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CREATING HUMAN-POWERED GROUNDSTATIONS BASED AROUND MODERN SMARTPHONE ARCHITECTURE FOR LOW-COST SATELLITE MISSIONS AND EDUCATIONAL OUTREACH

Abstract

An examination of how smartphones and humans can be combined to create simpler, cheaper groundstations for low-cost satellite missions and STEM educational outreach. As satellite missions get cheaper and are being created by ever-smaller and less-experienced groups, it is important for groundstation technology to likewise follow this trend of lower entry requirements. This presentation explores a variety of simple designs, harnessing the power of smartphones combined with the utility offered by having a '*human-in-the-loop*'.

The modern smartphone is incredibly powerful, offering significant computational ability together with a vast array of sensors. Features such as GPS geolocation, combined with accelerometers, gyroscopes and compass allow the phone to sense its location and orientation anywhere on Earth. When affixed to an antenna suitable for satellite communication, the antenna's location and pointing data can be inferred and compensated for, by providing the human operator with visual feedback.

By utilising COTS RTL-SDR dongles and simple software, smartphones themselves can serve as the 'brains' of a groundstation; tasked with both tracking a satellite and decoding received signals. Humans have evolved with precision motor skills but *without* an innate knowledge of orbital dynamics, and so in combination with clever software and visual feedback can take the place of significantly larger, more expensive, and more complex groundstation installations. In our solution, the human-in-the-loop holds the antenna and is fed pointing data by the smartphone visually, utilising accelerometer and compass data to ensure the target satellite is tracked accurately throughout it's pass.

Several handheld antenna designs are explored within, enabling communication with most satellites operating on the 2m or 70cm band. Antenna designs presented include common vertically- and horizontally-polarised versions, as well as both left- and right-handed circularly-polarised configurations - all interfacing with a smartphone as the 'brains' of the groundstation. With the exception of a cheap and ubiquitous RTL-SDR dongle, all key components can be purchased at a hardware store - or 3D printed at home - and assembled within a few hours without any prior knowledge of satellite communications or antenna design.

Such a system allows anyone to get involved and learn about how satellites improve and contribute to everyday life on Earth, making it perfect as a project for students in STEM fields. This provides a great first step (and indeed, last resort) for the next generation of low-cost, low-tech satellite missions being developed by students and small businesses alike.