Exploring Modular Architecture for Nano Satellite and Opportunity for Developing Countries

Bangladesh
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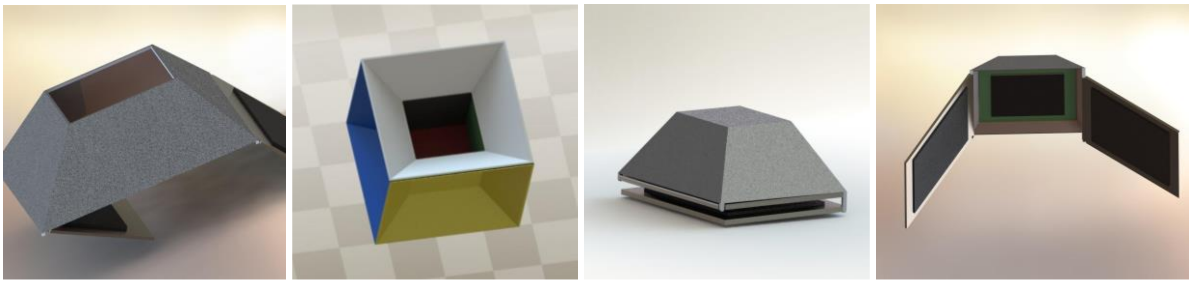
The extended SPACE Technology has the potential to provide information, infrastructure and inspiration that meets national needs in developing countries like Bangladesh. Many countries recognize this; in response they are investing in new national satellite programs to harness satellite services. Technology related to space is one example of a tool that can contribute to development both by addressing societal challenges and by advancing a nation's technological capability. To cope up with the advanced world in space technology Bangladesh seems to be highly potential country for satellite, Robotics, embedded systems and renewable energy research. BRAC University, Bangladesh is planning to launch a nano satellite with the collaboration of KIT, Japan. The proposed nano satellite project mission is to experiment about social, commercial and agricultural survey needs in Bangladesh. Each of the proposed applications of the project will improve the lives of millions of people of Bangladesh and it will be a pathfinder mission for the people of this country. Another intention of this project is to create a cheap satellite based remote sensing for developing countries as the idea of large space systems is very costly for us therefore we have decided to make a Nano-satellite.

The primary mission objective is to monitor formation and depression of Bay of Bengal leading to major hurricane, typhoon and other storm. The reason for monitoring monsoon wind & rainfall characteristics is to because excessive rainfall causes flood which is one of the major natural disaster of our country. Meteorologists are reporting that rainfall in Bangladesh in changing drastically (early on set and late on withdrawal in monsoon rain). Moreover, weather forecast use various observations from which to analyses the current state of the atmosphere. As Bangladesh is an agricultural country and most of the people here depend on agriculture for their livelihood therefore agriculture is one of the most important application fields of satellite. By using earth observation data we can do crop inventory, yield prediction, soil/crop condition monitoring and subsidy control. Another advantageous of this nano satellite is to monitor the forestry which helps to balance the eco-system as in recent years killing animals and cutting down trees illegally increasing immensely. By analyzing earth observation data can protect natural resources and ensure the safety of the animals in forest.

The main target of Bangladesh is to send own satellite in space. It was figured out that the vision of building small satellites is very possible in five years if we can give emphasis on human resource capacity building & develop an infrastructure. The very first step has been taken by The Robotics lab of BRAC University, Bangladesh to start this project by signing research collaboration with LaSEINE laboratory of Kyushu Institute of Technology, Japan who are pioneer on nano-satellite research in Japan. The project will be led by a team of faculty members from BRAC University supervising a group of undergraduate and postgraduate students. For project management a full time research assistant will be appointed. This kind of extensive research is very expensive and need high end technology & researcher. Since it also involve the national security and interest, it is very difficult to continue without direct support of Government. So, we are expecting financial help from the government of our country. We plan to deploy our nanoSat from ISS through nanoSat launching Robotic arm. With the collaboration of KIT and JAXA, our plan is to send our nanoSat in a cargo ship such as HTV-IV.

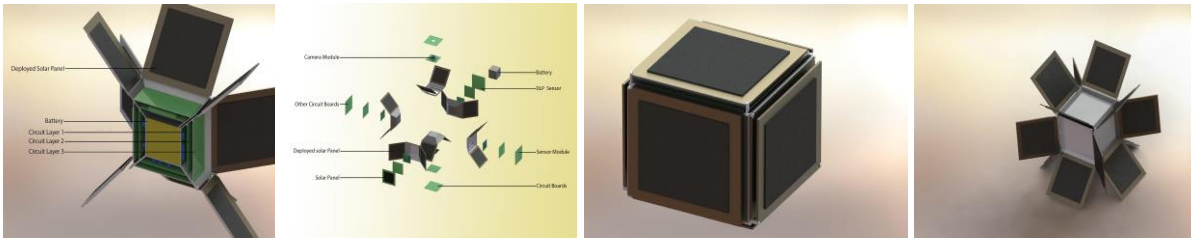
The proposed structure is composed of six individual pyramid shapes whose vertex has been clipped. Each Pyramid is 10 cm x 10 cm at the base with the height of 5 cm. Each pyramid structure has been clipped at 2.5 cm height (Figure 1(a)).



(a) (b) (c) (d)

Figure 1. (a) A single pyramid Unit (b) Six pyramids assembled to form a cube (c) A single unit with its solar panels folded (d) A single unit with its solar panels deployed.

Assembling six pyramids therefore leave a cavity of 5 cm x 5 cm x 5 cm in the center. This space is mainly intended for battery (Figure 1(b)).In contrast to usual cube sat structure; this structure allows us to setup observatory equipments to all six sides. Additionally, as the structure is made of six individual units, we can design and test each mission as a unit. This will further shorten the length of cubesat development period. Our aim is to adopt lego style architecture for cubesat. Of course, this will not allow us to build structure like 2u (10 cm x 10 cm x 20 cm), 3u (10 cm x 10 cm x 30 cm) cubesat format. By increasing the base size of the individual pyramids, the size of the cubesat can be increased. Each unit has 2 solar panels. The solar panels match the size of the base of the pyramid structure. Two solar panels are deployable and they fold on top of the other as seen in the Figure 1(c). The units are assembled alternatively, so when the solar panels are deployed they take the form as indicated in this Figure 1(d).



(a) (b) (c) (d)

Figure 2. (a) Cross sectional view of assembled nanoSat with solar panels deployed **(b)** Exploded view of nanoSat **(c)** Trimetric view of proposed model (solar panels undeployed) **(d)** Trimetric view of proposed model (solar panels deployed).

In our design we could stack three circuit boards on top of another (Figure 2(a)). The board sizes are 6.66 cm x 6.66 cm, 8.33 cm x 8.33 cm. Gap between top board and the middle board is 0.835 cm. The gap between lower board and the middle board is 0.88 cm. These boards can either house sensors or control circuits. Top circuit board can be a solar panel, sensor or a camera as per mission needs. Overall, the structure is entirely modular like lego piece (Figure 2(b)). Cubesat can be assembled and later modified as per mission requirement. Trimetric view of proposed model (solar panels undeployed) and trimetric view of proposed model (solar panels deployed) are shown in Figure 2(c) and 2(d) respectively. Three axis Reaction wheels are very essential for our design as there is a requirement for constant repositioning of nano satellite in order to get the maximum benefit from six open faces. Operating a single axis reaction wheel can take up to 28 watts of power, whereas a typical 1u solar panel can provide two watts of power. Continuous operation of reaction wheel will drain the battery quickly. In addition, it will put increased load on battery, decreasing its longevity. Hence we need to increase the number of solar panels so that it could harness enough power for the equipments to operate properly.

The equipment needed for this satellite is not available in Bangladesh and we have to design this satellite by purchasing equipment's from abroad or we have to design satellite compatible sensors, solar panel, power cells, control systems and mechanical structure and make it from expert countries. We have no highly equipped lab for testing all the equipment's of satellite. We have to test all the equipment, sensors, mechanical structure, solar, panel and lastly the whole satellite. As this is the first time we are starting our research to build our own satellite, so obviously we need a lot of help. LaSEINE lab of KIT, Japan is highly equipped with entire testing facilities for the satellite related equipment's including the whole small size nano-satellite. Hopefully with the help of KIT, testing problem will be solved.