$$Pr = Pt + Gt + Gr + 20 \log \frac{\vartheta}{4\pi} - 20 \log d$$

$$d = \frac{\vartheta}{4\pi} \sqrt{\frac{Pt \times Gt \times Gr}{Pr}}$$

(2)

Pt: transmitted power

Pr: received power

Gt: transmitter

Gr: receiver antenna gain

d: the distance between transmitter and receiver, or the range

Tetha: wavelength

V. CONCLUSION

To sum up, it can be said easily that UYARI Team quietly assertive and close to first degree in competition which will occur in France on 21-25 August 2011 due to relying on that things; experiences gained from old competitions, awards won both in Turkey and also Spain, professional work environment and members who are well-informed, ambitious and altruistic.

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