Design and Construction of a Wayfinding Method for the Completely Hackable Amateur Radio Telescope

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Background

- K-12 curriculum mainly covers basic astronomy, neglecting topics like radio astronomy[5]
- Designing amateur radio telescopes/opening telescopes to the public can solve this issue
- BHARAT, SALSA, and CHART (Completely Hackable Amateur Radio Telescope) are affordable examples[1-3]
 - Lack of wayfinding method limits their ability to record data in a specific area
- GAVRT Program allows public access to larger, more versatile telescopes capable of tracking[4]
 - Prohibitively expensive for amateurs
- Guidance system necessary to give amateur options like CHART the same capability

Aim

Design a way for CHART to identify the direction it points in in Altitude
 Azimuth, Galactic, Right Ascension-Declination coordinates

Methods

- CHART position information derived using 9-DoF Sparkfun IMU connected to laptop:
 - IMU relays acceleration and position data through computer
 - Laptop interfaces with IMU through Arduino IDE, calculates position through GPS coordinates, entered on the laptop
 - Coordinates are then displayed on the laptop screen
- IMU follows CHART's movements since it is attached to the waveguide via duct tape



Figure 1: CHART in use at Winona State University [2]

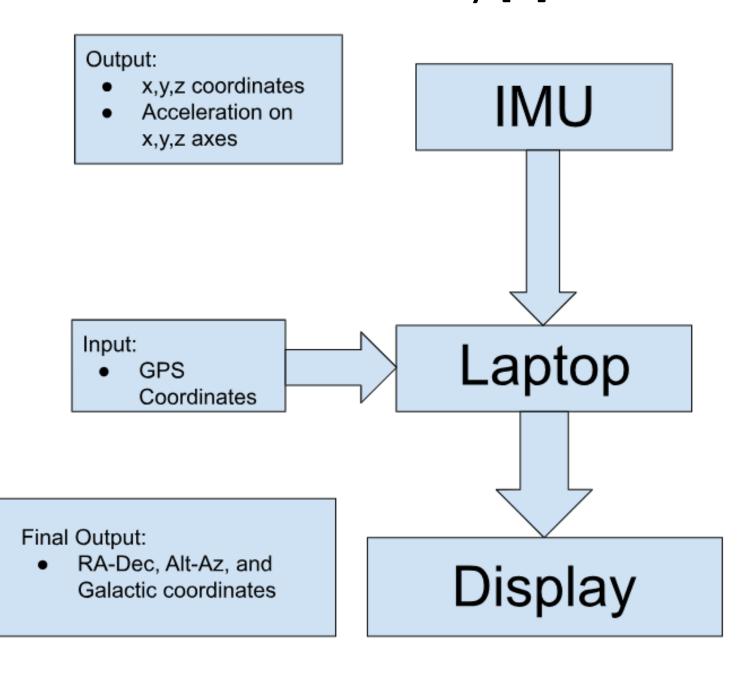


Figure 2: Block diagram illustrating how the system works

Future Goals

- Building and testing this approach in the field on CHART
- Adding a star-finding feature to allow the telescope
- Eliminate the need for processing data through the laptop to reduce system complexity by:
 - Replacing the laptop with a power supply
 - Adding an LCD screen to display the coordinates where CHART is pointing
 - Adding a hard shell to the guidance system for protection

Sources

[1]A. A. Mhaske, J. Bagchi, et al. "A Bose horn antenna radio telescope (BHARAT) design for 21 cm hydrogen line experiments for radio astronomy teaching". In: American Journal of Physics 90.12 (Dec. 2022), pp. 948–960. ISSN: 0002-9505. DOI: 10.1119/5.0065381. URL: https://doi.org/10.1119/5.0065381.

[2]Berkhout, L.M., Beardsley, A.P., Jacobs, D.C., Braithwaite, R., Gutierrez-Coatney, B., Islam, A. and Wright, A., 2023. The Completely Hackable Amateur Radio Telescope (CHART) Project. *arXiv preprint arXiv:2307.11173*.

[3]M. Sakhawat Hossain and B. Mallik. "SALSA is an ICT Based Educational Tool for Astrophysics Students to Study Structure and Dynamics of Milky Way Galaxy". In: 2018 21st International Conference of Computer and Information Technology (IC-CIT). 2018, pp. 1–6. DOI: 10.1109/ICCITECHN. 2018.8631979

[4]Roller, J.P., Klein, M.J. (2003). The GAVRT Partnership: Bringing the Universe to K-12 Classrooms. In: Organizations and Strategies in Astronomy. Astrophysics and Space Science Library, vol 296. Springer, Dordrecht. https://doi.org/10.1007/978-94-010-0049-9_11

[5]Salimpour, S., Bartlett, S., Fitzgerald, M. T., McKinnon, D. H., Cutts, K. R., James, C. Renee, Miller, S., Danaia, L., Hollow, R. P., Cabezon, S., Faye, M., Tomita, A., Max, C., de Korte, M., Baudouin, C., Birkenbauma, D., Kallery, M., Anjos, S., Wu, Q., Chu, H., Slater, E., Ortiz-Gil, A., & Salimpour, S. (2020). The Gateway Science: a Review of Astronomy in the OECD School Curricula, Including China and South Africa. Research in Science Education, 51(9), 975-996. https://doi.org/10.1007/s11165-020-09922-0

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