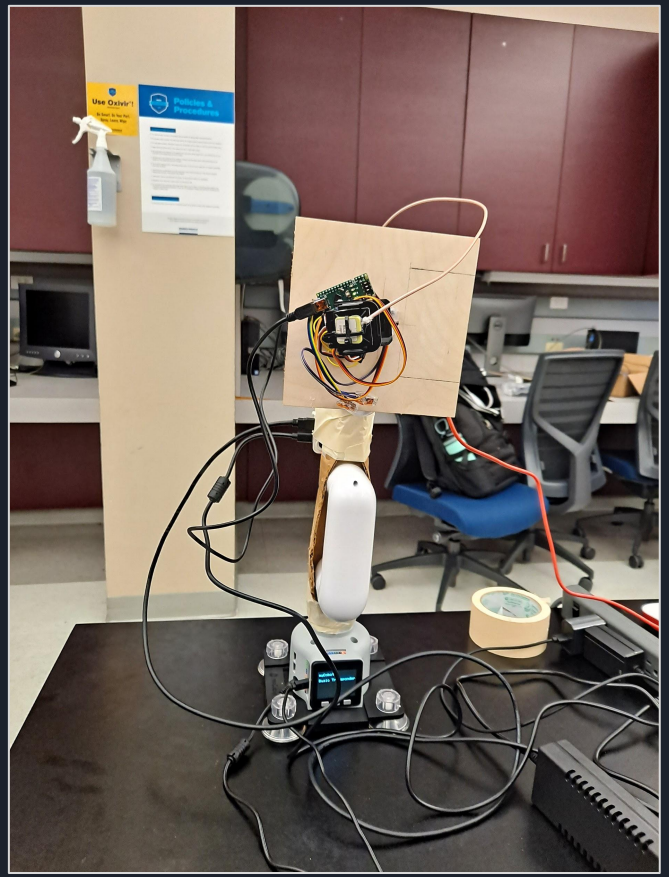
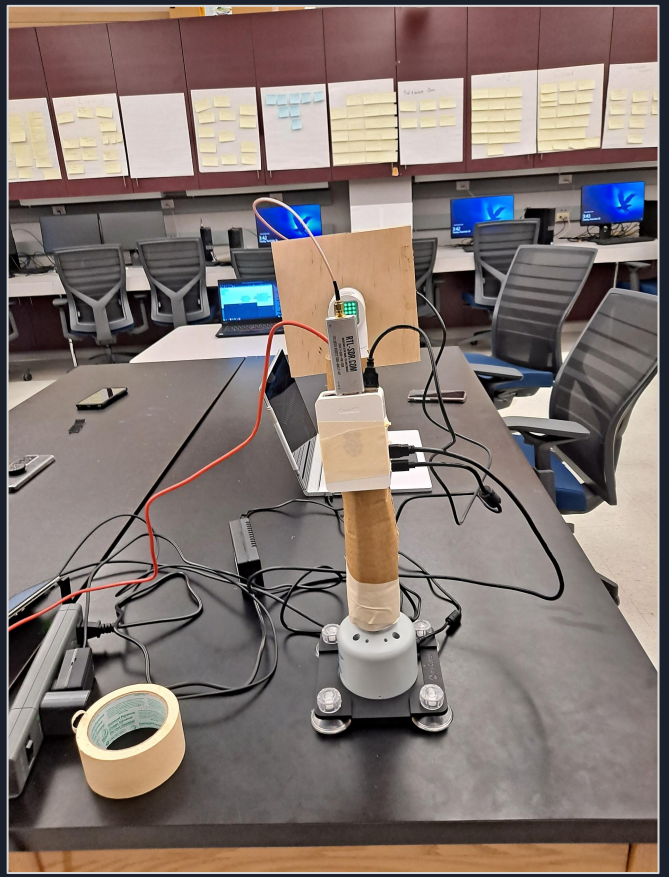
EmStart Demo

Participants: Ivan Borra, Matthew Gasper, Matthew Grabasch, TJ Scherer, and Matthew Selph





EmStart System

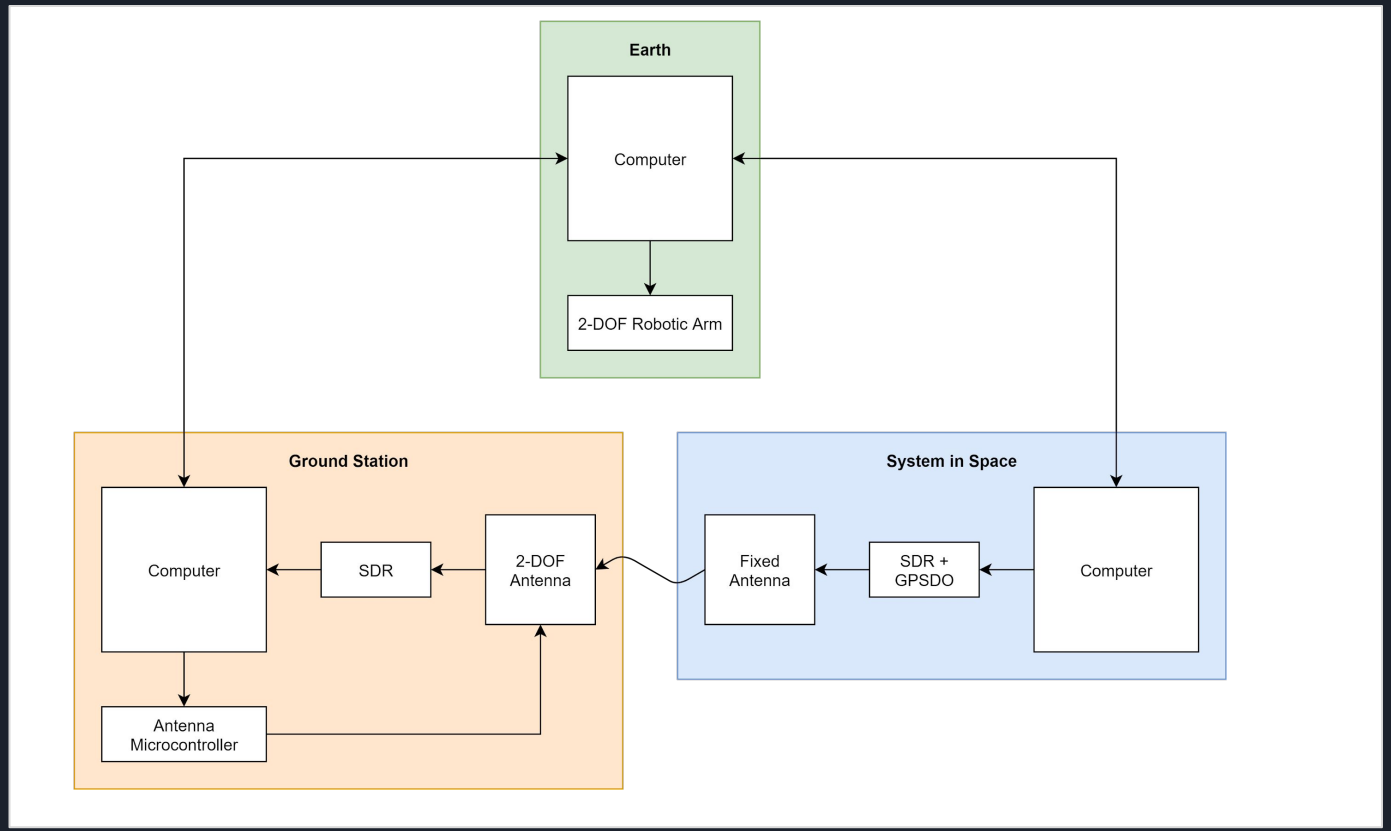
Benefits and Value

- Research
- Development
- Debugging
- Education

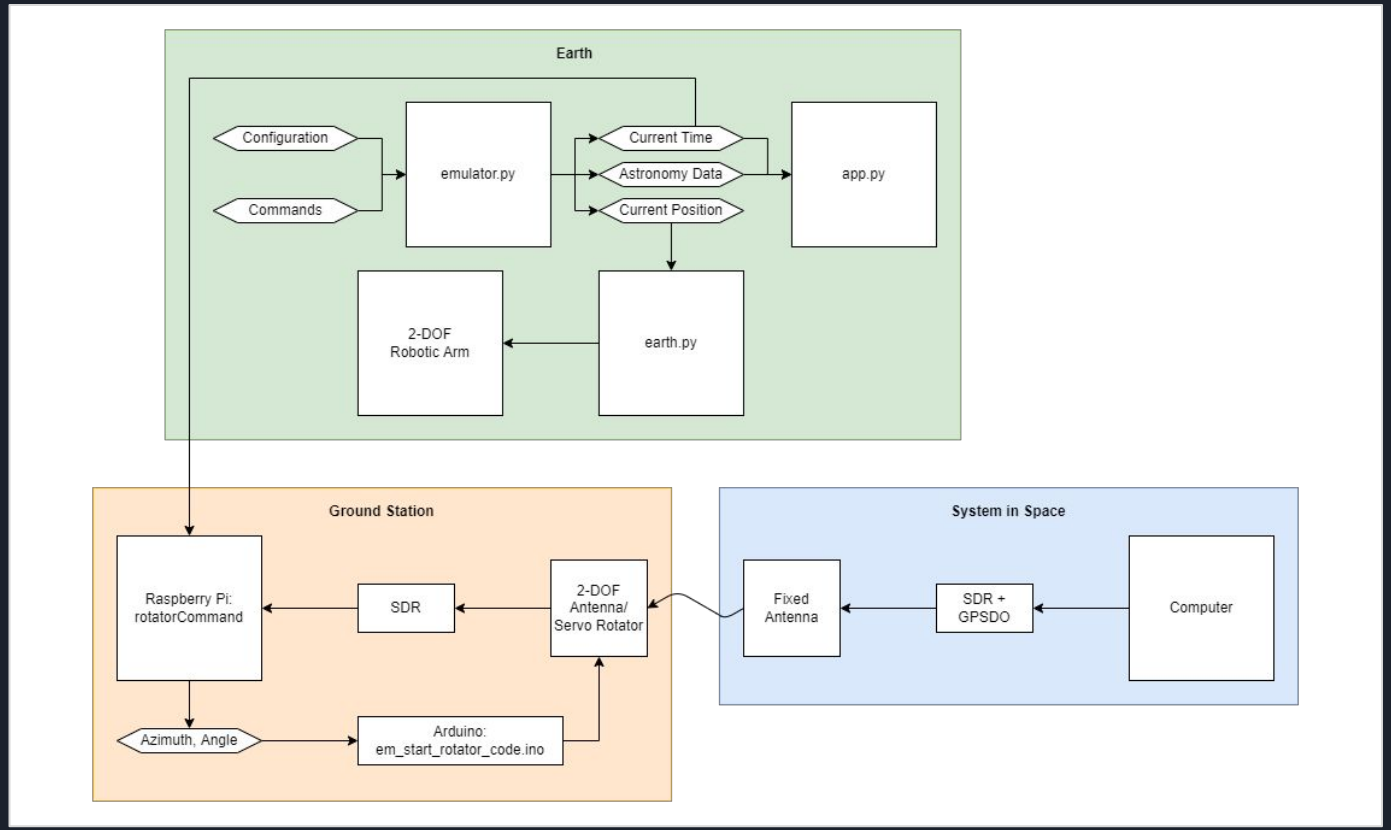
SRT Developed by Haystack Observatory

Design Considerations

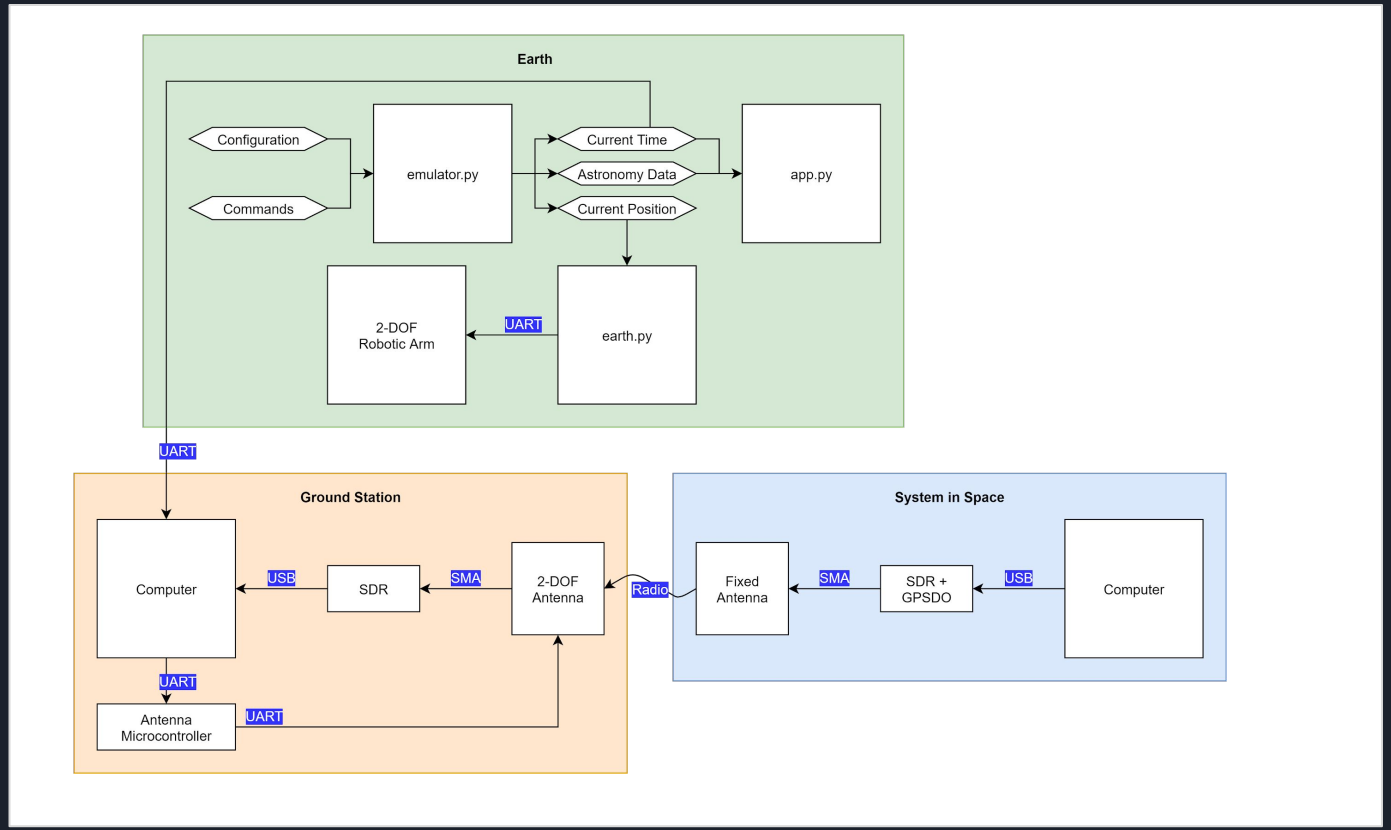
- System in space is stationary.
- Satellite transmits 24/7.
- Operates inside a moderately sized room.
- Eventually simplified for education purposes.
- Radio Defined Telescope hardware was predetermined.
- 250g weight limit for Ground Base.



Hardware Architecture



Software Architecture



Communication Architecture

Earth Emulation System

Earth Emulation System

Components:

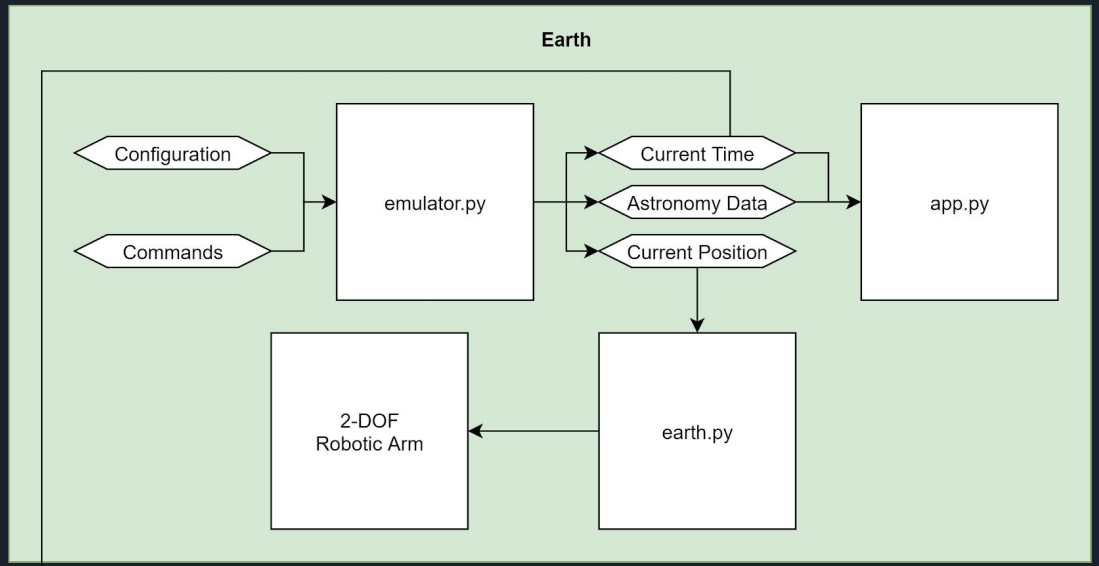
- Computer
- Robotic Arm

Usage:

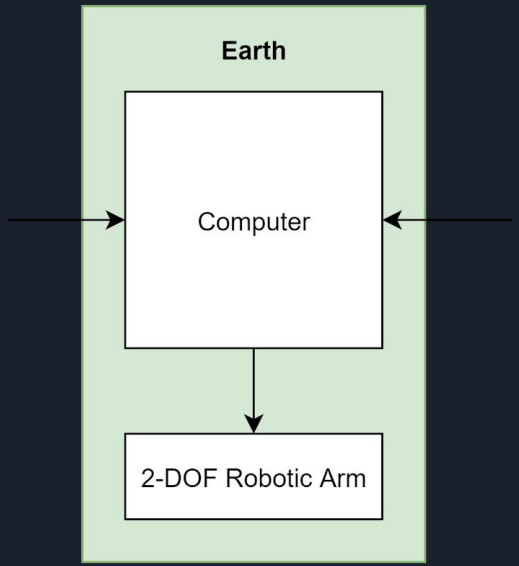
- User configures emulation on computer
- Astronomy data is gathered and processed
- Processed data displayed on user interface
- Computer controls robotic arm

Earth Emulation System (Design Diagram)

Software Configuration



Hardware Configuration



Earth Emulation System (Dependencies)

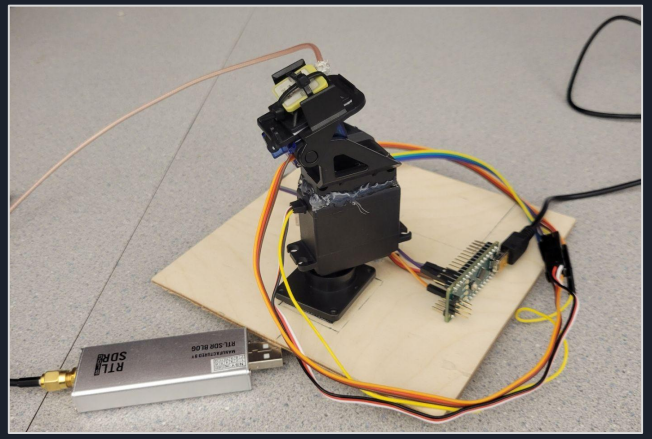
Python Package	Function
astropy	gathers astronomy data
dash	generates web-based user interface
pymycobot	controls robotic arm
pyserial	communicates through serial ports
pytz	translates the timezone to UTC offset
timezonefinder	determines the timezone at GPS coordinates
pyzmq	communicates through TCP sockets

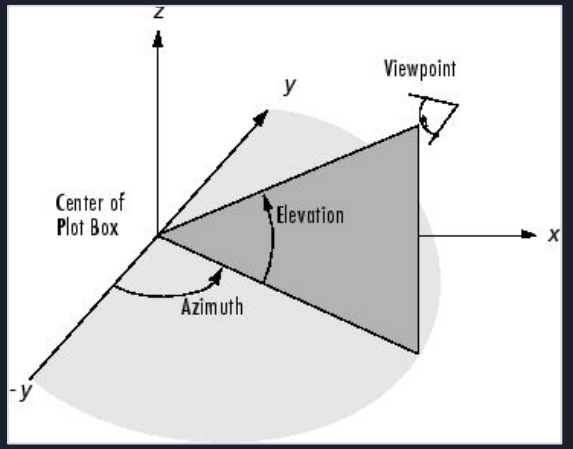
Earth Emulator Operating Alone

Rotator Emulation System

Rotator Emulation System

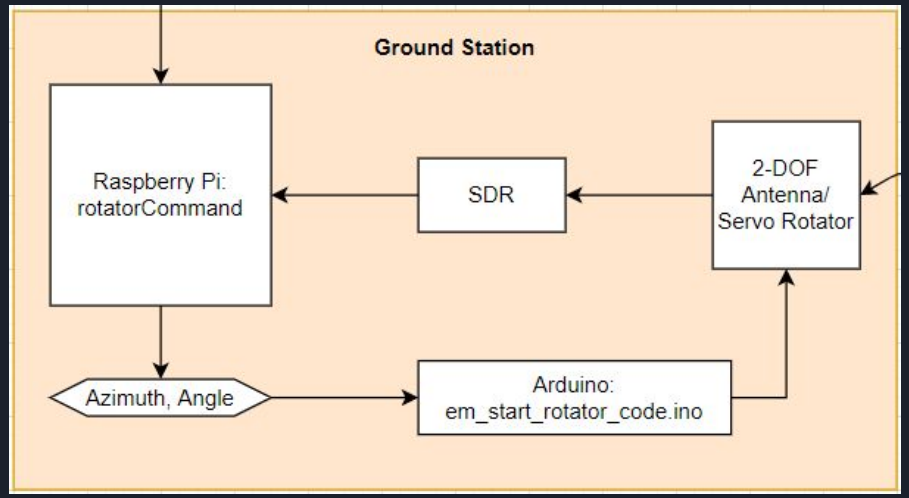
- Consists of 2 servos, one representing azimuth movement, and one representing angle
- Azimuth Servo: 360 degree Parallax feedback servo
- Angle Servo: 150 degree servo from Adafruit Mini Pan-Tilt kit
- Controlled by Arduino Nano
- Communicates via UART with the raspberry Pi for angle and azimuth values



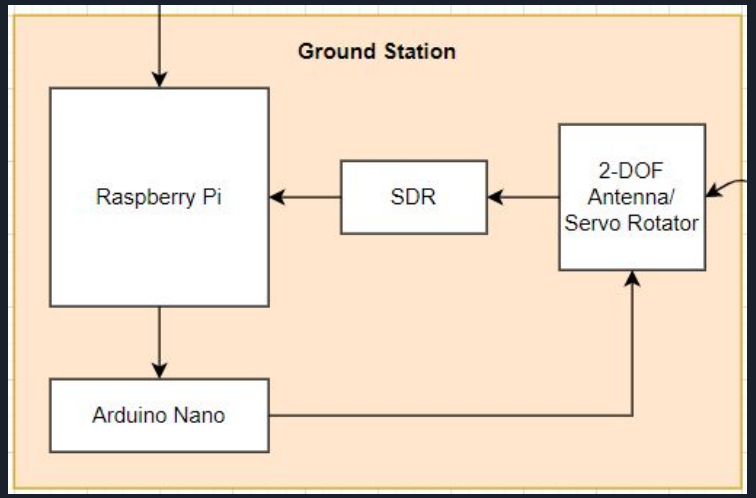


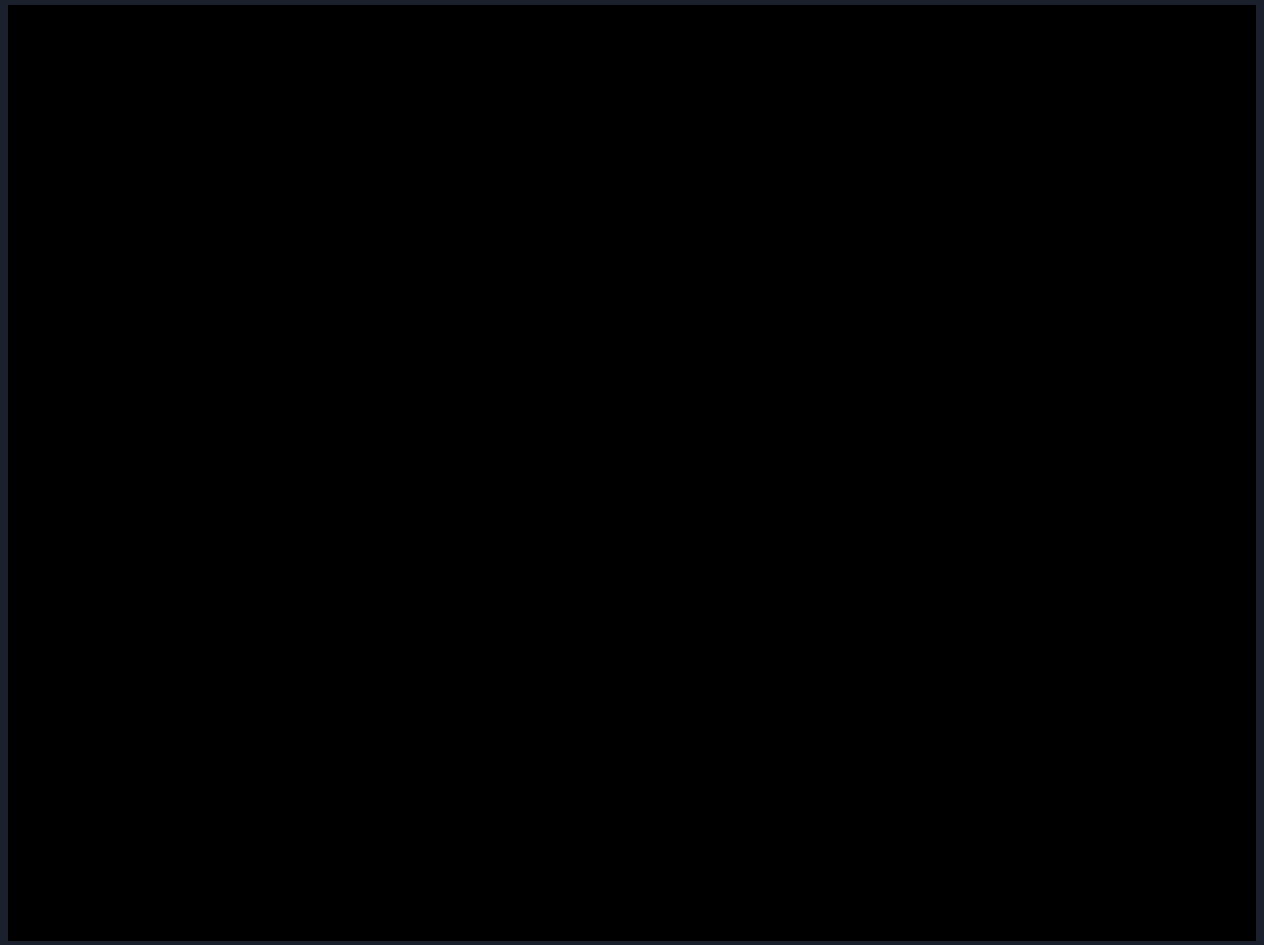
Rotator Emulation System (Design Diagram)

Software Configuration



Hardware Configuration



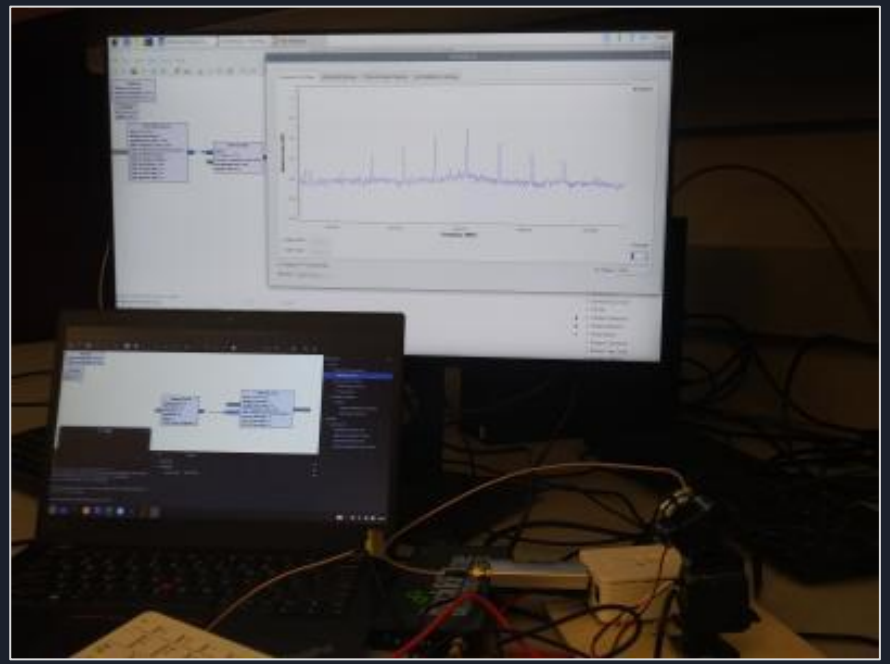


Rotator Operating Individually

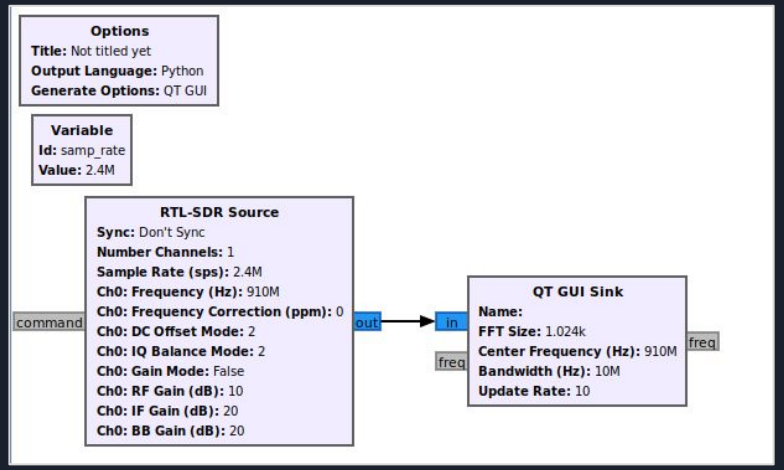
RF Emulation System

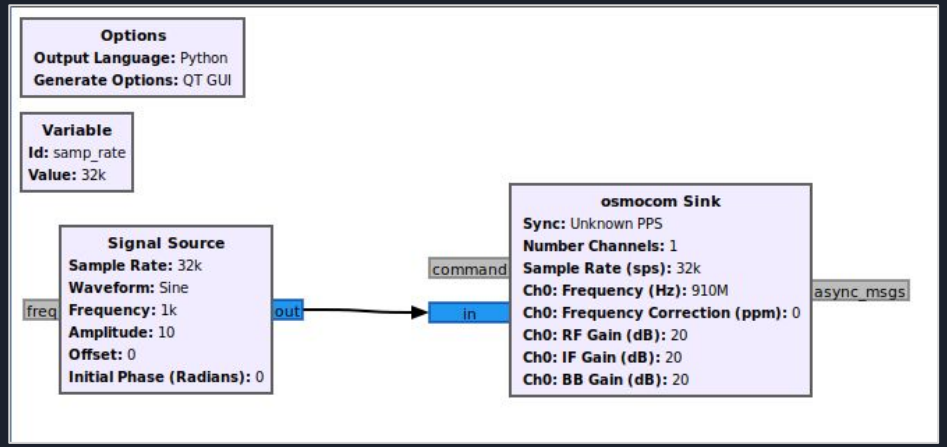
RF Emulation System

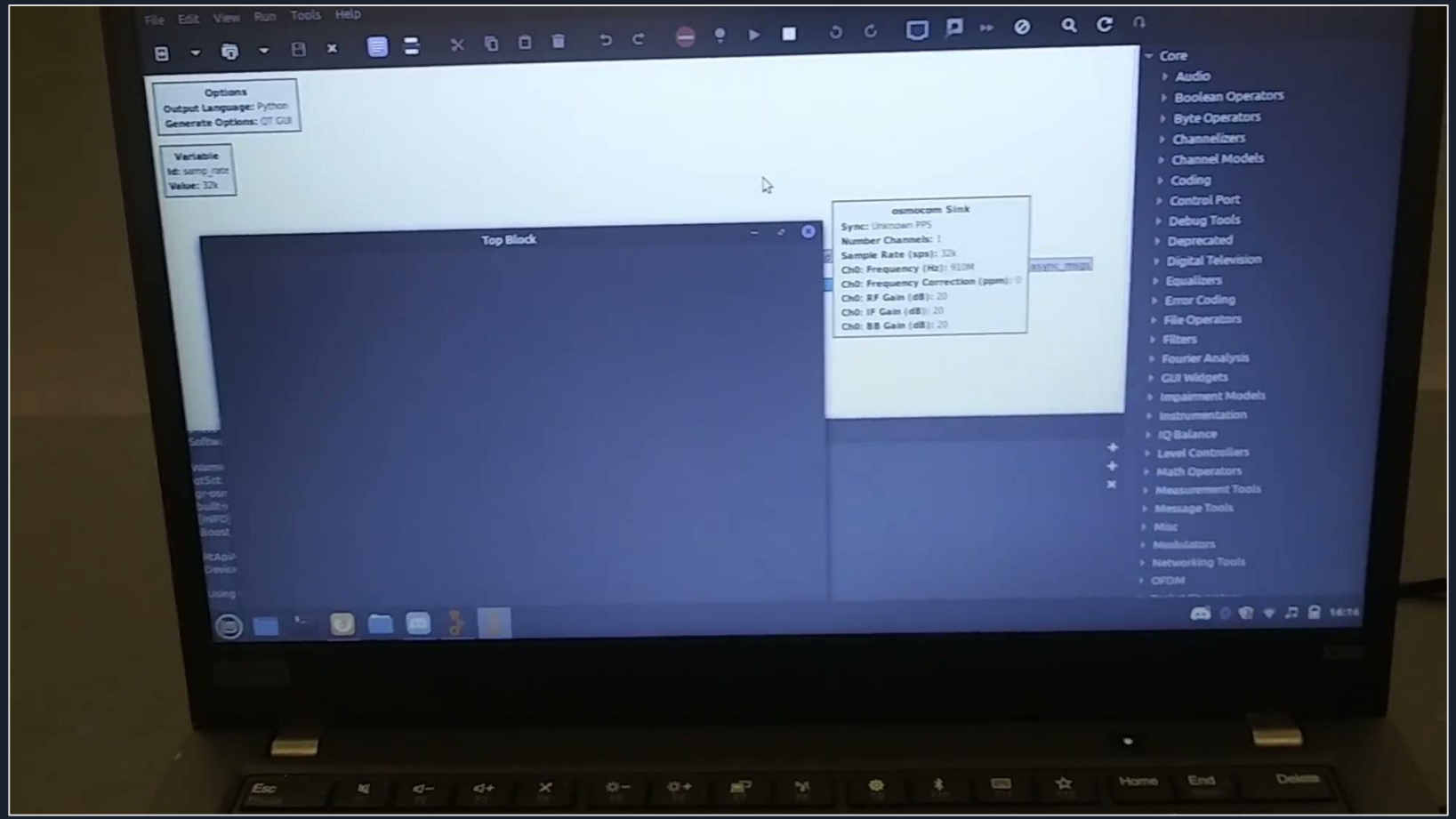
- Emulated celestial object transmits on a sinusoidal 910 MHz signal.
- Ground station emulated radio receives 910 MHz signal
- Displays received signal on a live frequency gain graph.



RF Emulation System

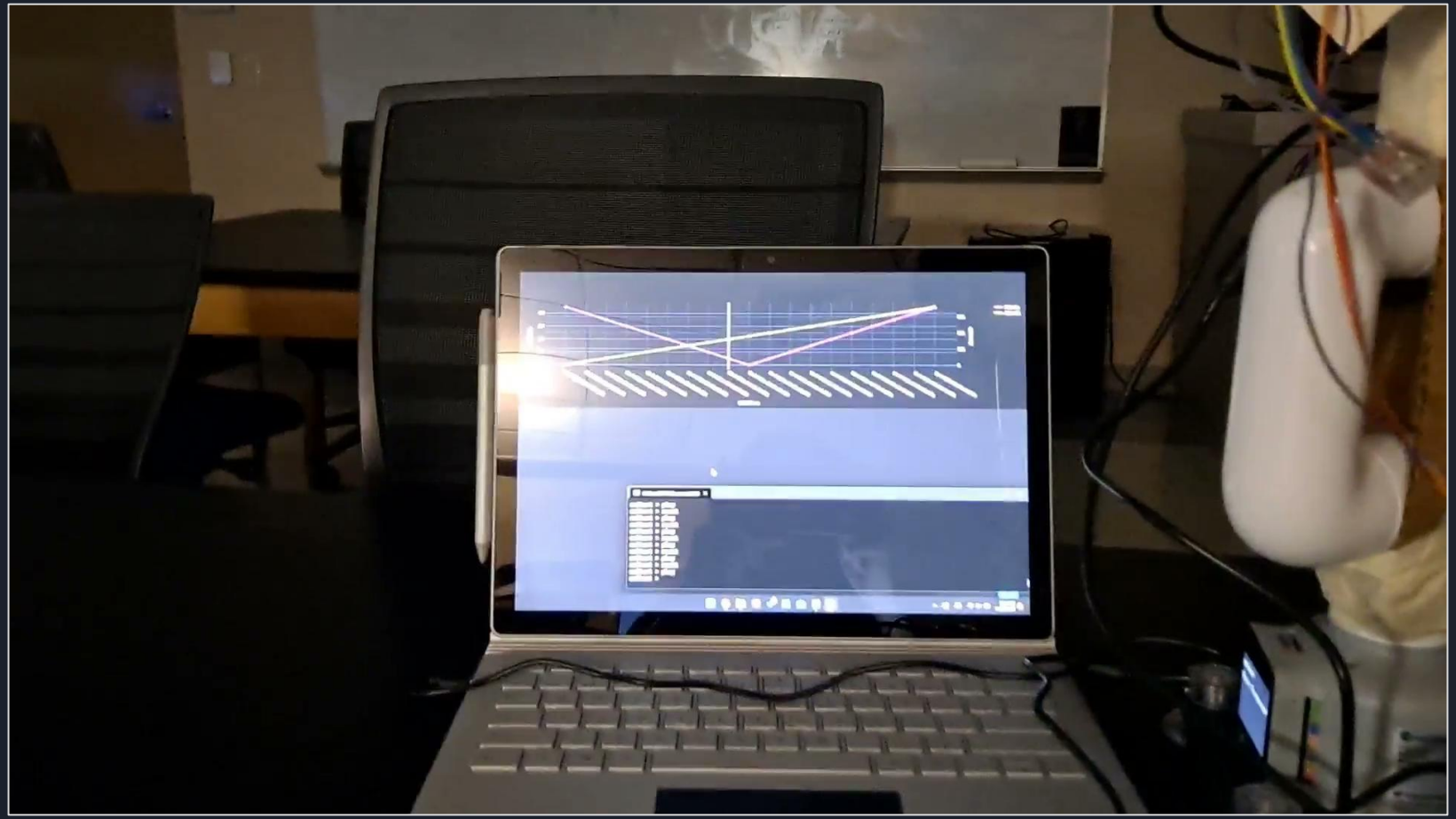






RF System Transmitting and Receiving Signal

Full System Demo



Full System Demo

Future Improvements

- Refinement
  - Packaging
  - User manuals
  - Software usability
- Prepare for use by Middle/High School Students
- Fixing/Replacing myCobot arm.
- Weight Reduction.
- Wire organization.

Lessons Learned

- When working with hardware, plan contingencies.
- Don’t rely on delivery dates.
- Research hardware extensively before purchasing.
- Weight regulation.

References

Arduino. (2015, April 23). *Servo*. Retrieved from Arduino: https://www.arduino.cc/reference/en/libraries/servo/

Gadgets, G. S. (2017, March 11). *SDR with HackRF One, Lesson 1 - Welcome - 720p*. Retrieved from YouTube: https://www.youtube.com/watch?v=zNUCiGVJQo0&ab_channel=PE1PID

Kazuaki, H. (2019, August 27). *Parallax FeedBack 360 Servo Control Library 4 Arduino*. Retrieved from Github: https://github.com/HyodaKazuaki/Parallax-FeedBack-360-Servo-Control-Library-4-Arduino

Massachusetts Institute of Technology. (n.d.). *SRT: The Small Radio Telescope*. Retrieved from MIT Haystack Observatory: https://www.haystack.mit.edu/haystack-public-outreach/srt-the-small-radio-telescope-for-education/

Parallax LLC. (2017, August 12). *Parallax Feedback 360° High-Speed Servo.* Retrieved from Parallax: https://www.pololu.com/file/0J1395/900-00360-Feedback-360-HS-Servo-v1.2.pdf

Shenzhen Elephant Robotics Technology Co., Ltd. (2020, March 18). *myCobot.* Retrieved from Elephant Robotics: https://static.elephantrobotics.com/wp-content/uploads/2021/03/myCobot-User-Mannul-EN-V20210318-1.pdf

The Robotics Back-End. (2021). Retrieved from Raspberry Pi Arduino Serial Communication – Everything You Need To Know: https://roboticsbackend.com/raspberry-pi-arduino-serial-communication

Questions?