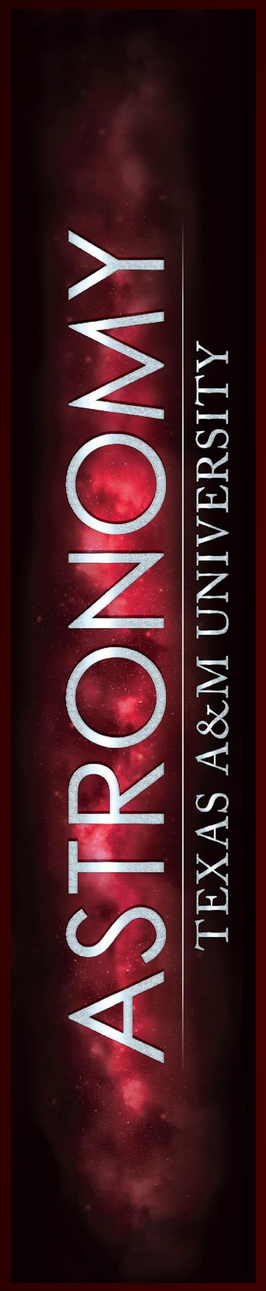
Python and GPIO Integration for Button Control Restoration on the Otto Struve 82” Telescope Control System

Simone N. Sheridan[1], Erika R. Cook[2], John W. Kuehne[3], Jennifer L. Marshall[2], D. L. DePoy[2]

[1]Department of Physics, Prairie View A&M University, Prairie View, TX, 77426 USA; [2]Department of Physics and Astronomy, Texas A&M University, 4242 TAMU, College Station, TX, 77843-4242 USA; [3]McDonald Observatory, Fort Davis, TX 79734, USA



ABSTRACT

At McDonald Observatory the Otto Struve 82” (2.1-m) telescope, underwent control renovations that moved the control of the dome slit and curtains to the Telescope Control Software. This project developed a Python-based control system to restore functionality to the buttons through Raspberry Pi control and communications. This modification improved maintainability while preserving operational logic. The restored system was successfully tested and demonstrated full functional recovery of all six control buttons. The project highlights the practical application of embedded programming, hardware-software integration, and control system design in addressing legacy equipment.

INTRODUCTION

The Otto Struve 82” telescope, located at McDonald Observatory in Texas, is one of the largest telescopes in the world since 1939 and has played a key role in astronomical discoveries. Over time, part of its original control system underwent updates (moving curtain and dome controls to the telescope software). The project focused on restoring function of these buttons using modern technology.

By utilizing a compact, low cost single-board computer called a Raspberry Pi, commonly implemented in embedded systems and prototyping. We programmed the Pi’s GPIO pins to detect button states and transmit HTTP commands to the telescope’s relay system using Python.

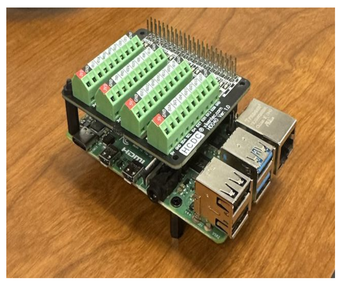


Figure 1. Raspberry Pi

Before connecting the Raspberry Pi to the telescope’s control system, a simple test circuit was built using LEDs, jumper wires, and resistors on a breadboard. This allowed me to safely experiment with the GPIO pins to better understand how they respond to input and output signals.

By lighting up LEDs with different pin configurations, it was easier to visualize the Pi’s control logic in real time. We then used a terminal hat to add a more organized and secure way of connecting each button wire to the assigned pin. A code outline was created for each button to execute different commands in unique and repetitive scenarios. Such as the code constantly rechecking if the button is in a high or low state.

Figure 2. Otto Struve 82” telescope Control System

Figure 3. Otto Struve 82” telescope

DESIGN

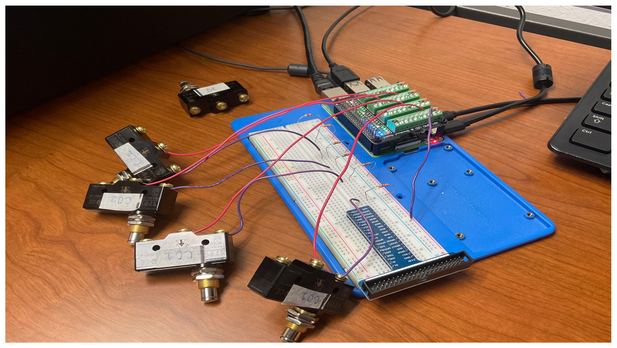


Figure 4. Final prototype

For the final prototype we used button terminals, resistors, and jumper wire to simulate the connection from the buttons in the control system to the Raspberry Pi. This allowed daily testing to ensure the code would not fail if different situations occurred. And for reliability, once reverse buttons are pressed to change the machine’s direction the code immediately has a controlled stoppage time to prevent mechanical damage.

Integration

To manually deploy the Raspberry Pi, wires would connect the buttons on the control system to the assigned GPIO pin. Once the code is being run, pressing a button will send a command to the relays to physically move the Curtain or Dome Slit.

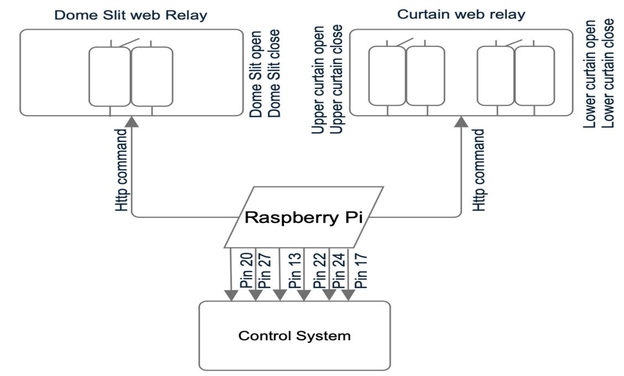


Figure 5. Full Circuit schematic at McDonald Observatory

At McDonald Observatory, the Raspberry Pi was connected to a monitor, used jumper wires to manually set the GPIO pin to a high state. This triggered the control system, and the telescope’s curtain successfully moved. The test confirmed that the code and hardware setup were working as intended.

Figure 6. Testing at McDonald Observatory in the Otto Struve 82” telescope Control Room

CONCLUSION

Potential next steps is to find a device that will see a dead man’s switch. If the Raspberry Pi cannot detect the dead man switch, it will not support all the capabilities we need. To function as intended, the Pi would have to power off automatically when the main console shuts down. However, because the Pi is sensitive to frequent power cycles, it may not be the most durable solution for this application. Additionally, the SD card used in the Raspberry Pi deteriorates over time with repeated reads and writes, making it an inefficient long-term option. As a result, we are exploring alternative devices that offer greater durability.

Follow our progress:
http://instrumentation.tamu.edu

TEXAS A&M UNIVERSITY DEPARTMENT OF PHYSICS AND ASTRONOMY IS AN INSTITUTIONAL MEMBER OF:

MUNNERLYN AIL astronomical instrumentation lab · GMT · HETDEX Hobby-Eberly Telescope Dark Energy Experiment · VERA C. RUBIN OBSERVATORY · DARK ENERGY SURVEY

ACKNOWLEDGMENTS

Texas A&M University thanks Charles R. '62 and Judith G. Munnerlyn, George P. ‘40, and Cynthia Woods Mitchell, and their families for support of astronomical instrumentation activities in the Department of Physics and Astronomy. We thank Dr. Ersen Arseven and the George P. and Cynthia Woods Mitchell family for their generous support of this research.

NSF · NASA · MITCHELL INSTITUTE TEXAS A&M UNIVERSITY