Radio Telescope

Astronautics Club - Project Proposal

International Institute of Information Technology, Hyderabad

Respected Sir/Ma'am,

We, the members of the Astronautics Club, are excited to propose a project to build a small-scale low-cost radio telescope. This project aims to provide hands-on experience in a range of inter-disciplinary domains, including electronics, computer science, signal proocessingn, and radio astronomy.

Project Overview:

Through this project, we aim to build a small-scale radio telescope that can be assembled and opererated by students primarily for experimental and educational purposes.
The initial objective is to detect strong and reliable sources such as the Sun, the artificial satellites, the Milky Way, etc. As the project progresses, we aim to improve the sensitivity and resolution of the telescope to detect weaker sources.

Our design and methodology will be guided by well-documented open-source radio telescope projects, like - CHART [1] and Project RT [4]
The telescope system will consist of the following modules:

- Antenna system: A parabolic dish antenna & a custom feedhorn
- Signal conditioning chain: LNA & bandpass filters
- A Software-Defined Radio (SDR) receiver: RTL-SDR with a dipole antenna
- Data acquisition and processing System : GNU Radio and Python-based tools

Project Impact:

- Foster interdisciplinary collaboration among students in electronics, computer science, and radio astronomy
- Develop hands-on experience in antenna theory and design
- Enable exploration of signal processing techniques using tools like GNU Radio and Python
- Enhance research and analytical skills through data collection, processing, etc.

In the following sections, we share our implementation timeline and potential future improvements. We welcome suggestions and collaborations to make this project a valuable learning experience for all involved.

Key Components:

1. **Antenna System:**
    - A parabolic dish antenna (e.g. a repurposed satellite dish) - primary collector of incoming radio waves
    - A custom feedhorn - to direct signals to the receiver chain
2. **Signal Conditioning Chain:**
    - LNA - to amplify weak celestial signals and minimize other electronic noises
    - Bandpass filter - To isolate our desired frequency band (1.42GHz - 21cm Hydrogen line)
3. **Software-Defined Radio (SDR) Receiver**
    - RTL-SDR with custom antenna - to convert incoming analog signals into a format suitable fro proccessing
4. **Data Acquisition and Processing System:**
    - GNU Radio, CubicSDR, etc. for real time signal processing
    - Python based tools for computational Analysis
    - MATLAB, SciPy, etc. for signal visualization

Project Timeline:

Phase 0: Literature review and Component procurement

- Literature review of existing amateur radio telescope builds
- Finalize bill of materials and begin procurement of key components
- JDocument the specifications of the project

Phase 1: Research & Planning

- Study radio telescope designs, focusing on HI-line detection and planetary emissions
- Develop a detailed blueprint for the antenna, receiver, and data pipeline
- Estimate budget and procure required components

Phase 2: Construction & Assembly

- Build the parabolic dish and feedhorn system
- Assemble the LNA, filters, and SDR receiver setup
- Perform initial system integration and debugging

Phase 3: Testing & Calibration

- Test the system using terrestrial radio sources
- Conduct celestial tests and compare signals with public datasets
- Calibrate the telescope for accurate measurements
- Optimize performance through iterative refinements

Phase 4: Data Collection & Analysis

- Implement data processing techniques to extract meaningful information
- Document findings and prepare presentations for the club
- Schedule and conduct observation sessions, beginning with the Sun

Bill of Materials: Radio Telescope Project

The following table outlines the estimated components required to construct the small-scale radio telescope.

Component	Specification	Estimated Cost (INR)	Supplier Link
Aluminium Foil adhesive tape	-	200	Amazon
Aluminium Foil	-	400	Amazon
Cardboard Sheets	4 36" x 48"	500	Amazon
Coaxial Cable	-	-	Amazon / Local
SMA female connector	-	790	Amazon
SMA male to male right angle connector	-	-	Amazon
male to male & female to female connectors	-	-	Amazon
RTL-SDR with Dipole Antenna Kit	-		Amazon
RTL Dongle	-	8450	Amazon
TATA Sky Set up (Reflector Parabolic Dish, the mount attachment, LNB and set-top box)	-	5000	Link

Table 1: Estimated costs

To-do:

- complete the bill of materials table with actual working and reliable links from which we can procure the components
- format the doc
- articulate the project timeline in a better way and include more details about the key cocmponents
- add few images of what can be expected from the project (use Project RT iamges as reference)
- highlight the research benefits
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Bibliography

[1] CHART (Completely Hackable Radio Telescope)
https://astrochart.github.io/telescope_design

[2] NASA's Radio Jove Project
https://radiojove.gsfc.nasa.gov/radio_telescope/building_testing.php

[3] CBSS Nsukka
https://astro4dev.org/nigerian-project-develops-diy-low-cost-radio-telescope-for-teaching/

[4] Project Radio Telescope - BITS Goa
https://projectrtbits.wordpress.com/

[5] MIT Haystack Observatory
https://www.haystack.mit.edu/haystack-public-outreach/srt-the-small-radio-telescope-for-education/

[6] IEEE Penn State Harisburg
https://edu.ieee.org/us-psu/2024/01/20/radio-telescope-project/

Thank you for considering our proposal. We look forward to your support and are happy to provide any additional details or clafications as required.

Sincerely,
Name
On behalf of the Astronautics Club
Department and Year
Contact info