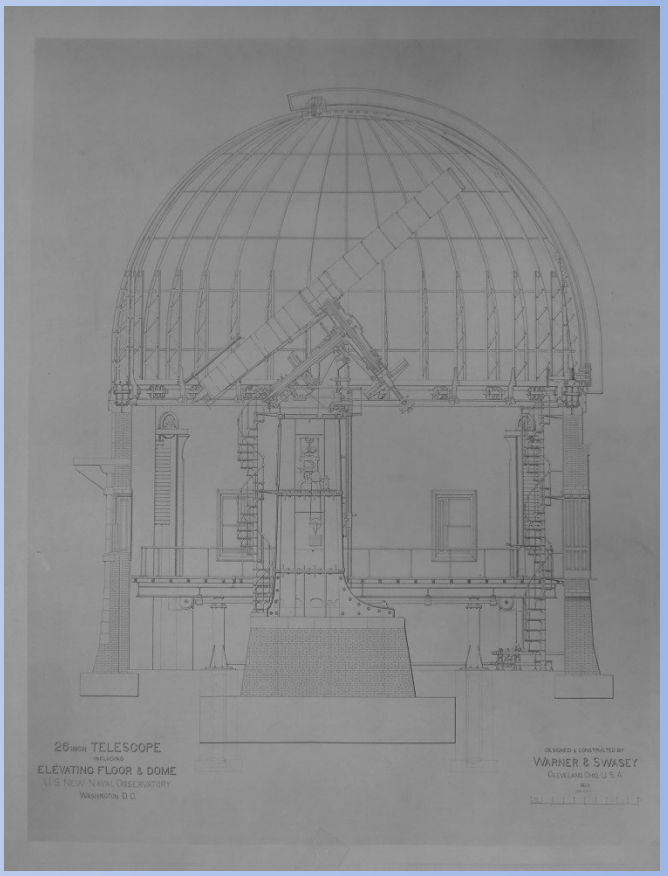
U.S. Naval Observatory

26-inch Refractor Automation

Introduction

- The 26-inch refractor was built for the U.S. Naval Observatory, located at the old Foggy Bottom site, by Alan Clark & Sons in 1873. When the observatory moved to its current location in 1893, except for the Clark objective, nearly the entire telescope was replaced. Warner and Swasey built a new telescope tube, mount, pier, elevator floor, and dome. Though the telescope has been upgraded a number of times since 1893, most of the telescope built by Warner and Swasey remains unchanged. The upgrades have mostly focused on the motions of the telescope, floor, dome shutter, and the dome. In 1893, the motions of the telescope were controlled by ropes, handwheels, and weight-driven drives. Throughout the years, these motions have been motorized. One of the major upgrades of the telescope occurred in the early 1960's, lead by A.H. Mikesell (1968). This work included adding a synchro system to display the pointing of the telescope, a new right ascension clamp, a new tailpiece for the telescope tube, a new diaphragm and grating system in front of the objective, new console, and new motors, wiring, and electronics. The 2003/2004 upgrade, lead by T.J. Rafferty, involved replacing the right ascension clamp, console, most of the motors, and all the wiring and electronics.
- *From T.J. Rafferty document 2004



Basic Operations

prior to current efforts

The 26-inch refractor uses the basic German equatorial mount that most of the classic refractors used. Fast or slew motions of the right ascension and declination axes are made using DC motors. The right ascension axis is turned at the sidereal rate when it is clamped to a 60-inch diameter worm gear. When the right ascension clamp is clamped, a magnetic clutch is deactivated, which removes the drag of the slew motor and it's gearing on the axis. The 60-inch diameter worm gear is turned by a synchronous motor operated at 60.3 Hz to have it rotate the right ascension axis at the sidereal rate. Right ascension slow motion adjustments are made by a motor and universal gearing mounted on the drive shaft to the worm gear. Declination slow motion adjustments are made by a motorized tangent arm connected to the declination clamp. As in the case of the right ascension, when the declination clamp is clamped, a magnetic clutch is deactivated, which removes the drag of the slew motor and it's gearing on the axis.

The pointing of the telescope is displayed by two setting dials on the console. A synchro system is used to determine the telescope pointing. Two transmitting synchros are geared to each axis. For declination, one transmitting sychro measure the axis rotation in degrees and another in arc minutes. These transmitting sychros are connected to two receiving sychros mounted to the declination setting dial on the console, with one turning the degree hand of the dial and the other turning the arc minute hand. For right ascension, one transmitting sychro measures the axis rotation in hours and the other in minutes. These transmitting sychros are connected to two differential sychros mounted to the sidereal clock on the console, with one connected to the hour hand of the clock and the other to the minute hand. The two differential syschros are then connected to receiving sychros mounted to the right ascension setting dial on the console, with one turning the hour hand of the dial and the other turning the minute hand. By inputting both the rotation position of the right ascension axis and the sidereal time, the setting dial can display the right ascension pointing of the telescope.
*from T.J. Rafferty document 2004

Current Efforts

- Basic plan follows URAT automation with the exception that original hard wired circuit logic was retained.
  - Existing solid state and mechanical relays provide control and safety interlocks.
- Galil PLC (industrial COTS programmable logic controller) used to interface existing telescope control electronics to computer.
  - Existing hardware (including motors, motor controllers, clutches and control electronics racks) from 2004 upgrade was retained.
- US Digital absolute encoders and inclinometers were integrated with existing sychro system.
  - RA and Dec movements are encoded utilizing a pair of volatile HD-25 absolute multi-turn encoders.
  - A non-volatile X3M absolute inclinometer used as part of a redundant backup system in case of power loss.
  - All encoder and inclinometer outs are feed directly to control computer.
  - A set of Indicator switches are used for zeroing the encoders prior to observing.
- Mercury horizon switches and pier avoidance switches backup software travel safety zones.

Computer control system

- Single control computer using Linux operating system.
- Control computer located in observers office with remote monitor and keyboard located in dome.
- Automation control software provided by contract with Greg Bredthauer.
  - The same contractor and scheme used with URAT and the future .7 meter
- Fiber optic and CAT-5E extenders were used for remote data connections from the telescope to the control room

Summary / Issues

- The development of the speckle observing system is planned in a phased approached.
- Pointing accuracy is limited due to unknown mechanical limitations of the telescope.
- Degree of astronomer interface necessary will be changing as software and hardware testing continue.