IAF-CSA
Space Universities CubeSat Challenge

A High-gain Inflatable Cable-net Reflector Antenna for CubeSats

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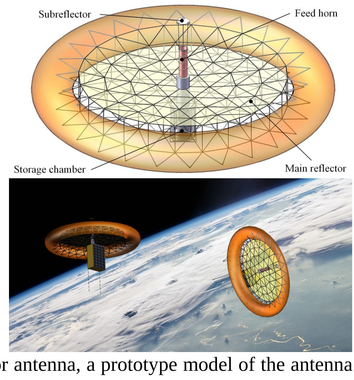
Introduction

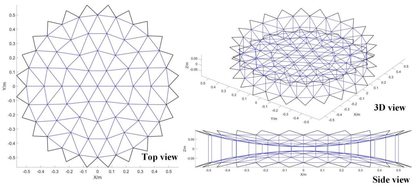
In view of the urgent demand and the deficiency of existing design schemes for high-gain antenna of CubeSats, a new inflatable cable-net reflector antenna is proposed. This new antenna adopts a central-fed Cassegrain reflector structure, including an inflatable cable-net reflector, a retractable sub-reflector, and a storage chamber. The structure size of the antenna in the storage state is 0.1m×0.1m×0.15m, and the physical aperture of the main reflector in the deploying state is 1.4m, and the effective aperture is 1m. The antenna main reflector combines the advantages of the cable-net antenna and the gas-filled antenna. The inflatable ring is used as the expansion-tension structure of the tension cable-net system, which can not only improve the storage rate and deployment reliability of the antenna, but also achieve higher surface accuracy.

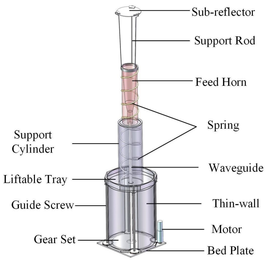


Based on the proposed design of the new inflatable cable net reflector antenna, a prototype model of the antenna structure is made. After testing, the air-tightness of the inflatable ring of the main reflector is good, and the structure is stable; the cable-net structure is fully tensioned in the unfolded state, and the symmetry is good, which is consistent with the theoretical design results. The antenna model verifies the rationality and feasibility of the design.

Design

The cable-net reflector mainly includes three parts: an inflatable ring, a tension cable-net structure and a metallic mesh, and the cable-net Can be divided into front net, tension ties and rear net. Both the front net and the rear net are in a rotating parabolic configuration, and the corresponding nodes of the two are connected by ties. The key to the design of the inflatable cable-net reflector is the geometric configuration of the reflector, in this project, a quasi-equilateral triangle method is used to obtain the geometric configuration, and design a reflector cable-net with more uniform cable elements and higher surface accuracy.





The antenna storage chamber and the deployable structure are shown in left figure, where the storage chamber comprises a motor, a gear set, four guide screws, a base and four thin-walls, the telescopic feed includes a feed horn, a telescopic waveguide and a spring. The antenna is stored in the CubeSat, and after launching into the orbit, the motor drives the four guide screws to rotate synchronously through the gear set and slowly push the antenna out of the storage chamber. Then, the inflatable ring self-inflate and deploy through powder sublimation with the cable-net becomes tensioned gradually. Finally, after the main reflector is fully deployed, the feed horn and the sub-reflector are pushed out by springs.

Prototype

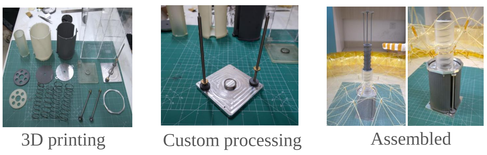
Inflatable ring

Cutting film | Paste in internal | Splicing film | Paste in external

Cable-net system

Preload and mark | The circumferential cable | Cable connection

Storage chamber



3D printing | Custom processing | Assembled

Works show

Innovation

(1) Propose a new high-gain antenna design scheme suitable for CubeSat;
(2) The antenna main reflector is mainly composed of a cable-membrane structure, which is light in weight and has a high storage rate;
(3) The inflatable ring is used as the supporting structure of the cable net reflecting surface, which effectively reduces the complexity of the deployment mechanism.

Team of CubeSat Eye
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