Ground Station and Satellite Tracking System

Project Abstract

Western University's Cubesat program is designing and developing two satellites on varying frequency bands, with the intention of capturing images of the earth from low orbit. With the relatively large amount of data that is transferred per image taken, ensuring maximum connectivity and consequently, data transfer rate, is required so that the entire image is received by the ground team in a timely manner. Current ground station technologies use stationary, unidirectional, systems that do not attempt to locate or align with the satellite, rather just achieving uplink whenever the satellite in question passes overhead. These systems are also fixed, and thus cannot be relocated to otther areas if needed.

The solution that we came up with was an autonomous tracking station that uses the GPS coordinates of the ground station as well as the two line element set of the satellite to determine its location in orbit and the corresponding horizontal and vertical angles to point to the satellite. The ground station is able to provide real time communication with the satellite, monitor and predict its trajectory, and adjust the antenna's alignment based on the trajectory of the satellite. The angles are controlled with a coupled stepper motor pair that are set to the precalculated horizontal and vertical angles, and encoders are used in a closed loop configuration to account for any missed steps of the motors. The system is supported by a metal mast that resists deflection well, and a large base that prevents the system from tripping during high winds. Additionally, to resist torsion caused by wind force and the mass moment of the antenna, a 160:1 ratio gearbox is used to multiply the torque output of the relatively small motors. The entire system is controlled by a Raspberry using the robotic operation systems (ROS) to control two Arduinos, each of which control one motor with feedback from its respective encoder.