Components of a Scale Training Telescope for Radio Astronomy Training

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NRF National Research Foundation | SARAO South African Radio Astronomy Observatory

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Introduction

A need was identified to create a teaching telescope that would serve as a vehicle for presenting the fundamentals of radio astronomy in the Square Kilometer Array (SKA) African partner countries in order to establish the engineering and science underpinning of radio astronomy. The Scale Training Telescope (STT) will be used as an interactive teaching tool for the fundamentals in radio telescope design, assembly, and operation.

The STT provides students, at various academic levels in various educational institutions, access to an telescope design that they can assemble and operate. While an overview of the mechanical and electronic systems will be given, it should be noted that the focus of the project is the control system of the STT.

Mechanical overview

- Sub-systems for the scaled telescope are derived based on full-scale telescope functionality.
- Key mechanical subsystems include yoke and pedestal assemblies, elevation drive assembly, and reflector assembly.
- Anti-backlash mechanisms are implemented for accuracy in azimuth and elevation.

The overall STT design can be seen in Figure 1 & 2 respectively.

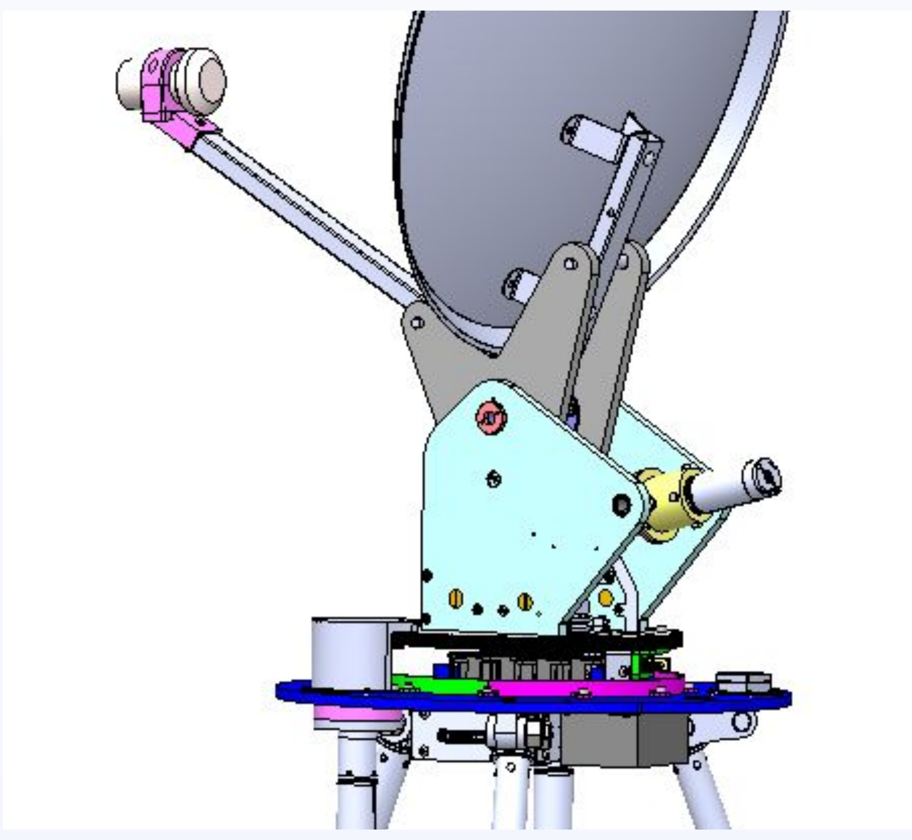

Figure 1: STT Yoke

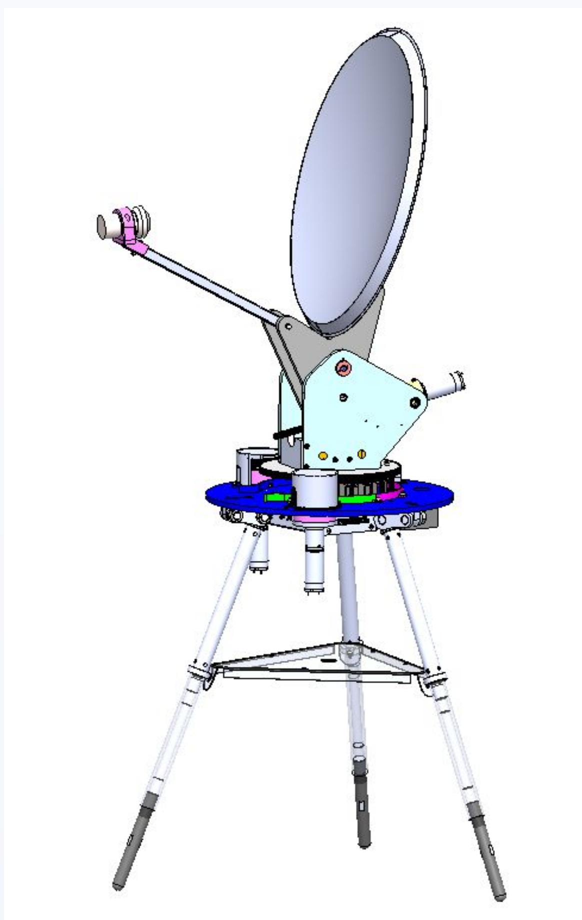

Figure 2: STT Structure

Electrical overview

The block diagram shows the interfaces between the various electrical components, including the limit switches, motors, tachometers, and encoders on the STT and the 12V DC power supply. The STT movement is limited by limit switches, preventing damage to the telescope construction. The STT incorporates both DC and stepper motors.

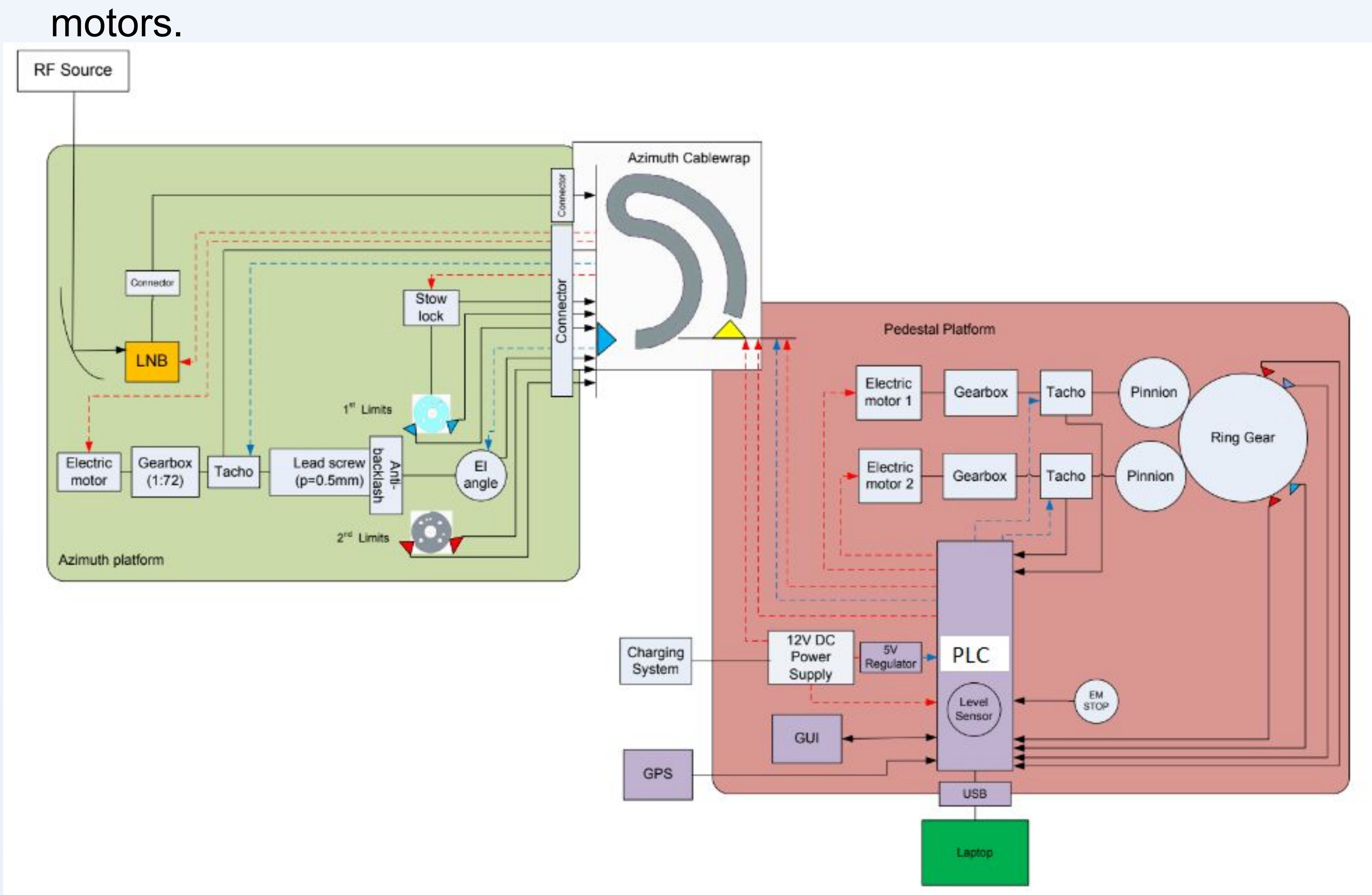

Figure 3: Electrical Block diagram

Telescope Control System

The control system is a Programmable Logic Controller (PLC)-based controller system.

- The chosen PLC, Barth STG-800, utilizes the CANopen communication protocol for networking and communication with other components.
- Currently a CANOpen simulator is being developed and used for testing prior to the physical PLC implementation into the training telescope.

Control and Monitor Software Architecture

- Software comprises of three components: Telescope Simulator, Component Manager, and GUI developed using C++, Python, Flask respectively.
- Users use a web-based interface for commands and simulations.
- Component Manager manages communication between GUI and telescope Simulator.
- GPS receiver is used to enhance simulation precision.
- Core functions of the software include initialization, pointing, telescope control, sun tracking, and source scanning.

Figure 4 & 5 shows the software functionality and architecture respectively.

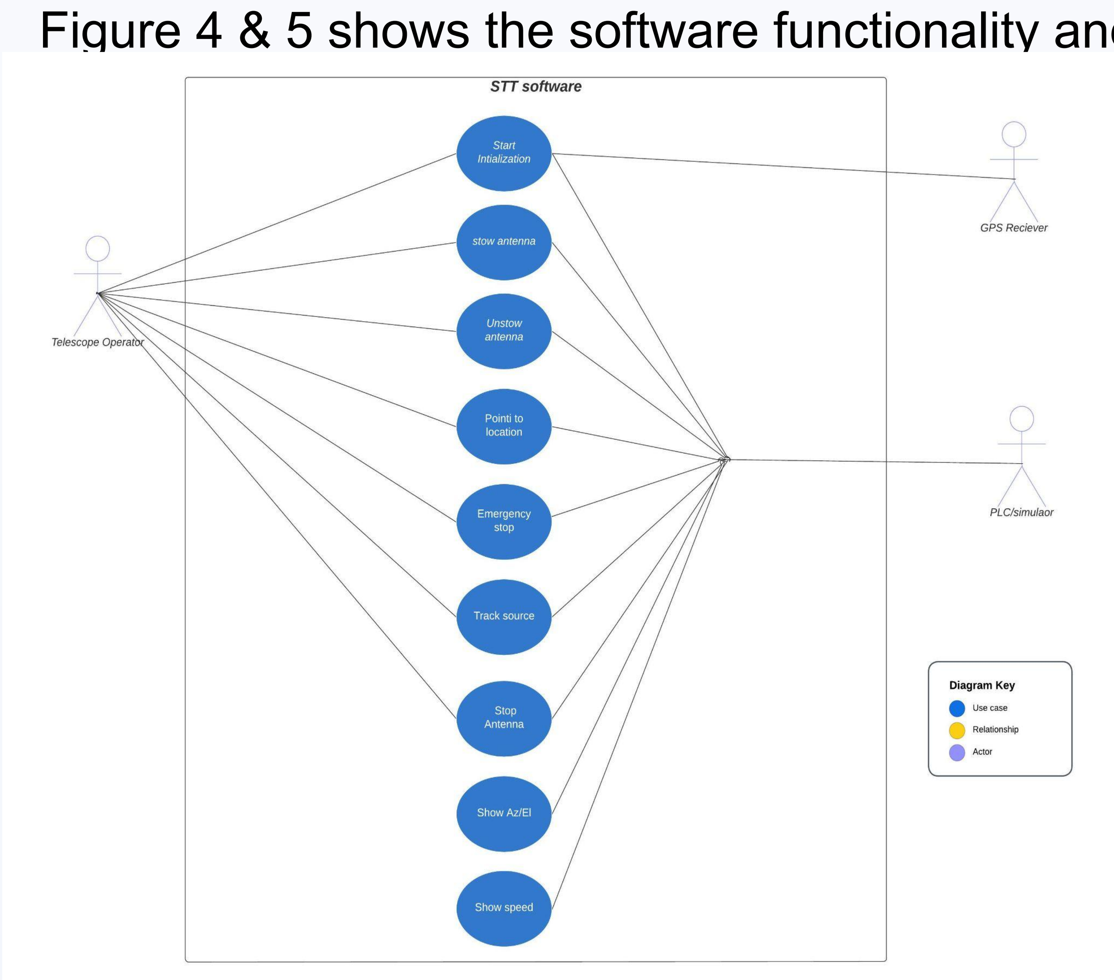

Figure 4: Software functions

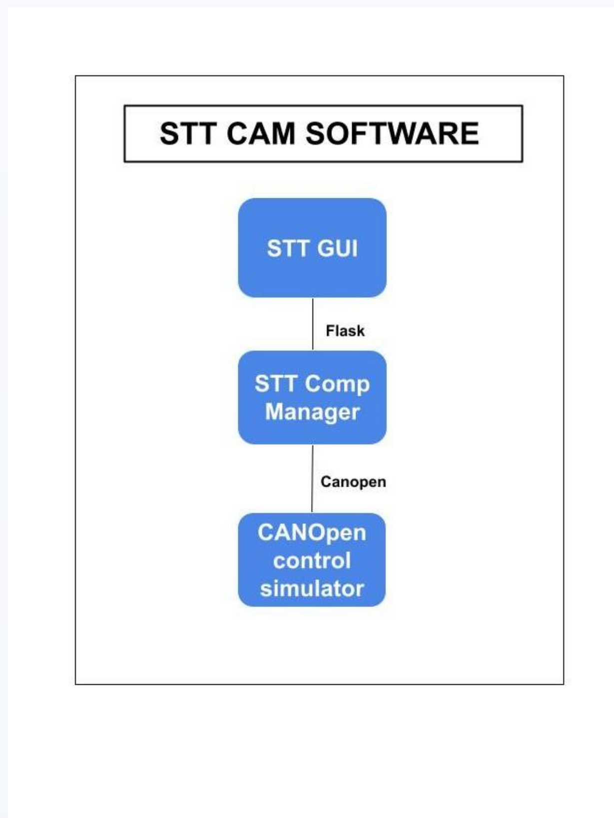

Figure 5: Software architecture

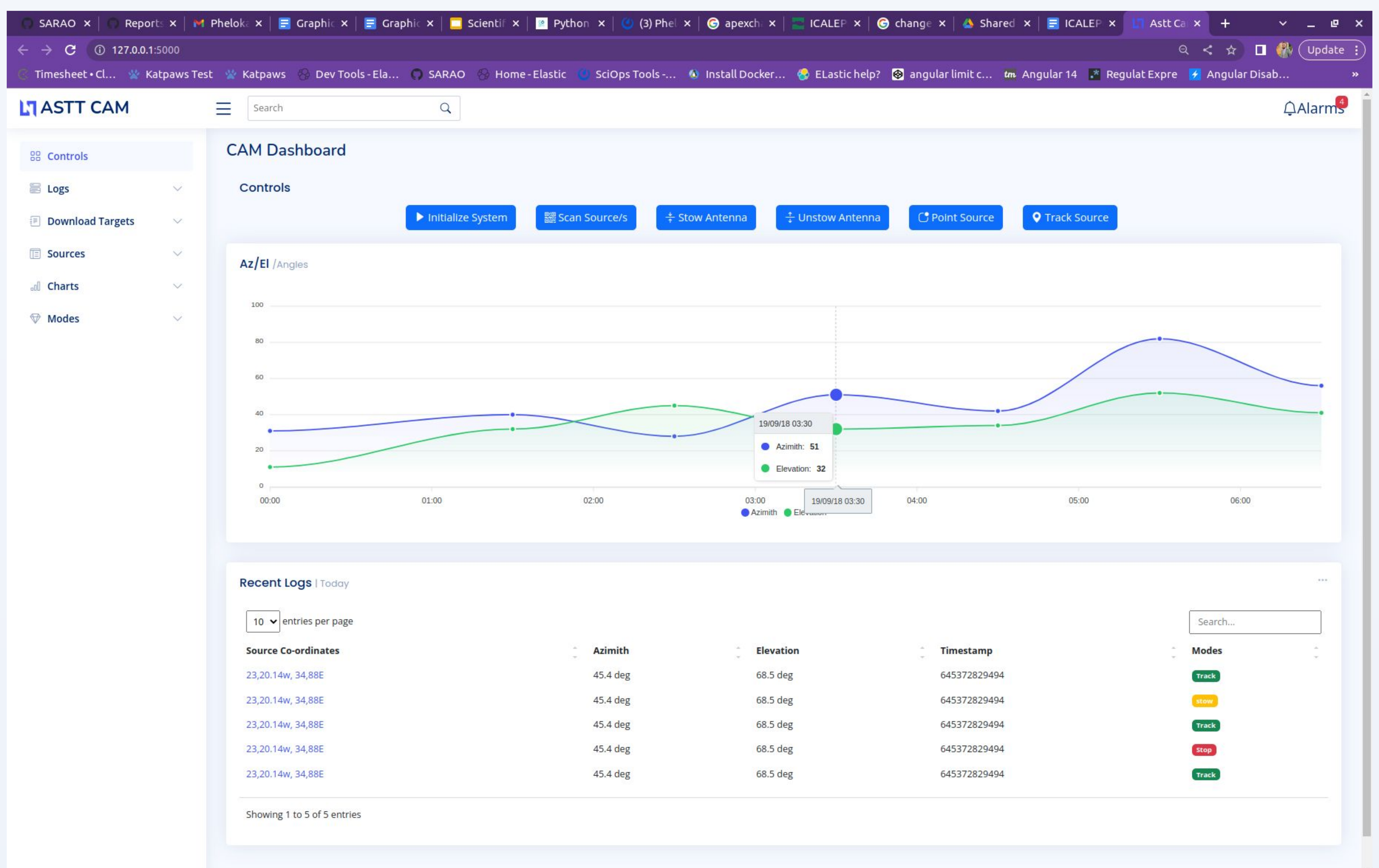

Figure 6: Software GUI

Conclusion

The development and implementation of the STT system is complex due to the numerous diverse sub-systems. However, the breakdown of system requirements through functional analysis and an error budget allows the subsystems to be fully defined prior to integration. Overall, the STT is a good development tool for teaching the development process, operation and construction related to a radio telescope.