Foldable Transparent Mesh Patch Antenna for CubeSat

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The miniaturized satellite known as CubeSat was widely used due to its compact size, low weight, low cost, the simple structure used a short time to develop, etc. Since it has a small size, therefore, has a limitation for place the necessary components for satellite operation. Especially the antenna which has various types of antennas reported by [1] such as planar antenna, dipole antenna, monopole, reflector antenna, array antenna, etc.

The transparent antenna is widely used for occupied satellite areas due to it has a transparent property that can integrate with the solar cells as known Super-solar which is place above the solar cell. There are two methods by which the antenna achieves optically transparent which is used the conductive film and conductive mesh structure. The conductive film such as Indium tin oxide (ITO) material provides a transparency property. However, the film has high surface resistance regarding the antenna efficiency. Besides, a conductive mesh provides optical transparency which the light pass-through a mesh structure. It has low surface resistance [2, 3]. Therefore, the mesh structure is the best choice for optically transparent and has less effect on antenna efficiency. This paper focuses on the antenna design and fabrication of the foldable optical transparent mesh patch antenna for CubeSat. The proposed antenna utilized the advantage of transparency which can place an antenna in an occupied area above the solar cell. Additionally, it can foldable the antenna structure which can improve the antenna performance when arranged in the array. Moreover, there can be changing the antenna radiation. It provides omnidirectional and unidirectional when unfolding and folding the antenna respectively.

The proposed antenna was designed based on a 41 mm square patch structure operated at 2.0 GHz which the radiating patch and ground meshed. They are made from a mesh copper sheet with a mesh-line thickness of 0.27mm and separated with a spacing of 1mm. The transparent substrate, a thickness of 3 mm acrylic plate with a relative dielectric constant of 3. The mesh line in vertical and horizontal axes on the radiating patch and ground were 33 and 53, respectively. The antenna model was simulated by the CST microwave studio simulator. The measurement of the antenna characteristics such as the reflection coefficient and impedance bandwidth was done with the Network analyzer. The measured antenna radiational pattern and gain were done under an anechoic chamber room. The measured results were in good agreement with the simulation. The proposed antenna was operated at 2.225 GHz which is a reflection coefficient of -28.96 dB with an impedance of 52.73+j2.45 Ω. However, the resonance frequency of the antenna prototype was shifted to a high frequency from 2.0 GHz which possibly reason is caused by the dielectric constant which is assumed in the simulation was different from the actual acrylic material. The impedance bandwidth of 65 MHz is operated from 2.195 to 2.260 GHz. The peak gain at 2.225 GHz was 4.46 dBi with the beamwidth of 96 and 92 degrees in the H-plane and E-plane, respectively. For arrangement in the array, we fabricated another antenna with the same design and it has given similar measured results. The proposed antenna provides optically transparent which can integrate with above on the solar cells. Since the nature of solar cells might affect the antenna performance. The proposed antenna array used the mechanism for deploying the antenna structure when arrange in an array and changing the antenna pattern which we will do in future work.

The design and fabrication of a foldable transparent mesh path antenna for CubeSat were proposed in this paper. The simulation and measurement were demonstrated. The measurement results were in good agreement with the simulation.

References

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