Beamsteering Reflectarray Antenna for CubeSat Application

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CubeSats are picosatellites which typically reside in the Low Earth Orbit (LEO). A cube of dimensions 10 cm x 10 cm x 10 cm constitutes one unit (1U) of a CubeSat. Additionally, the weight of a CubeSat should be approximately 1kg/unit cell. Their cost-effective design coupled with reduced development time and their ability to be launched as secondary payloads have made CubeSats a feasible alternative to their larger satellite counterparts, especially for university students [J. Puig-Suari, C. Turner, W. Ahlgren, 2001 IEEE Aerospace Conference Proceedings, vol 1, pp. 347-353].

Depending on orbital parameters, satellites placed in the Low Earth Orbit may obtain around 5-10 minutes of time-in-view to exchange information with the ground station in each pass. Typical CubeSats which use an omni-directional transmitter antenna and a high gain tracking receiver antenna at the ground station may achieve data rates of about 2400 bits per second. Assuming 9.4 minutes of time-in-view, the net data transferred would be 1.3 Mbits [O. Popescu, IEEE Access, vol. 5, pp. 12618-12625, 2017]. Due to this limited time-in-view and the need to transmit a large amount of data from the CubeSat to ground station, it becomes imperative to maintain high data rates. A potential solution to combat this low data rate is to use higher gain antennas with beamsteering capabilities for transmission from the CubeSat to the ground station.

A brief motivation for the use of beamsteering high gain reflectarray is provided, which includes a quantitative study showcasing the advantages of this antenna over an omni-directional antenna with respect to data rate for the CubeSat to ground station link. A novel beamsteering reflectarray antenna design is proposed for a 6U CubeSat configuration. Various physical properties such as angle of arrival of the incident wave from the feed, number and size of patches used for the reflector, and the spacing between individual patch elements are studied for their effect on antenna parameters. These parameters include frequency bandwidth, polarization, gain, beam steer angle and radiation pattern. Furthermore, the link budget is analyzed, which includes various atmospheric losses associated with satellite communication.