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Design of a New Multi-Variant Solar Panel Deployment System (MVSPDS)

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Abstract— **Multi-Variant Solar Panel Deployment System (MVSPDS) is defined as the satellite deployment System which can change its orientation according to the power supply required for the satellite or power supply source available to the satellite. To deploy the solar panels completely, it is necessary to design the deployment mechanism which has high precision and reliability. So this Method of deployment will not only provide the said benefit but also it will allow a wide range of application. Consequently, the analysis on the dynamic characteristic of the deployment mechanism must be done at an initial design stage. The design effectiveness and structural safety of the proposed solar panel module were validated by launch vibration and in-orbit environment tests at the qualification level.**

In this paper, the complete design of a new Multi-Variant Solar Panel Deployment System in a Satellite is proposed, where I have inculcated various deployment methods and proposed a new method of satellite deployment. The complete design is done in the Autodesk 360 software (Educational license) where the design and animation method are extensively used to make this possible. It will be clearly depicted from the design that the structure is very compact during the process of orbit insertion. Yet when it come into working it definitely works according to the power need of the satellite. For an example when the satellite needs less amount of power it will transform itself in such a way that the amount of power generation will be less on the other hand when the satellite needs more power than the Solar Panel will change itself in such a way that it will have the maximum surface area as a result of which the power generation will be maximum. Moreover, the variety which provides is really unique as it also has the power to change its solar panel into different structure for an example it can change itself into a circle like structure it can change itself in the canister to form another structure and moreover it will work completely according to the need if programmed properly for space flight mission. And hence can give rise to a wide variety of different deployment methods.

Keywords—Satellite, solar panel orientation, Solar panel deployment, multi-Variant Solar Panel

I. INTRODUCTION

Multi-Variant Solar Panel Deployment System (MVSPDS) is defined as the satellite deployment System which can change its orientation according to the power supply required for the satellite or power supply source available to the satellite. The sole purpose of this project is based on designing a of a new Multi-Variant Solar Panel Deployment System. Solar technology can be a political football on the ground— tossed around and tackled often—in space, it encounters little opposition. For space limited operations many components were successfully miniaturized. The stabilization types changed from simple spin stabilization and passive stabilization using permanent magnets to fully three-axis stabilized spacecraft. Some recent missions also validated propulsion systems for satellites. Despite this significant progress, two problems remain unsolved due to the small surface area of satellite. The commonly used body fixed panels produce insufficient energy and similarly provide too little surface area for adequate energy dissipation. This project will address the basic arrangement along with various variation in the arrangement of solar array. One of the possible solutions is the use of deployable structures to increase the available surface area in many possible ways and with different transformation mode. This paper deals exclusively with a new multi-Variant structural design of a single satellite although dual system is possible. There are many aspects of the design, construction, and operation of such a space solar power system that are outside the scope of this project (e.g., the design of lightweight photovoltaic cells, large-scale phased arrays across independent spacecraft, integrated circuits for microwave signal synthesis, and formation flying).

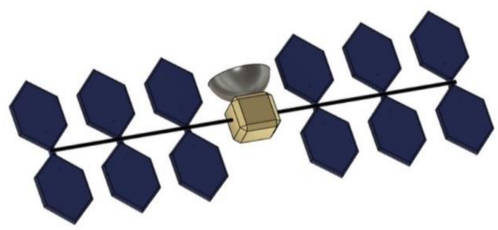

Image of Basic Deployable Structure

However, the concern herein is purely structural design and its deployment, and, as such, only relevant metrics will be considered which include the operation of the solar array. This paper will present a preliminary structural design of a spacecraft that has less area with small packaged volume, and is sufficiently stiff.

The developed design is based on a generic satellite mission and an orbit with an altitude of 400 kilometers. The satellite is assumed to be three-axis stabilized. The panels are usually in stowed position to avoid damage during the launch phase and are deployed later on when the satellite reaches its desired orbit.

In general, mechanisms on board of satellites are limited to small dimensions and are required to be extremely light weight by the Satellite launch system. Working in an environment with no possibility of later corrections or modifications requires a high functional reliability and repeatability. The two major impacts on the satellite are the compatibility of the thermal heat

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expansion ratios and the large occurring temperature changes. These result in thermally induced stresses which might cause cracks in components or delamination of glued components like solar cells.

II. LITERATURE REVIEW

This section covers the literature review of solar arrays used and the method of deployment for space applications. The first section gives a brief overview of the principal solution options. Afterward currently used techniques are evaluated to determine the most valuable direction of development.

For a systematic review of existing solar array systems, the complete system of a deployable solar array was split into several subsystems:

- Actuation mechanism for deployment
- Guiding mechanism for deployment
- Damping mechanism for deployment
- Initial release mechanism
- Actuation mechanism for articulating
- Control mechanism for articulating
- Solar cell technologies
- Solar panel materials

Solution options were generated by analysis of current solar panel systems and research in scientific journals, patent databases and books. The options originate from satellites ranging from small satellites to very large satellites, like the ISS or the Hubble Space Telescope. But is concept of design is completely new.

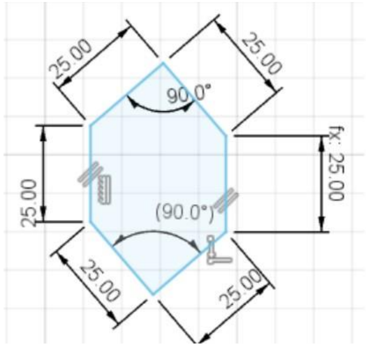
III. SOLAR CELL

Although many types of solar cell are to be used but it is recommended to use a triple junction solar cells because it has high efficiency and good radiation resistance. While the earlier discussed solar cells use just one n-p junction, triple junction solar cells combine three material pairs to cover a larger part of the spectrum of the electromagnetic radiation. A possible combination is the three junctions are Gallium-Indium-Phosphorus, Gallium-Indium- Arsenide and Germanium. Current solar cells provide a conversation efficiency of 28.3 percent and experience a degradation of 15 percent by 1 MeV in 33 years.

Triple-Junction solar cells offer the highest conversation rate and a good radiation resistance. This enables this project of reaching the optimum power output from the solar cells. Therefore triple- Junction solar cells will be used within this paper. Each panel contains 6 solar cells of 12V. Hexagonal shape is given to fit the six panel all together apt for design.

IV. DESIGN OF SINGLE PANEL

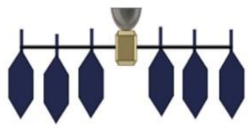
Initial side of the panel is kept constant so as to keep the solar cell in a less complicated manner. Although the hexagonal panel is done but different shape is also possible.



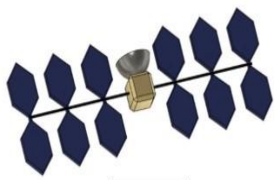
Detail Design *Front View*

V. DESIGN OF DIFFERENT VARIANTS

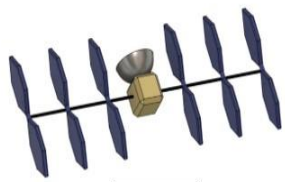
Different variant accounts for different range of power supply to the satellite. Possible variant of the MVSPDS is given below.



Variant-1

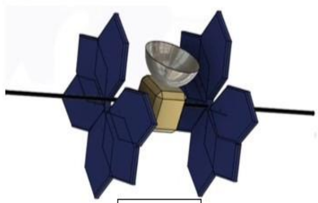


Variant-2

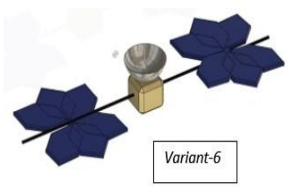


Variant-3

Variant-4



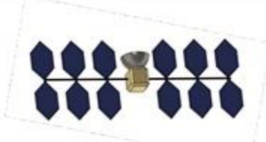
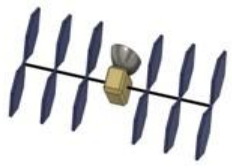
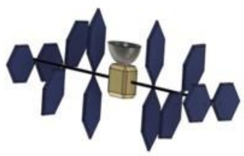
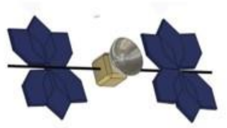
Variant-5



Variant-6

VI. STAGES OF DEPLOYMENT

Different stages of deployment are given below in a tabular form.

Stage	Explanation	Image
Stage-1	• Solar panel is inserted in the orbit. • Solar panel deployment starts. • Set of panel moves in the longitudinal direction of canister as shown in the figure.	 *Image before Deployment*
Stage-2	• Solar panels get deployed by 180 degree • After deployment the surface looks like as shown in the image.	 *Image of deployed by 180 degree*
Stage-3	• Panel rotates through its lateral axis by a 90- degree angle. • They are arranged in the way they are shown.	 *Image of* Panel rotates through its lateral axis by a 90^0
Stage-4	• Solar panels are moved 45^0 and the one near the satellite is kept fixed. • Solar panels are arranged like in the given figure.	 *Image Solar panels are moved 45^0*
Stage-5	• Panels are joined like the way they are show. • After bringing it back to the stationary panel the orientation of the array is moved by 90^0	 *Joined panel*
Stage-6	• Solar panel is finally place in the plane made by lateral and longitudinal axis of the satellite. • Still accessible in all directions.	 *Image of satellite placed at the plane made by lateral and longitudinal axis.*

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CONCLUSION

From the above design it can be concluded that the design is a unique design which is not only having multi variant structure but also having wide range and dynamic performances.

It is clearly depicted from the design that the structure is very compact it during the process of orbit insertion. Yet when it come into working it definitely works according to the need of the satellite. For an example when the satellite needs less amount of light it will transform itself in such a way that the amount of power generation will be less on the other hand when the satellite needs more power than the Solar Panel will change itself in such a way that it will have the maximum surface area as a result of which the power generation will be maximum. Moreover, the variety which provides is really e unique as it also has the power to change its solar panel into different structure for an example it can change itself into a circular structure it can change itself into a canister form and moreover it will work completely according to the need if programmed properly. And hence can give rise to a wide variety of different deployment methods for solar panels in space.

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