Automated Multi-Frequency Antenna System for Stratospheric Research Balloon Telemetry

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Because flight radios must be lightweight, they trend to be low power, thus, the HARBOR team requires line-of-sight antenna tracking for data collection and interfacing capabilities. This new system provides automated tracking of the near-spacecraft during the entire flight. The previous system required visual contact with the flight package to allow manual pointing of the antenna. Difficult in the best of situations, manual tracking completely fails when there is cloud cover.

Future advancements:
The current system is dependent on a level platform oriented towards magnetic south. We would like to use μ-metal to shield our 3-axis magnetometer from the magnetic field induced by the stepper motors. Shielding would remove the need of the extended arm holding the 3-axis accelerometer and 3-axis magnetometer, allowing us to mount the system on top of a moving vehicle while tracking.

(left) Shown is a typical HARBOR flight setup. The position telemetry radios are what provide our system with telemetry data from the balloon in order to be tracked. One of the science payloads requires line-of-sight tracking for data collection.

(above) This is a pre-manufactured tracking antenna design created by a company called Optimum Solutions (image from Optimumsolutions.com). The cost of this model is approximately $15,000-$50,000 depending on added features and accuracy capabilities. (right) We see the current model for the student designed and constructed automated tracking antenna (ATA). It has only been tested with ground-based signals, but is considered functional. It will provide ground support for its first HARBOR flight this coming May. The final cost of the project unit was roughly $1,500.

The original tracking antenna design used powerful stepper motors without the aide of worm-gears. This greatly increases the rotational velocity output of a motor, while equally increasing the effective torque output by a fixed ratio. For this project, we used a ratio of 10:1 (factor-of-10 decrease in rotational velocity output with a simultaneous factor-of-10 increase in torque output).

Stray magnetic fields became a serious problem. The large currents flowing through the coils of the stepper motors created strong electromagnetic fields, causing sensor measurement corruption in the 3-axis magnetometer (measuring Earth’s magnetic field). In order to correct for this, the sensors had to be placed at a distance from the stepper motors, at the end of the extended arm - shown above.

(above) Ozone data from the Ozonesonde. Line-of-sight tracking is required since the ozonesonde radio is weak. The data are then interpreted at the ground station from current levels to ppm measurement of ozone at specific altitudes. Other data are also in the downlink including position, temperature, and humidity.

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