Main assignment in "Intro to Space Engineering" course - part A

Department of Computer Science & Mathematics

Submitted by:
Or Mendel: 315524389
Eran Levy: 311382360
Omer Michael: 316334671

Lecturer: Boaz Ben Moshe

Project intro and problem definition:

Our project involves the design and assembly of a pico satellite, a small spacecraft with a mass between 0.1 and 1 kg.

The satellite will be equipped with a variety of sensors and communication systems, and its main mission still unknown.

To achieve this goal, we will use a combination of off-the-shelf components and custom-designed parts, and we will test the satellite in various environments to ensure its reliability and performance.

We believe that our project has the potential to contribute to the growing field of space exploration and to provide valuable insights into our planet's complex systems.

Developing a pico satellite can be a challenging process, with a number of potential problems that can arise.

One major issue is the selection and integration of components, as space-grade parts can be expensive and difficult to source.

Additionally, designing an energy system that can provide reliable power to the satellite can be a complex task, especially given the limited space available for batteries or solar panels.

Furthermore, the development and production of panels to protect the satellite from radiation and other hazards can require specialized knowledge and equipment.

Overall, the success of our project will depend on our ability to overcome these challenges and to work collaboratively as a team.

Literature survey in the field:

[1] This paper compares conventional satellites with a constellation of Pico-satellites, and discusses the advantages of the Pico-satellite constellation for coverage and data collection compared to a single large satellite at a high altitude. The paper demonstrates how several Pico-satellite constellations can replace traditional, large satellites.

Satellites help us understand more about the Earth and thus actually prevent disasters.
Big satellites take money and a lot of time. To solve this problem, smaller satellites called Pico-satellites were created.
They are cheaper but have limitations with power and communication. To compensate for this, a group of Pico satellites can work together to cover more area and get better pictures.

A constellation of pico-satellites provides better and more reliable coverage of the Earth than a single conventional satellite.
A single conventional satellite has many limitations in data collection and surface coverage, while a network of Pico-Satellites has a higher probability of collecting data in a shorter time and provides continuous coverage.
But, the use of several pico-satellites in different orbits poses a risk of collision and contributes to space debris.

[2] An academic paper dealing with various Pico satellite projects under development, including UWE-3 at the University of Würzburg, which aims to develop an active access control system (ACS).

The HiNCube project at Narvik University College is building a modular Pico satellite for Earth imaging and future missions. Development of the first Tunisian Pico scientific satellite.
The paper actually presents for us the mission analysis, architecture and development of subsystems such as communication, power and image capture for ERPSat-1.

Some background on the satellite: ERPSat-1 is a CubeSat satellite measuring 10 cm and weighing 1.33 kg. It will operate for two years in low Earth orbit and there will be a camera on board that will photograph the Earth and the sky.
The satellite has many purposes in both the scientific and educational fields.

The Attitude Determination and Control Subsystem (ADCS) is designed to stabilize ERPSat-1 against environmental effects in Earth orbit and furthermore to actually direct it towards a predetermined point on Earth.

The frame of ERPSat-1 is the only part that will have contact with the POD. The frame is actually made of aluminum, with an estimated mass of about 125 grams.
The cube satellite actually has 5 lobes containing solar cell panels, various sensors and magneto torques for attitude control, while the sixth face contains a solar cell panel, patch antenna and camera. A deployable two-way antenna will be mounted on the sixth face for UHF communications with the ground station.

Description of the project's development plan:

Chassis

When we talk about developing a satellite we refer to 2 parts of it:

1. Bottom part - standard electronics that we will not bother with.

   A board with 2 batteries that takes up almost half the volume of the satellite and handles charging and batteries. They have standard sizes, batteries and screws. This board looks like a "babysitter" because it "saves the battery". So in fact, there is very little room left to "work" in.

However, for this project it will be relevant to deal only with the other half of the satellite that will be described next.

2. Upper part

   This part contains a board in which the different components are organized in the way we choose, following space limits. We have to organize while coping with this problem, and here are 2 possible solutions:

   1. Gluing on both sides of the board.
   2. Put several plates on top of each other that are connected to each other with wires in between (by "connectors" - he showed but they are visible).

Ingredients list

A list of components (20 components) will be built when there is a pre-prepared activity plan for each component, in a manner suitable for the 1P satellite model. These components will be ordered according to availability, production capacity and on the basis of desired dimensions of the satellite panels. The list will include standard basic structural components such as: screws, camera, aluminum parts and PCB boards. In addition, necessary additional components such as: communication components, solar panels, water piping, electrical system components and wiring will be ordered or produced independently.

Click here to view the excel file (components list).

Antenna

<u>The importance of the antenna:</u>

Satellites communicate with antennas. Therefore, to add this communication component, an antenna connection must be made in a certain way. The length of the antenna is usually measured by meter, because it is easily available and convenient to use. However, it is also possible to measure the antenna by a wire.

<u>The production process of the antenna:</u>

- In order to adjust the antenna, it is necessary to test different antenna models that are suitable for 1P type satellites. In most cases, it will not be possible to order models in this way, due to a low amount of orders, but it is possible to produce them independently.
- The length of an antenna is measured at a length of approximately 17 cm on each side. The location of the antenna is done over a structure of 5cmX5cmX5cm (meaning, the antenna should make a number of laps around this structure). The most recommended preference for designing the antenna is to find a built-in construction plan for a satellite which already solved the problem of placing the antenna on it.