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GROUND STATIONS NETWORK USING SOFTWARE DEFINED RADIO FOR ENVIRONMENTAL STORE & FORWARD CUBESATS MISSIONS IN COSTA RICA.

Abstract

The Costa Rican space program has expanded after the Irazú CubeSat, the first Central American satellite, was successfully developed. The main mission is to demonstrate a Store Forward (S&F) System that enables transmission of biomass and carbon dioxide fixation data from a remote fast growth tree plantation in the north of Costa Rica, to a research ground station for its post-processing and analysis.

Additionally, another S&F CubeSat mission for environmental monitoring in Costa Rica is being developed in collaboration with the George Washington University (GWU). The GWSat is a 3U CubeSat that will contain a payload capable of receiving, storing and forwarding data from Costa Rica's ground stations to the GWU's ground station. The main purpose is to contribute to the preservation of the biodiversity and hydrological equilibrium of the Costa Rican wetlands by improving their monitoring.

Using CubeSats as S&F systems has brought many challenges in the development of the ground stations, given that the CubeSat has a low transmission power (1W), causing very low received signal strength. A Low Noise Amplifier (LNA) was used to compensate the link budget and a Software Defined Radio (SDR) was used to improve the modulation and demodulation. The results of the design, implementation and operations of Irazú's Ground Stations using SDR are presented and discussed. This includes the main subsystems and its interfaces: the embedded hardware used for the SDR and remote sensing, the mission software with the CubeSat Space Protocol (CSP) and the tracking algorithms for frequency shift correction. The Irazú satellite's pre-launch environmental testing results, performed at the Kyushu Institute of Technology facilities, are also included. After each environmental test was completed, a functional test, using the SDR ground station, was performed, resulting in an error rate in the communication link of less than 8%.

In addition, the milestones achieved are presented in the design and development of the first prototype for the GWSat ground station in Costa Rica, where the performance of the SDR algorithms were improved and tested with different COTS hardware. Using the SDR resulted in a 12% reduction in error rate compared to the Kenwood TM-D710G radio-modem. For a better reliability, a Digital Signal Processing (DSP) software was developed for acquiring the environmental data from the remote sensors.