Arcadia Student Transformed Remote Observatory (ASTRO): What will it take to revive a campus sky?

Paul Broccardi, Cole Baugh, Ian Sharp

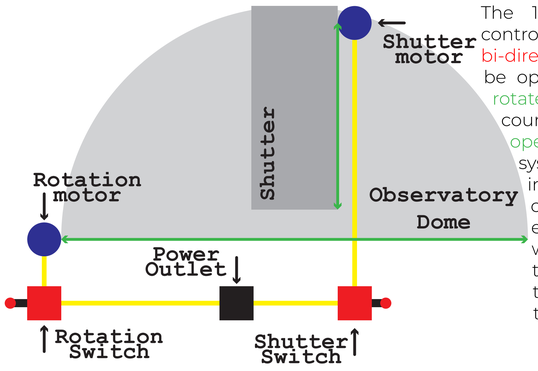
Department of Computer Science and Department of Chemistry and Physics, Arcadia University, Glenside, PA

The Idea: The idea of this project is simple. Arcadia University has an old, underutilized observatory that has a lot of potential. With this project, we want to leave the University with a new and improved, software driven, remote observatory that is user-friendly and extremely capable.

Timeline of Observatory Not to scale*

- Construction Finishes 1987
- Roof closed for safety (observatory inaccessable) 2011
- Covid-19 leads to astronomy club collapse 2020
- Roof reopens 2021
- Project begins Sep 2022
- Planned completion May 2024

The Old System: The original observatory control system built in 1987 was very simple and lacked important features found in modern obvservatory systems like security and remote controllability.

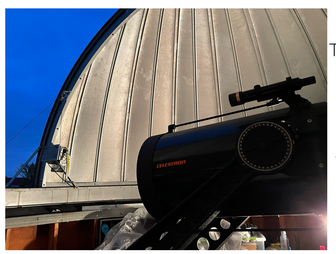


The 1987 system: The dome is controlled by two powered, bi-directional switches that have to be operated manually. One switch rotates the dome clockwise or counterclockwise. The other switch opens or closes the shutter. In this system, there is no way to interact with the telescope, control the dome remotely, ensure the shutter is aligned with the telescope, focus the telescope, take images through the telescope, or point the telescope.

Primary Project Goal: Rebuild observatory control system from the ground up, allowing for full remote functionality.

Secondary Project Goals:

- Foster interest in the observatory as an academic tool around campus through events run by the astronomy club, Sky High.
- Write a simple and intuitive user manual on how to operate the new control system.
- Ensure that interest in the observatory and its potential continues for years to come.

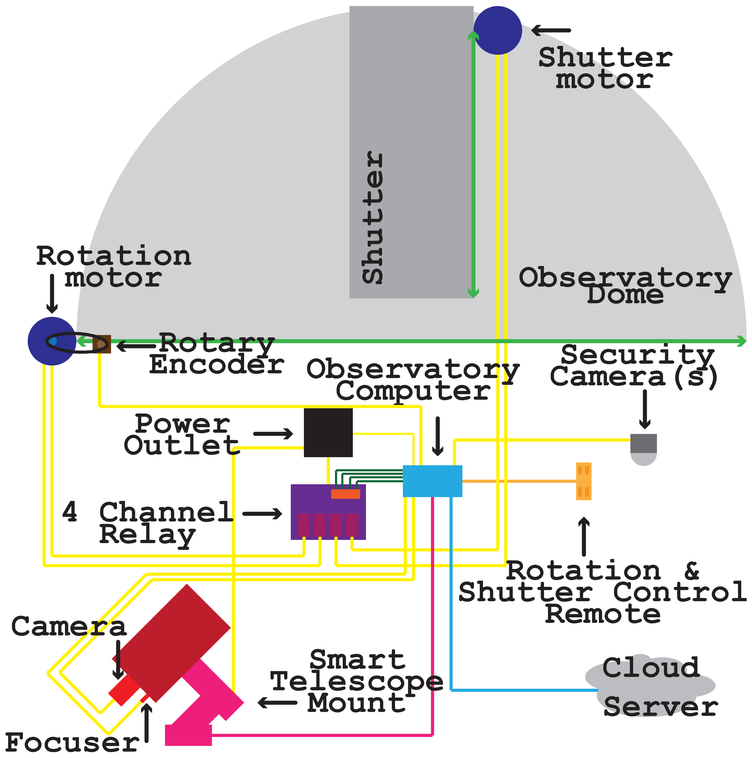


The original Celestron C14 Telescope on its wedge mount (left)

The new Celestron Edge HD 11 Telescope on its CGX-L smart telescope mount (right)

Smart Telescope Mount: Accurately and precisely controlling the telescope is integral for capturing good astronomical data. Our Celestron CGX-L Smart Telescope Mount is an amazing piece of equipment that, through the help of guiding, is able to accurately track objects through the sky within 0.5 arcseconds of error (that's 1/7,200th of a single degree of accuracy!)

The Planned System: The dome is controlled by a computer through software or a remote. The motors are controlled through a 4-channel relay. The main computer can interact with the smart telescope mount, astronomy camera, security cameras, focuser, rotary encoder, and a remote server. In this new system, the observatory can be controlled remotely while maintaining functionality.



Camera & Focuser: Our dedicated astronomy cameras capture photons from astronomical objects and send them to the observatory computer for later processing. We also have a focuser that is able to not only focus the telescope but keep focus throughout a night as temperature fluctuations cause small changes in focus.

ZWO Dedicated Astronomy Camera

ZWO Electronic Automatic Focuser

Observatory Computer: A central computer will be the foundation of the control system and will handle the communication between hardware and software. We plan to use the following software in our final control system:

N.I.N.A: The main observatory software. Interconnects hardware and handles image capture, camera sensor cooling, image previewing, and many other important tasks.

ASTAP: Our plate-solving software. Plate-solving is the process of analyzing star positions in a photo against a database of star positions in order to determine where in the sky the telescope is pointed with great accuracy.

PHD2: Handles automatic guiding in order to keep the telescope tracking accurately. Allows for more consistent andd reliable data capture.

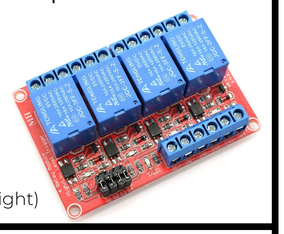
Stellarium: Our main planetarium software that handles target selection and telescope pointing.

Deep Sky Stacker: Used for stacking of captured data. Stacking is a process that combines multiple images to reduce noise and resolve more detail on the target object.

CPWI: Required driver software for controlling Celestron CGX-L Telescope Mount.

4-Channel Relay & Rotary Encoder: Rewriring the motors up to a 4-channel relay will allow us to control the rotation of the dome and the dome shutter remotely. However, how does the telescope mount know the rotation of the dome? Our solution is to install a rotary encoder, a device that can measure rotational data, on the motor that controls the rotation of the dome. This solution will allow us to periodically match the rotation of the dome to the rotation of the object the telescope is pointed at.

Rotary encoder (left)



4-channel relay (right)

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