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EXPERIMENTAL VALIDATION OF THE UPLINK PERFORMANCE OF A CUBESAT-BASED IOT COMMUNICATIONS SYSTEM WITH AN INTEGRATED FRACTAL PATCH ANTENNA

Abstract

There is a rapid advancement in satellite-based Internet of Things (IoT) communications to employ a tiny cube-shaped small satellite, known as nanosatellite or cube satellite (CubeSat) to be deployed in low-earth orbit (LEO) mission due to its low cost, relatively fast development, and smaller space requirement for launching. Generally, the effectiveness of the CubeSat-based IoT communications system is determined by the link budget estimates, and one of the important components determining this is the performance of the antenna. For each of the missions, the key feature that impacts the antennas is the link to the ground station terminal (GST). Therefore, the antenna should ensure a communication link between the CubeSat and the GST to support the required data rate.

In this research, an initial attempt to exploit the self-similarity features of the so-called *fractals* in the design of a patch antenna will be presented. Primarily, it intends to assess the performance of the designed fractal antenna mounted on a standard 1U (10 cm x 10 cm x 10 cm) CubeSat frame and compare its radiation characteristics with a commercial off-the-shelf (COTS) patch antenna resonating at the ultra-high frequency (UHF) band.

A proposed antenna will be optimized at a solution frequency, $f = 920$ MHz by adopting a commercial finite element method (FEM) solver for electromagnetic structures software, High Frequency Structure Simulator (HFSS). The simulated results of the reflection coefficient (S11), voltage standing wave ratio (VSWR), and radiation pattern will be compared with a conventional UHF patch antenna as a reference. Experimental measurements will be performed in an anechoic chamber located at the Center for Nanosatellite Testing (CeNT) of Kyushu Institute of Technology (KyuTech) in Japan to evaluate the actual performance of the antenna in a more realistic environment while a long-range communication test will be performed to verify the uplink communication performance on a 1U CubeSat flight model (FM) with the antenna mounted on it while emulating a ground-satellite distance (orbital altitude) of about 400 km.

An analysis of the radio link will also be done to account the gain of the proposed fractal antenna, the calculated data rate, the identified losses, and measured sensitivity among others, and to assess the link budget of the CubeSat-based IoT communications system.