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Author: Mr. Hooman Jazebizadeh
Carleton University, Canada

Ms. Heidi Bathory
Carleton University, Canada
Prof. Bruce Burlton
Carleton Univeristy, Canada
Prof. Tarik Kaya
Carleton University, Canada

A SATELLITE COMMUNICATION EXPERIENTIAL LEARNING ACTIVITY FOR UNDERGRADUATE STUDENTS IN AEROSPACE ENGINEERING

Abstract

The experiential learning activity introduced in this paper is devised to inspire undergraduate students to attain knowledge of satellite telecommunication by building and operating a ground station. This activity is aimed towards aerospace engineering students specializing in avionics or space systems at Carleton University in Canada. Such students partake in a spacecraft design course, through which various topics relating to spacecraft engineering and space exploration are studied. This activity enhances the course curriculum by introducing the necessary background knowledge of ground station design and satellite operation.

Through this interactive activity, teams comprised of two students build and operate a ground station to receive and decode a signal sent by NOAA 15, 18, and 19 satellites to obtain real-time weather images. A comprehensive user manual is developed to guide the students step by step through the implementation and operation process. The ground station is designed to be modular and to utilize commercial off-the-shelf (COTS) products such as software defined receivers (SDR) to reduce the total cost as well as the construction time. The modularity aspect provides an opportunity to demonstrate how the addition of components to the system configuration affects the reception performance. The overall performance is measured using the image pixel quality and the signal-to-noise ratio. The performance of each individual component is also measured by a cost-effective vector network analyzer. A link budget tool is provided to the teams to correlate the individual and overall performance.

This project applies experiential education to provide students with lasting impressions of the material by reflecting on the experience of capturing a real satellite image. Through hands-on involvement and employing analytical and problem-solving skills, the student becomes familiar with fundamental topics, such as frequency modulation and Doppler shift. Preliminary rehearsals for the activity resulted in the successful validation of the hardware, software, and procedure. The validation criteria for the activity includes the reception of the satellite images and the successful completion of a knowledge-based questionnaire after the rehearsals. Moreover, valuable lessons were learned including the importance of the ground station location and pre-activity tutorials. The location of the activity should be flexible to reduce the effects of radio frequency interference and undesirable weather conditions. Lastly, providing online tutorials to the students before conducting the project is advisable such that they are better prepared for the activity sessions.