Optimization of Solar Array Positioning Actuators for Small Satellites

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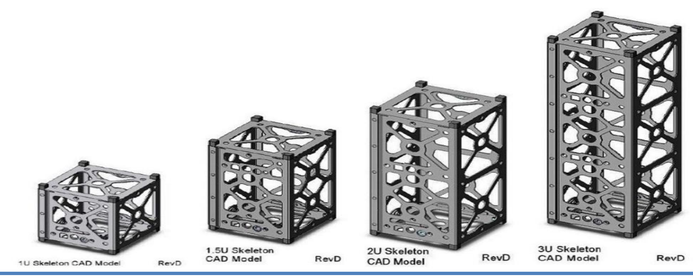
Objective: The goal of this research is to simulate a 3U CubeSat Satellite in both geo-synchronous orbit and sun-synchronous orbit and determine the energy capturing capability from various solar panel configurations and positioning in both orbits. In addition, create design models of these various mechanisms configurations by using Sarrus linkage mechanism that elevates the solar cell away from the body of satellite to make sure that these configurations are suitable for the size and weight of the CubeSat.

Introduction:

CubeSats are small satellites that are built to standard dimensions (Units or “U”) of 10 cm x 10 cm x 10 cm. They can be 1U, 2U, 3U, or 6U in size, and weigh less than 1.33 kg (3 lbs) per U. CubeSats rely solely on a solar array to generate energy from the sun. The size and weight limitations place constraints on solar panels' size and thus the available power budget and stored energy reserves, which decreases the CubeSat functions. The CubeSats capabilitie could be greatly enhanced by increasing the availability on-board power.



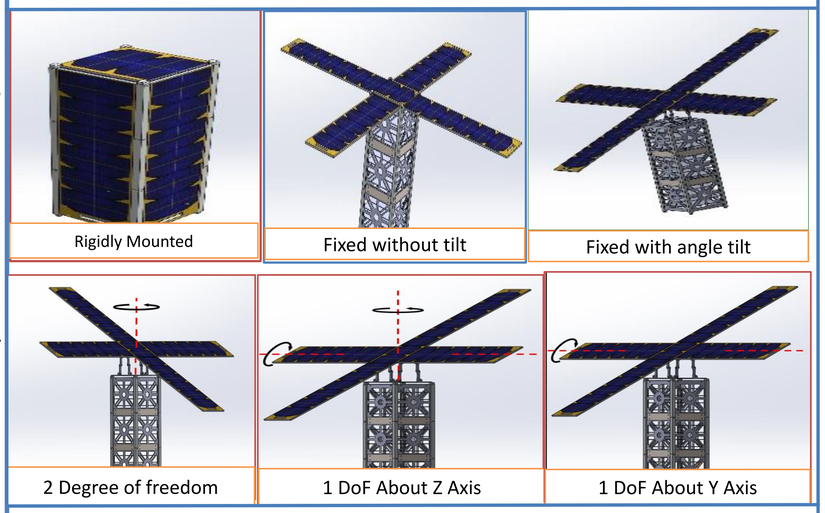
Geo-Synchronous Orbit:

The orbital period of the Geosynchronous orbit is equal to the rotational period of the earth, that period is 23 hours, 56 minutes and 4 seconds, and it stays in place over a single longitude but can move above or below the equator.

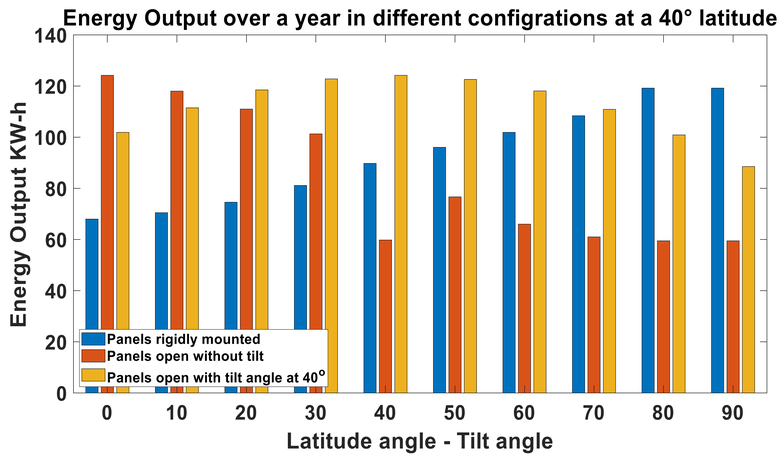
Sun-Synchronous Orbit:

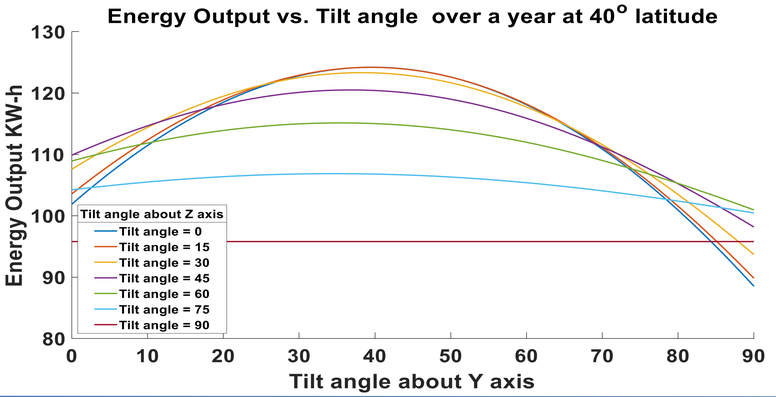
Sun-Synchronous Orbit is an earth orbit which can always be in the same ‘fixed’ position relative to the Sun. This means that the satellite always visits the same spot on the earth at the same local time. There are two special cases of the Sun-synchronous orbit which are the noon/midnight (N/M)orbit, where the local mean solar time of passage for equatorial latitudes is around noon or midnight (12hrs sunlight), and the dawn/dusk (D/D) orbit where the local mean solar time of passage for equatorial latitudes is around sunrise or sunset(24 hrs sunlight).

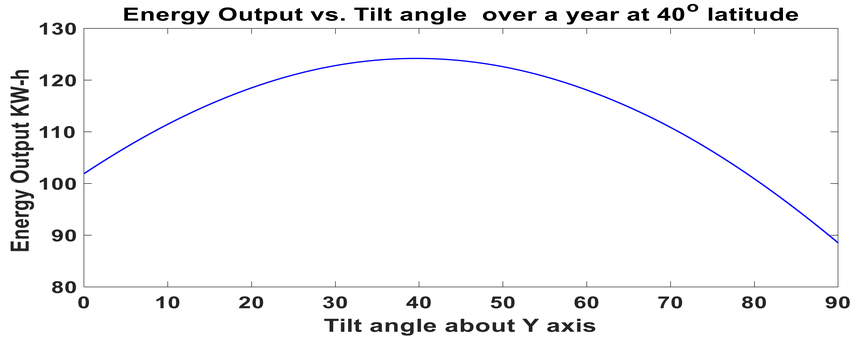
Solar panel configurations



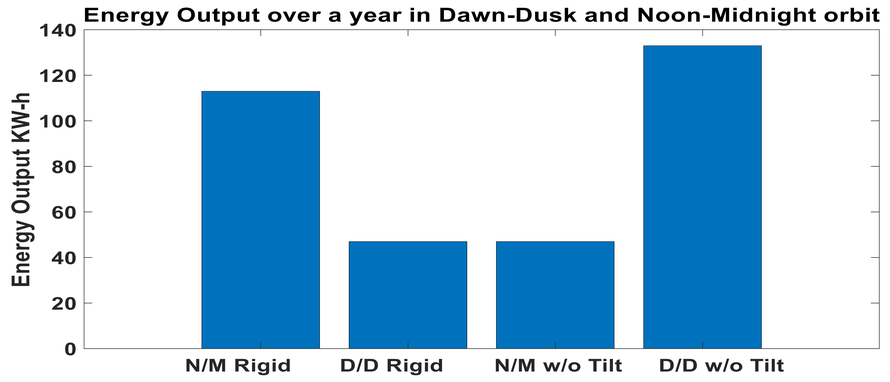
Energy output Geo-Synchronous Orbit:





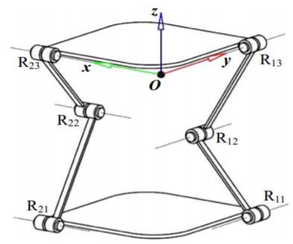


Energy output Syn-Synchronous Orbit:



Design Concepts

Since the size and the weight are limited in the CubeSat, Sarrus linkage mechanism is suitable for folding and unfolding the solar cell panels like the umbrella.



Sarrus linkage mechanism

Sarrus linkage mechanism

The Sarrus linkage is a mechanical linkage that converts rotational motion to linear motion without reference guideways using only hinge joints.