A Unique Approach to Telescope Control

Brandt M. Westing
The University of Texas at Austin, Electrical Engineering Dept., Austin, TX 78705
westing@ece.utexas.edu

Abstract

A new Graphical User Interface (GUI) has been proposed to replace the current Telescope Control System (TCS) interface at the Hobby-Eberly Telescope (HET). The proposal centers on a purely graphical interface to supplant the current interface for use in controlling the telescope and related equipment, as well as providing a display for several sources of crucial data for the telescope operator. In this endeavor, I analyze the possibilities of a graphical interface. The observations of the telescope operator are described to elucidate some of the decisions made about the interface, as are some of the considerations that must be made when developing a new interface for a complicated telescope control scheme. I also discuss the decisions on the integration of other control GUI's into the control system interface.

Introduction

The Hobby-Eberly Telescope (HET) is unique in that unlike a classical equatorial or Alt-Azimuth telescope, it has a fixed elevation/zenith angle and moves only in azimuth. (Fig. 1) The Alt-Fixed Azimuth paradigm requires a moving instrument platform to allow tracking and precision pointing ability. The prime focus moving instrument platform, known as the "tracker" moves with six degrees of freedom and contains a spherical aberration corrector, the Low Resolution Spectrograph (LRS) unit, guide cameras, as well as feeds for the other instruments. The HET requires more than just the RA/DEC movements of classical telescopes to acquire a target.

This design was developed to accommodate a low cost telescope suited for spectroscopy, although is capable of surveys, namely the future HET Dark Energy Experiment (HETDEX). The telescope is also unique in that it is a multi-mirror primary design. Ninety-one hexagonal mirrors make up the 10 by 11 meter primary to overcome some of the problems inherent in large mirror design, albeit at a computing and control cost.

The HET is located on Mt. Fowlkes at the McDonald Observatory and is operated by the University of Texas at Austin and paid for by five institutions: The University of Texas at Austin, Pennsylvania State University, Ludwig-Maxmilians Universitat Munchen, Georg-August-Universitat Gottingen, and Stanford University. The telescope uses three instruments, a low, medium, and high resolution spectrograph to allow for diverse science operations. The medium and high resolution spectrographs are locating below the telescope in the basement of the dome and are fed by fiber.

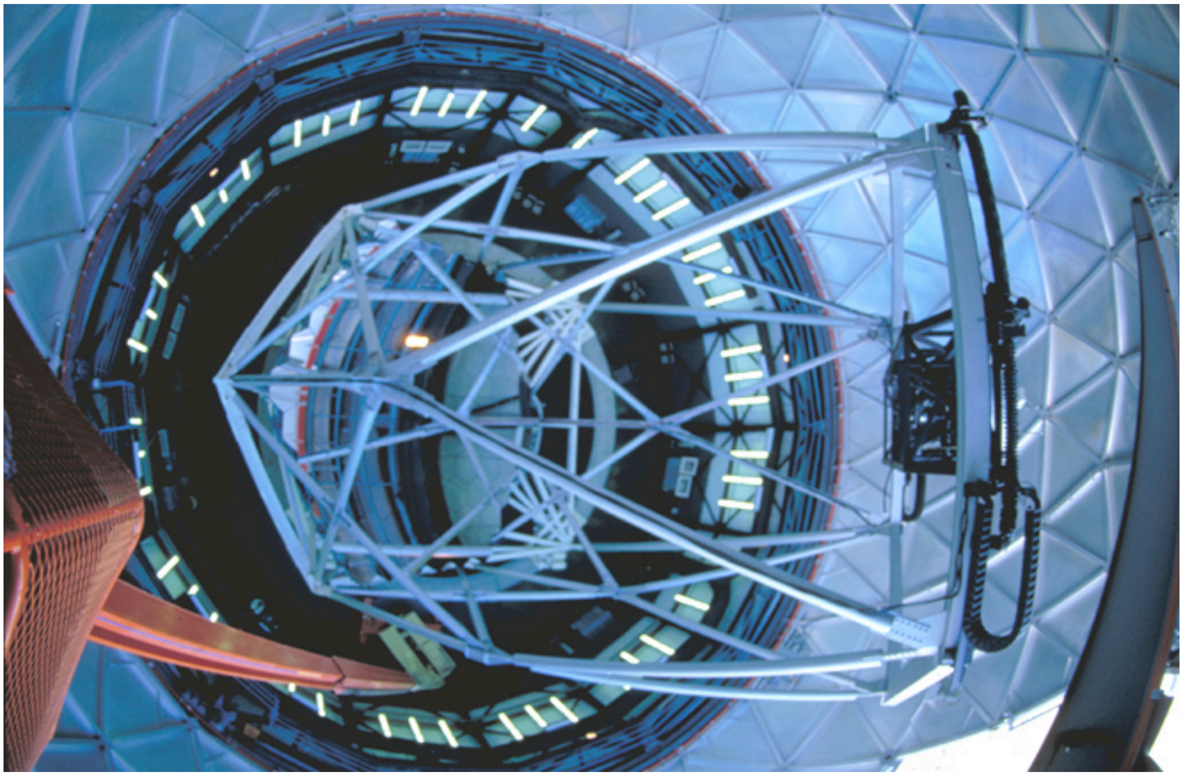


Figure 1. HET Structure and Tracker

Considerations for a New Observatory Control Scheme

The HET is generally operated by two staff members at night: a telescope operator and a resident astronomer. During the day there is a full time engineering staff on duty. The telescope operator is responsible for several tasks in the observatory environment at night, but primarily safety and telescope operation. The definition of telescope operation is one we are primarily concerned with in designing a new control interface. There are several questions that must be asked to accurately provide the correct data and control methods for the operator's use.

To provide an answer to this question, or to complete this definition, it is necessary to observe the operator on a nightly basis for an extended amount of time. In this case, the various operators were observed for a period of about six to seven weeks. The actions of the telescope operator on both a casual control basis and on a troubleshooting control basis are of concern. When the actions and the informational needs of the telescope operator are documented, an interface can then be designed around those requirements.

Another consideration for a control interface is not only determining the data and information requirements of the telescope operator, but determining the regularity of use of said data. It is detrimental to include irrelevant information in the interface as it is impractical. The telescope operator should not have to sift through data to make a decision, especially when such decisions are made regularly. If irrelevant information is reduced and relevant information is easy to discern then less mistakes are made by the operator, who is spending less time operating the telescope and more time taking data for scientific purposes.

Defining the Project: An Operators Control System

Fundamental decisions about how the project would proceed were made during the time in which the operators were observed. These decisions culminated in the fact that using the general method for programming a GUI would be unfit for this project and redundant. The current control system interface *works* as a control system(Fig. 2), what would be the advantage in creating an interface around the programmer's ideas if the operators needs were not first documented and taken into account? The programmed interface may be no better than the original.

Although a study on the operator use was not made previous to the prototype of the new Telescope Control System (TCS) GUI, programmed by a Research Experience for Undergraduates student from the previous year, considerations were taken into account on behalf of the operators. The groundwork for the new control system had been completed, and a mock-up interface was created. Accordingly, it has been the continuation of the project to document the telescope operator's data requirement needs as well as specify any changes that should be made to the prototype. It is important to also allow engineering use of the telescope via the new TCS. In addition, a new telescope hand paddle system has been specified as well as a few complements to the interface that astronomers and operators have expressed interest in.

.

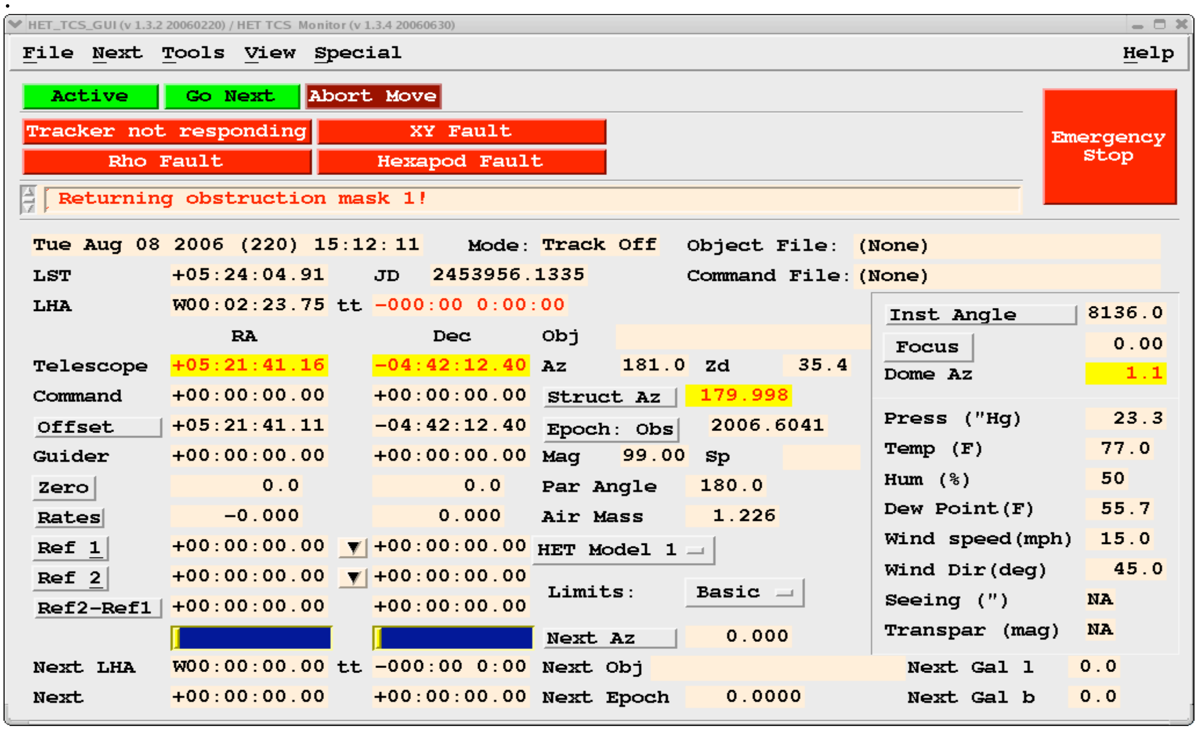


Figure 2. The current control interface.

The New User Interface

Several changes have been made to the prototype interface as well as a couple additional functionality features specified. Specifically, Differential Image Motion Monitor (DIMM) data have been requested in the user interface as well a separate interface for the resident astronomer to monitor some of the information that the telescope operator uses. It is more pertinent, however, to explain the new interface (Fig. 3) as well as mention some of the changes made from the prototype over the course of the summer:

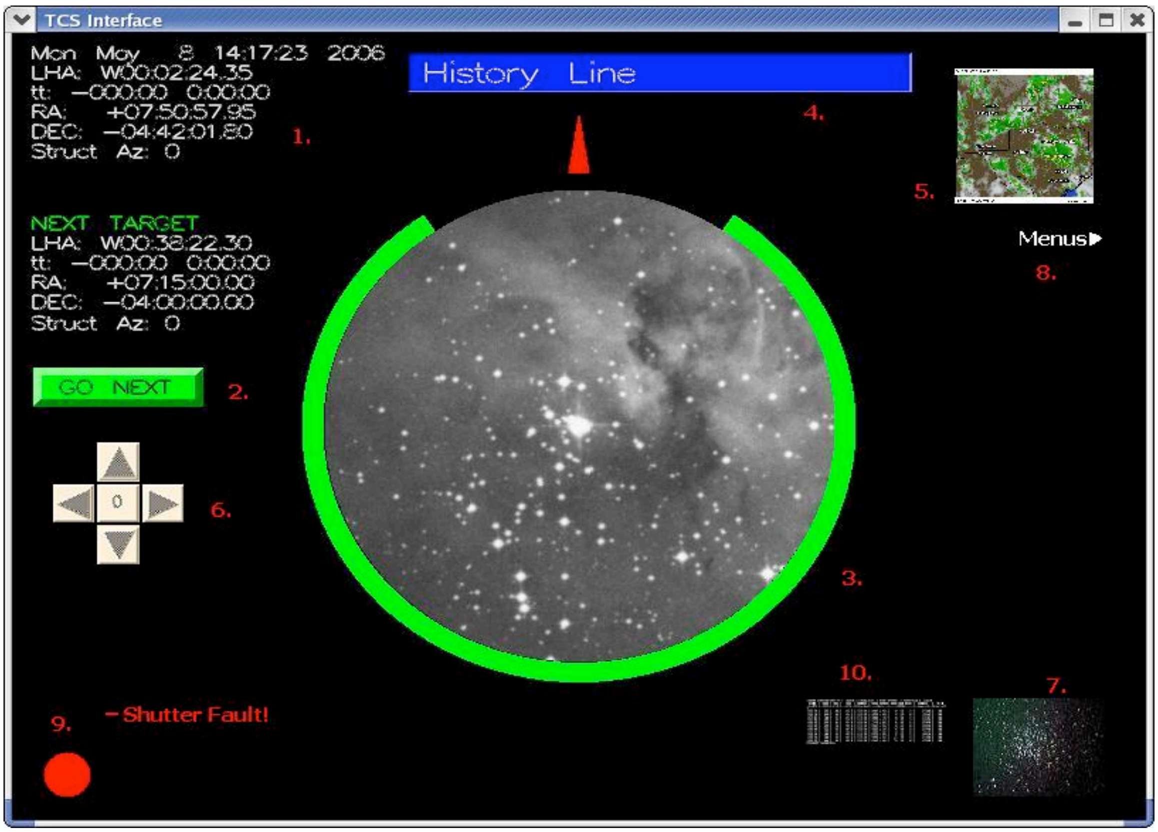


Figure 3. The New TCS Interface

1. *Text Module*

   The text module displays the current time as well as data that is pertinent to the T.O. The content of the text module will contain the track time and the current and next azimuth.

2. *Go Next*

   "Go Next" will initiate a target move. The button will automate the dome to the Next Azimuth position assuming dome automation is enabled. Go Next will take the RA and Dec sent by the astronomer via Htopx protocol and calculate the correct offsets for X, Y, Z, and theta for slew and track.

3. *The Heading Circle*

The heading circle is the center of the telescope status representation. The red pointer will indicate the azimuth of the telescope and dome. Also included within the heading circle is a reference star field from an online sky survey database.

4. *History Module*

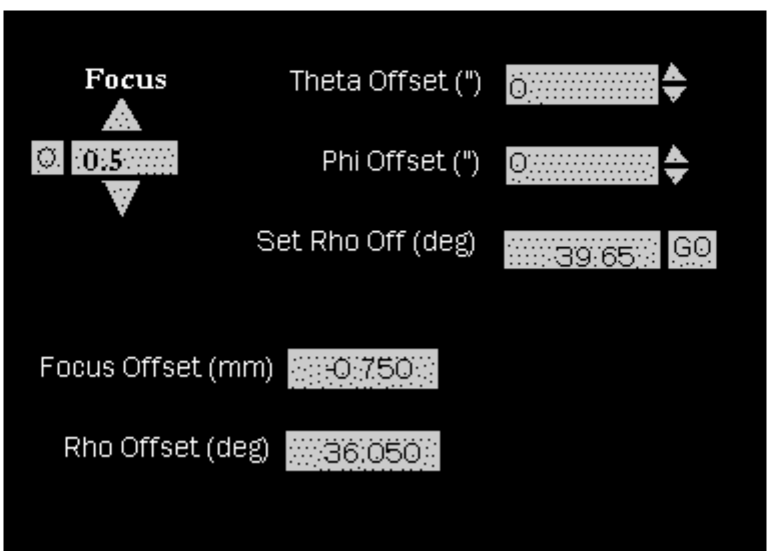
This module will show the latest input from the T.O. to the interface. The history module with respond to a left mouse click by expanding to show the last 5 – 10 entries in the history. The history module will also contain programming to log the input to the interface.

5. *Radar Map*

The Radar Map will show the current weather conditions radar from an online source via expansion after a left mouse click.

6. *Hand Paddle Module*

The new hand paddle module will differ from the previous hand paddle in several ways based off of T.O. input. It has been suggested that two hand paddles should be used, one for night operations and one for engineering operations. An example sketch of the new hand paddle for night operations:



A simple control set as in the hand paddle above will make a less cluttered and simpler interface for night operations while supporting all manual controls. Minimal controls will reduce T.O. fatigue. A second hand paddle, for engineering use, could be similar to the current hand paddle. The hand paddle displayed when clicking the hand paddle icon will depend on the option set in the menu under hand paddle type.

7. <u>*SkyCam*</u>

The SkyCam is currently in development and will display the current sky conditions in a picture format (FITS) updated every 5 minutes. The source of the saved camera image is TBD, however it will likely be a web server. The SkyCam picture will expand to cover the primary window when left clicked.

8. <u>*Menus*</u>

The Menus object will display a drop down menu for several configurable options as well as an optional method to view the modules. The menu will support engineering operations for the telescope

9. <u>*Flag/Warning Module*</u>

This module will display the current warning or flags received by the system. The system will flag or "flash" a warning when either a fault occurs or an action of relevance to telescope safety or operation occurs. A text message will be displayed. Examples of such events are: rain detected, humidity warnings, wind warnings, and operation faults. This will warn the TO of any faults or problems with the system, and is meant to keep the TO from constantly needing to monitor data.

10. <u>*Weather Data Module*</u>

This module will expand to cover the primary interface when left clicked and will display Mt. Fowlkes local weather available from the dome computer. This is optional, the dome weather status is generally visible via the TV monitor during night operations.

While some of the interface details had been determined previous to operator observations and documentation, a large majority had not. The viability of the following have been determined over the summer and included into the interface plans: Skycam functionality, a hand paddle module, menu functionality, warning and flag module, as well as the weather data module.

Another functionality of the interface that has been determined is a "dome and structure follow telescope" automation. Currently, the operator must specify a dome azimuth and structure azimuth separately upon receiving the next target via the resident astronomer. It would be prudent as well as obvious to integrate a dome and structure automation scheme in the new TCS. This, again, would allow more time for science by decreasing operation time.

Summary

A new GUI for telescope control at the Hobby-Eberly Telescope has been defined and the specific interface details have been determined according to the relevancy of the control information to the telescope operator. The requirements of the operator were determined by a six week period of observation of the telescope operator both in troubleshooting situations as well as in casual control situations. The observed requirements of the operator were used to further define and develop the new Telescope Control System interface.

Acknowledgements

Special thanks to the National Science Foundation for support in the McDonald Observatory REU program. I would like to than Dr. Matthew Shetrone for acquiring the NSF grant and showing us how great a REU summer can be. I am thankful for Dr. Jim Fowler for his guidance and insight into how much more there is to programming than just the code; Of course, the code is very important as well! I would especially like to thank the entire McDonald Observatory staff for showing myself and others how attractive a field astronomy really can be, and that it is not just contained in a textbook or a classroom.