Radio Telescope Control System

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Abstract:

Many people are familiar with the experience of looking up during a clear night and gazing at the stars. Whether through a telescope, binoculars, or with the naked eye, the night skies provide a provoking image of beauty and wonder as we observe the heavens. The night sky has long fascinated humankind, and observing celestial patterns has brought a wealth of information to mathematicians, physicists, and travelers.

A low-cost, small-scale radio telescope can provide university undergraduate students with the ability to learn the basics of radio astronomy, the universe, electromagnetic waves, and electronics by plotting measurements at a common radiative frequency of 1.42 GHz referred to as the “hydrogen line”. This paper presents the design, test, and creation of a control system that contributes to the Penn State Harrisburg IEEE branch’s small-scale radio telescope project.

This system employs an embedded subsystem that uses DC motor drivers in a closed-loop feedback configuration to control accurate pointing of a 3-meter dish antenna and communicate with a main system computer over a wired link. The primary objective of the subsystem design is to create a layer of abstraction for the main computer through a set of commands—an application programming interface (API)—that direct the dish antenna in an azimuth-elevation coordinate system. The subsystem integrates several functions onto one custom printed circuit board. For motor control, H-Bridge motor drive and rotary encoder feedback are available. Power is supplied through a low-cost commercial off the shelf (COTS) module. A simple LCD display interface is employed to monitor and control the unit without the intervention of the main computer. A custom command API is deployed over a USB-UART bridge to the main computer, which enables flexible and universal control.