MOTORIZED NEWTONIAN TELESCOPE

Submitted to: Troy Scevers
Submitted by: Nathan Wiley

Version: 1.1

Submitted in partial fulfillment of the requirements of CST374 Embedded Project Proposal, Oregon Institute of Technology.

REVISION HISTORY

Version:	Revision Date:	Revision Description:	Author:
0.0	5/25/2022	Rough Draft	Nathan Wiley
0.1	5/26/2022	Fixed typos	Nathan Wiley
1.0	6/5/2022	Final Proposal Submission	Nathan Wiley
1.1	10/4/2022	Updated info	Nathan Wiley

AGREEMENT

This proposal is approved as a partial fulfillment of the requirements of CST374,

Embedded Project Proposal. Oregon Institute of Technology 2022.

Author Signature: Nathan Wiley ______________________________

Date: 6/5/2022 ______________________________

Professor Signature: ______________________________

Date: ______________________________

ABSTRACT

This project is a motorized 10” Newtonian Telescope that can automatically track coordinates in the sky such as stars or planets. Ideally, it could be operated remotely without any physical interaction with the telescope. Aside from weather concerns, it should be able to be mounted in a permanent spot and utilized without wasting valuable time setting up. If it is needed to be moved, it should be easy to recalibrate it. There are many tracking telescopes out there, but they require an operator to be present in the middle of the night to capture the images. This project would be to create a telescope that can be operated remotely and still have the functionality of one that is operated by a person. This includes things like adjusting focal lengths, camera exposure settings, and possibly even eyepiece swapping.

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PROJECT MANAGEMENT

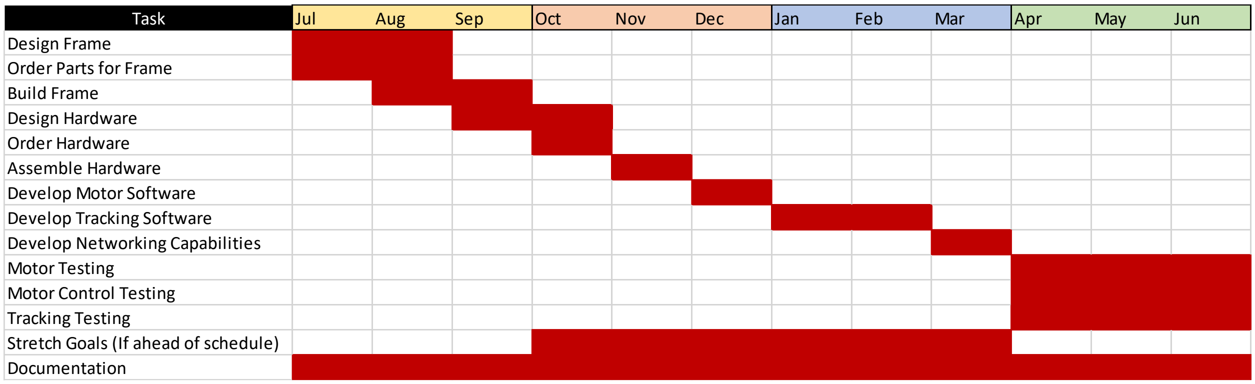

Figure 1, Project Timeline

Due to the extensive nature of the project, I will have to do some prep work over the summer. This project has a longer timeline because of that, and some phases in the design may move earlier to accommodate. From July to September, I will be working on the frame and mount for the telescope. I will have to do some design decisions during this time, so I will be documenting and researching during this time as well. From October to December, I will design the hardware assembly for the device and hopefully start programming. January to March will be the software development portion, and the rest will be testing. If at any time, the project is ahead of schedule, I plan on considering some of the stretch goals for implementation. Some of them will be easier to develop than others, so I will do a decision matrix and consult others for their opinion.

NON-RECURRING ENGINEERING COST ESTIMATE

ITEM	DESCRIPTION	COST
ENGINEER	25 hrs. /week * 40 weeks = 1300 hrs. @ $25 / hr.	$25,000
RAW MATERIALS	Printing Spools, Wood, Bearings	$200
PART COST	Motors, Electronics, Hardware	$1,200
TOTAL:		$26,400

ISSUES:

The main issues that I can see are:

- Frame not being finished in time
- Issues getting microprocessor to work with the motors
- Issues getting coordinates and database to work properly

I plan on reaching out to professors and classmates for their advice on these problems and any others I encounter. I think it would help me solve the issues faster than doing it all on my own.

PROPOSED RESOLUTIONS:

I think since the frame is not part of the senior project directly, I can build it over the summer. This will allow me to work on the motorization, board production, and programming in the fall and winter. That leaves the coordinates and database, which I will need to choose carefully, because there are many different places I can get those. Once I do more research in that area, I will need to choose the one that is easiest to integrate and understand.

CONCEPTUAL OVERVIEW

The basic idea of this project is to create a Newtonian telescope that will adjust what it points at with an embedded device. It is likely that stepper motors with a gearing that is TBD, would control these motions. The motorization would be calibrated to coordinate system, and commands could be sent to the device over a network that would allow the telescope to point to, and track, a given coordinate.

DESIGN CONSIDERATIONS

There are two ways of mounting the Newtonian telescope, the Altitude-Azimuth (or Alt-Az) mount, and the Equatorial Mount. The main benefit of the Equatorial mount is that as the Earth spins, the image experiences no rotation over time. This is useful for long exposures for deep space photography. An Alt-Az does experience image rotation over time, which can be corrected with a motorized device that counter-rotates the camera, or with a wedge that is set to make the telescope parallel with the equator. In Klamath Falls, we are at about 42° Latitude, so the wedge would have to be 48°. I think this is a bit unrealistic with how large the telescope will be. The rotational problem can also be corrected with software, which I think could be a feasible solution. The figure below shows what an image would look like from an Alt-Az mounted telescope in red, and an Equatorial mounted telescope in yellow. As you can see, as Orion appears to move across the sky, the Equatorial mounted image is aligned with the constellation throughout, but the Alt-Az mounted image's alignment is fixed with the ground, so the image appears to rotate as time goes on (McNish, 2007).

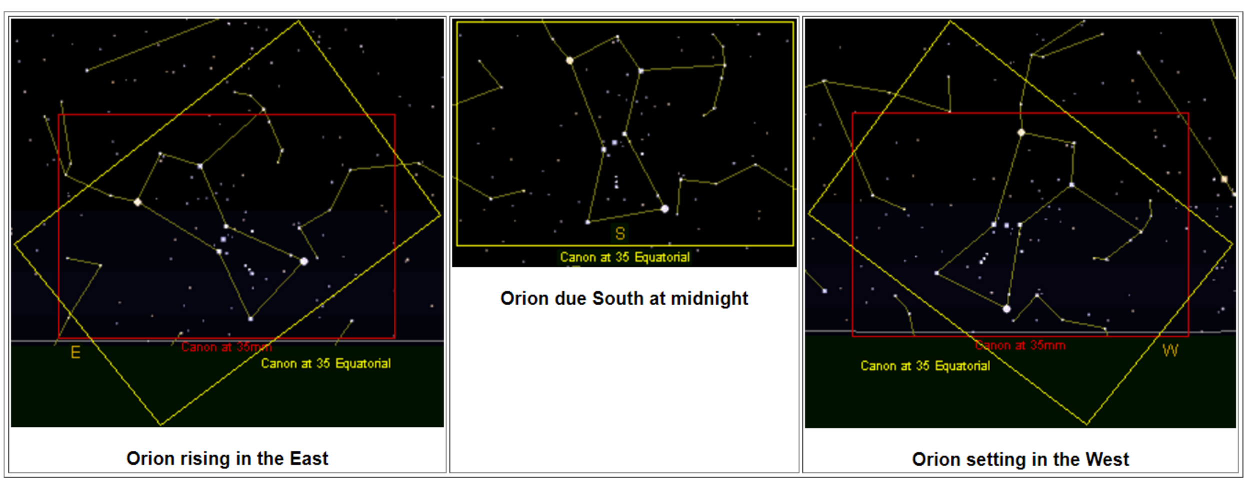

Figure 2, McNish, 2007

SYSTEM DESCRIPTION

Since much of this project is still under design considerations such as the mounting type and hardware to be used, I can't get into the specifics of how each part will function. The general overview is that a networked computer should be able to send commands to the device controlling the telescope, such as coordinates to track, and it will point the telescope at those coordinates and track them through the sky over time. In Figure 3 to the right, the dark grey blocks represent the components of stretch goals, and the light blocks represent the required parts.

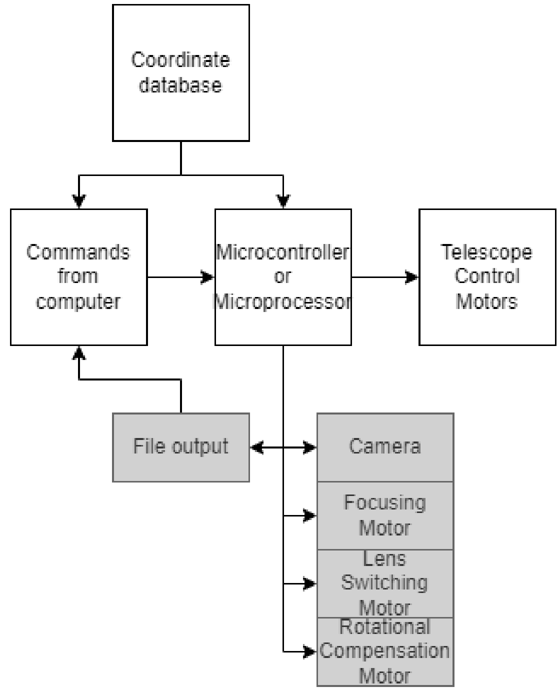

Figure 3

REQUIREMENTS

The current requirement list for the project is as follows:

- It must have a Newtonian frame for mirrors
- It must have motorized control of the telescope
- It must have basic network capability
- It must have some form of coordinate input
- It must be able to track coordinates

These items are essential for the project to be considered complete, and I think each is feasible with the timeframe and can easily quantified without getting into specifics such as the type of mount it will use or camera use. The frame is not an embedded system, but it is the foundation of the entire project, so the telescope shall have a Newtonian design. The telescope shall be controlled with motors, it is the base functionality required for the rest of the project. The network capabilities shall be to the extent of issuing commands over a network to the device controlling the telescope and having it respond. The device shall be able to have coordinated input into it. And the device shall track those coordinates using the motors.

STRETCH GOALS

The ideal version of the project would have many features allowing remote operation. This may include:

- Lens Switching
- Rotational Compensation
- Onboard Camera
- Network File Transfer for Images
- Location Based Calibration
- Control over Internet Connection

Lens switching would allow different objects from planets to galaxies to be captured with appropriate lenses without having to be on site to switch the lens. Rotational Compensation can be approached in a few different ways as described in the conceptual overview section. An onboard camera would allow the telescope to be functionally used for recording observations which would be very desirable for a telescope of this size. Networked file transfer for images would be fantastic if paired with the camera because you wouldn’t need to go on site to access the images the telescope takes. With location-based calibration, the device would be able to be placed anywhere in the world and it would still function normally. Control over internet connection I would define as being able to completely use the telescope over the internet. This includes remote operation of the lens switching, rotational compensation and camera use.

GLOSSARY

Alt-Azimuth Mount

Any telescope mount that rotates on a horizontal and vertical axis.

Newtonian Telescope

A telescope using a primary reflective mirror, and a secondary mirror to direct light to an eyepiece.

Dobsonian Telescope

A Newtonian telescope mounted on an Alt-Azimuth base.

Equatorial Mount

A telescope mount that compensates for Earth's rotation by setting the horizontal axis parallel to the Equator.

APPENDIX

REFERENCES

McNish, L. (2007, November 20). *RASC Calgary Centre - Field Rotation*. Calgary.rasc.ca.

https://calgary.rasc.ca/field_rotation.htm#whatis