The Improvements on TUG - T60 Robotic Telescope

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Abstract - A robotic telescope is a telescope that can make observations without hands - on human control. Its low level behaviour is automatic and computer – controlled. Robotic telescopes usually run under the control of a scheduler, which provides high – level control by selecting astronomical targets for observation. TÜBİTAK (Scientific and Technological Research Council of Turkey) National Observatory (TUG) - T60 Robotic Telescope is controlled by open-source OCAAS software, formally named TALON. This study introduces the improvements on TALON software, new electronic and mechanic designs. Those improvements were tested on the simulation environments (driver – motion control card and the running TALON computer). The designs and software improvements were implemented in the T60 telescope control software and tested on the real system successfully.

Keywords: Astronomy, Robotic Telescope, TALON Software, UNIX.

1. Introduction

The design concept of the robotic telescope system has been developed and implemented over the last two decades. One of the earliest microcomputers based telescope control system was introduced by the Indiana University group (Honeycutt et al. 1978), followed by many investigators (e.g. Genet 1986). The advantage of the computer-based robotic telescope system was discussed elsewhere (Genet et al. 1989) for low operating costs with high operating efficiency and high scientific productivity. Some demonstrations of scientific usage of the robotic telescope were described by Hall (1995), and more recently by Kaye et al. (1999). The robotic control design concept was developed further by applying internet access, and an example was introduced by Drummond et al. (1995).

TUG - T60 Robotic Telescope is controlled by open – source OCAAS software, formally named TALON .This study introduces the improvements on TALON software, new electronic and mechanic designs. Those improvements were tested on the simulation environments (driver – motion control card and the running TALON computer). New design and software implementation including mirror cover have been integrated to autonomous structure of the T60 perfectly. Thus, the external effects such as dust, heavy particles (which can fall down from dome directly to the surface of the mirror; oil, metallic particles etc.) will be avoided successfully. The all improvements that have been made in T60 robotic telescope make it more stable for robotic mode and encourage for the new challenges and projects at the future.

2. T60 Software and Hardware Architecture

T60 is controlled by TALON formerly called OCAAS software based on open source GNU/C UNIX platform. The telescope can be operated on robotic mode and the observations are made as object – oriented. The corresponding technical specifications are on the table 1. T60 robotic telescope is able to

survey the dynamic catalogs such as edb; response for the gamma ray burst alerts and makes long - time observation projects.

Table 1. T60 technical specifications

Model	OMI RC06
Optical Class	Ritchey-Chrétien
Aperture	600 mm
Focal Length	6000 mm
Focal Ratio	f/10
Resolving Capacity	0.19''
Image Scale	34''/mm
Filter Wheel	12
Dome	ASH-DOME, "R" model 14'6'' 100 sec/rev

2. 1. Software Architecture

T60, telescope control software, TALON provides the users to control the telescope both manual mode (by GUI) and robotic mode (batch mode). The users are able to prepare the observations by using the TALON tools such as mksch, telsched.

The software architecture based on the daemons which are able to execute all the processes simultaneously. TALON has two main daemons, telrun and telescoped. The telrun daemon is responsible for operating the schedule on robotic mode by sending appropriate command to telescope daemon (telecoped). The telecoped is responsible for the control of the dome, focus, filter wheel and the telescope axes by sending the low – level commands to the motion controllers (Fig. 1). The specific motion controller type is designed to control telescope by CSI (Clear Sky Instute) company. Therefore, it has specialized built functions for the telescope control. The motion controller cards could be programmed by using those functions, so that feature gives the developers hardware independent design to improve the telescope control.
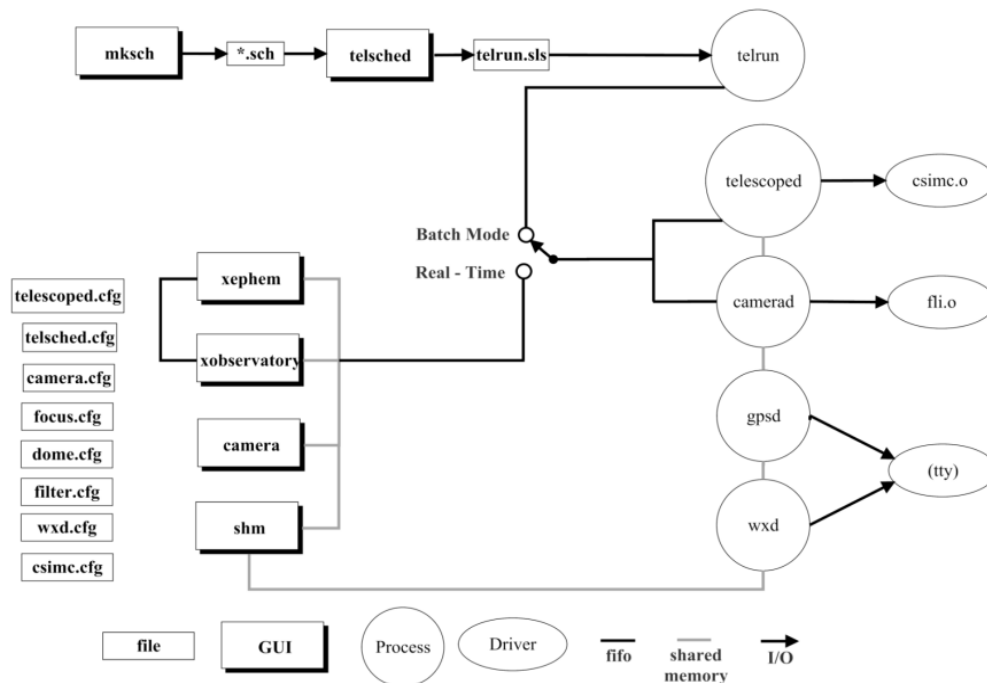

Fig. 1. T60 software architecture.

2. 2. Hardware Architecture

The servo motors are used in order to control the axes RA , Dec, focus and filter. The single phase AC motor is used in order to control the dome. All motors are controlled in "*Closed – Loop*" by using the motor drivers and the motion controller cards.

Every motion controller card is independent and programmed for the distinct processes (Fig. 2). By the taking advantage of the programmability of the motion control cards, the new designs could be easily adopted the telescoped control system. Therefore, the hardware architecture is open for the developments.
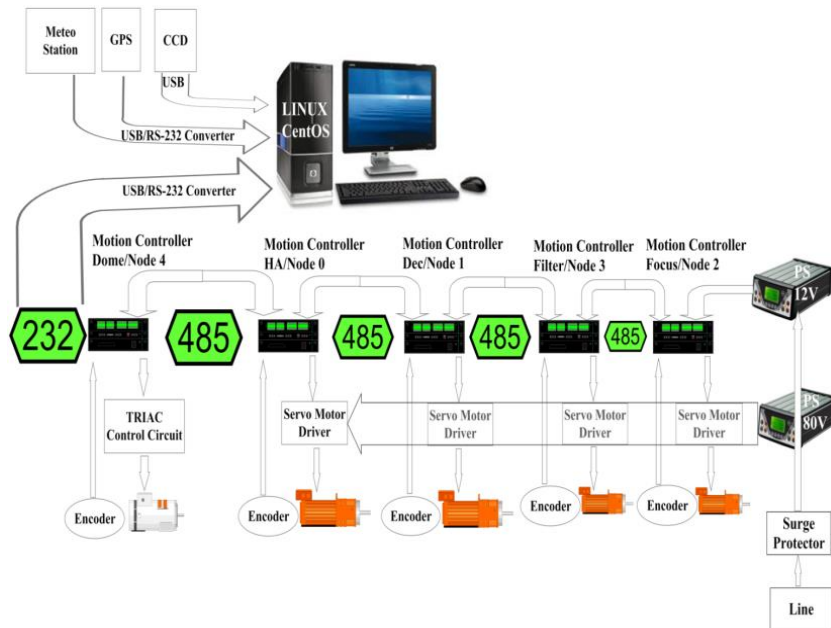

Fig. 2. T60 hardware architecture.

3. T60 Software and Hardware Developments

The TALON software handles all the control for the components of the telescope such as filter, focus, RA/Dec axes (Fig. 3). TALON controls the position of the components of the telescope according to schedule file in the robotic mode. The astronomical calculations are made in TALON and the raw encoders for the axes are sent the control cards. The position of the focus of the secondary mirror could be calibrated up to inside temperature of the dome.

The schedule file could be prepared by using the *mksched* individually by the observers and the telescope operator merges the individual schedules by using the *telsched* tool within TALON. Therefore, the new design and improvements should be adapted to robotic structure of the telescope. In the robotic mode telescope can go to the defined coordinates and tracks on the object during the defined duration in the schedule.

The some developments could be summarized as followings. The first design of the T60 dome was controlled in open – loop and mostly controlled manually. The opening and closing processes have been done time dependently. Therefore, the dome sometimes got stuck and observations failed. While searching the solution, the bug which TALON software tried to open the shutter in one time was detected, so if it fails to open the dome before observation starts, all observation night will be lost. In order to solve the problems, the close – loop control has been improved by designing a new electronic card and low – level software for the feedback.

The low level software for the CSI motion control card is simply check the feedback from the limit switches of the dome – shutter, then the success result is returned to the TALON user computer, if it fails to open the dome – shutter; it tries again and again until it opens the dome, successfully.

The mechanic, electronic and software components of mirror cover were designed by TUG engineers (Fig. 4). Node 0 for the control of RA axis is used to control the mirror cover as well. Therefore, the new control program was written for the CSI motion control card.
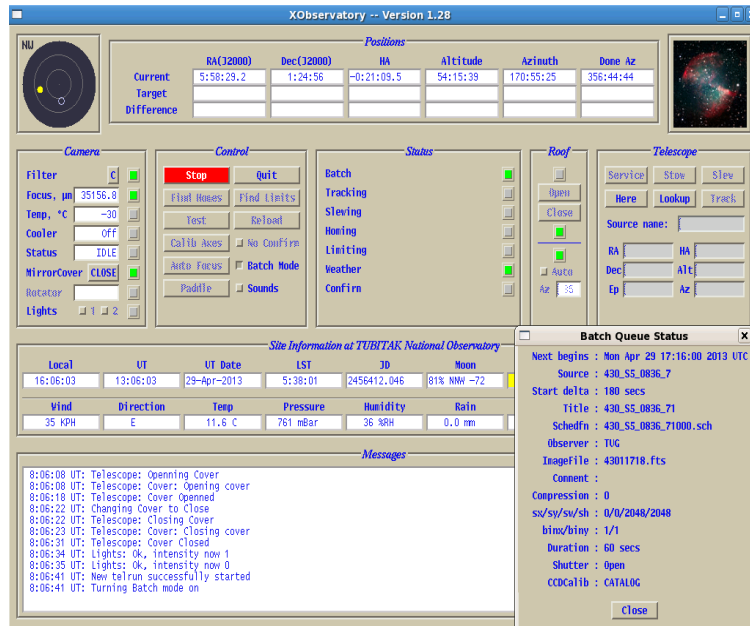

Fig. 3. Improvements on TALON GUI.

For the new design, the new drop – down list is implemented to the TALON GUI in order to control the telescope in manually. The main challenge was to make it work in robotic. In order to achieve that, the new algorithm is implemented to adopt the mirror cover in existing system by taking into account the extreme situation such as the weather alert. When the weather alert happens, the closing sequence should be mirror cover and dome – shutter respectively. While closing in any case, weather alert or normal closing at the dawn. While opening case, vice versa.

Node 0 is used for tracking as well, so the process for the mirror cover should be finished exactly, before the observation starts. Otherwise, the processes (tracking and mirror cover movement) are conflicted and the system will get stuck. The new attribute for the dome state is checked firstly and if it opened clearly, and then the open command sent to node 0 for the mirror cover in recursive functions.

During T60 test observation, sometimes it was enough to open just upper shutter according to the observed object. However, if the object is close to the horizon, it is required to open the lower shutter manually first and then upper shutter respectively which consumes ten minutes of observation time. On the other hand, it is not allowed in the schedule to shorten observation time in order to get rid of ten minutes loss within observation. Therefore, the objects which exist 25 degree below of horizon are omitted from the schedule. Then, reverse of this procedure is carried out at upcoming observation nights and, in turn, schedule is revised frequently to observe the objects which are close to horizon by leaving the lower shutter open.
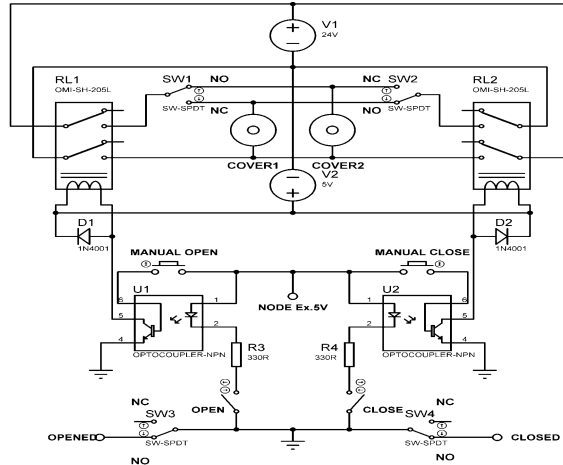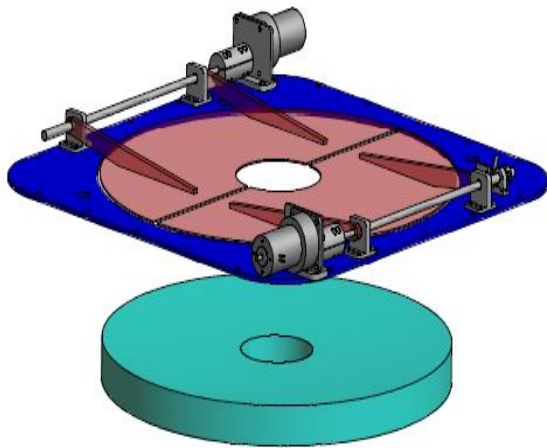
Fig. 4. The mechanic and electronic design of the mirror cover.

To avoid the ten minutes loss, the lower shutter cover is automated. On the hardware side, a geared motor, limit switches, steel wire and double connecting rods are used. By adding some improvements to the software, when the open command is received, lower shutter is opened and with the usage of upper shutter's limit switch which informs it is opened, then upper shutter starts to open. After opening both shutter cover automatically, control software is informed (Fig. 5).

Fig. 5. The new design of the roof-shutter.

4. Conclusion

Developments and improvements that have been achieved so far on T60 robotic telescope make it more stable for the robotic mode, and encourage us for further improvements and future challenges.

As future project, it is thought that VoEvent protocol has been employed to implement T60 telescope software so that the telescope can be used in observing GRBs and asteroids.

References

Drummond, M., Bresina, J., Edgington, W., Swanson, K., Henry, G., & Drascher, E. (1995). "Robotic Telescopes: Current Capabilities, Present Developments, and Future Prospects for Automated Astronomy", ed. G. W. Henry & J. A. Eaton (San Francisco: ASP), 101.

Genet, R. M. (1986),"Automatic Photoelectric Telescopes," ed., D. S. Hall, R. M. Genet, & B. L.Thurston (Mesa: Fairborn Press), 1.

Genet, R. M., Hayes, D. S., Epand, D. H., Boyd, L. J., & Keller, D. F. (1989). "Robotic Observatories: Remote-Access Personal computer Astronomy" (Mesa: AutoScope Corporation), 21.

Hall, D. S. (1995). "Robotic Telescopes: Current Capabilities, Present Developments, and Future Prospects for Automated Astronomy", (San Francisco: ASP), 65.

Honeycutt, R. K., Kephart, J. E., & Hendon, A. A. (1978). S&T, 56. Kaye, A. B., et al. (1999) AJ, 118, 2997.