Deployable Microwave Antenna for CubeSats, NanoSats, and SmallSats

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The miniaturization of microwave sensors and the rapid growth of the CubeSat market have introduced competition in several fields of research that were once reserved for much larger and more expensive satellite missions. The reduction in payload associated with CubeSats necessitates efficient volume usage and deployable structures have become more critical than ever. The AstroMesh™ reflector is an excellent example of a highly deployable structure, able to maintain the required curvature much better than other deployable reflector designs. However, this reflector is intended for much larger platforms, with a minimum aperture of three meters advertised for purchase. To meet the demands of CubeSat missions, this design must be drastically reduced in size, while still providing the required degree of surface accuracy, especially at higher operational frequencies.

A miniaturized, offset, paraboloidal, deployable reflector is presented, for use at frequencies between 8 and 100 GHz. This significantly extends the current maximum operational frequency of woven mesh reflectors (~40 GHz), and therefore requires a corresponding increase in the surface accuracy of the employed mesh. This mesh surface accuracy is maintained by a lightweight support structure composed of a perimeter ring truss and two opposing support nets connected to the perimeter and to each other through tension ties. The design of this support structure is an involved process, with several steps including paraboloid determination, triangulation of the support net grid, projection of the triangulated grid onto the paraboloidal surface, optimization of the triangulated surface for uniform tension, adjustment of the perimeter nodes to reduce reflector weight, and finally a check of the static determinacy of the calculated structure. To achieve this goal, and to allow for rapid iteration of design parameters, a series of automated scripts were developed that take user inputs of desired aperture, focal length, offset, maximum frequency, and gain loss of the reflector, and output the associated reflector geometry and several possible configurations of the support structure. This process was used to design a reflector with a deployed aperture of 550mm, a stowed diameter of 55mm, and a stowed length of 110mm, corresponding to a volume ratio of deployed to stowed of 25:1. This reflector is designed to stow in 1.5U, like other CubeSat deployable antennas, though the addition of the offset design and increase in the reflector frequency improves on the operational capabilities of existing designs.

In addition, this approach could be easily extended to produce larger deployable antennas for satellites in the 10 – 100 kg range.