U-SmART - SMALL APERTURE ROBOTIC TELESCOPES FOR UNIVERSITIES

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(Received November 30, 2014; Revised May 31, 2015; Accepted June 30, 2015)

\begin{abstract}
A group of universities have come together with the aim of designing and developing Small Aperture Robotic Telescopes (SmART) for use by students to observe variable stars and transient follow-ups. The group is deliberating on the components of the robotic system; e.g. the telescope, the mount, the back-end camera, control software, and their integration keeping in mind the scientific objectives. The prototype might then be replicated by all the participating universities to provide round the clock observations from sites spread evenly in longitude across the globe. Progress made so far is reported in this paper.

Key words: telescopes: robotic - instrumentation: CCD cameras
\end{abstract}

1. INTRODUCTION

The automation of a small observatory for the purpose of taking remote observations is a desirable exercise as it allows a wider and easier observing experience. If such observatories are spread across different geographical locations around the world, round the clock observations of an object become possible. This means a better phase coverage for variable star photometry and a better follow-up of transients as at least one of the telescopes are available for observing at any instant of time.

It is also our endeavor to use existing or newly developed control systems that are based on open source components as far as possible. With this objective in mind, efforts have been initiated to develop a prototype automated observatory system with the following components that can be integrated together for remote access:

- Dome or enclosure.
- Weather station.
- Telescope and mount.
- Instruments/Camera and filter system.
- Control hardware and software.

2. OBSERVATORY SUB-SYSTEMS

In the following we give a brief description of initial testing and present the status of some of the observatory sub-systems.

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2.1. Dome or Enclosure

Two particular enclosures are under consideration, a proper dome and a movable roof, and it is expected that the participating observatories will choose either of the two depending upon budget and space considerations. The University of Delhi has tested a 3.5 meter diameter dome from Sirius Observatories for the past few years that is capable of remote observations (Figure 1). Dome rotation and shutter opening/closing can be done manually or remotely. Figure 2 shows the dome controls and a solar panel that can charge the batteries that run the DC motors for the shutter and rotation. The Marburg University observatory (Figure 3), however, has a movable top structure that, at present, can only be operated manually but can be modified for remote control.

2.2. Weather Station

A weather station designed for astronomy is absolutely essential for observatories capable of remote operation. The essential features of such a station include a sky brightness monitor, wind and cloud sensors as well as a rain and snow detector capable of reporting through a web interface. While keeping an eye on the weather, it should be capable of triggering an alarm for emergency shut down. Shelyak Sentinel astronomical weather station is being considered for first installation and testing.

2.3. Telescope and Mount

We have tested the Celestron 11 inch optical tube assembly (University of Delhi and Marburg University) with
2.4. Instruments/Camera

The instruments tested within the remote setups so far are CCD cameras with and without filter wheels. Instruments of this type are capable of being remotely controlled; you only need the drivers for the control system. At Marburg University we are using the INDI library (see next section 2.5). Cameras tested are ATIK and SBIG cameras, for APOGEE cameras drivers also exist. The guiding system of our setup used an QHY5 CMOS camera.

2.5. Control sub-systems

The control system was set up with the open source software system of the INDI library running on a high-end Linux based single board computer Banana Pi attached to the mount of the telescope setup. The board has a dual core processor, USB connectors and a gigabit internet port. The realization of the INDI protocol using the INDI library (www.indilib.org) is a new system for astronomical instrumentation control which uses a client–server architecture. On demand the INDI server executes the drivers for the instruments at the Banana Pi computer at the site of the telescope setup and the client software connects to the server via internet. A typical Linux client is the KSTARS program. A complete setup, e.g. the EKOS suite, includes highly accurate GOTOs using the astrometry.net solver, the ability to measure and correct polar alignment errors, auto-focus and auto-guide capabilities, and the capture of single or stack of images with filter wheel support. With the testing setup at Marburg University (see Figure 4) we were able to remotely perform the following tasks: accurately position the telescope to the desired object, auto-guiding the scope with a QHY5 cmos camera while taking pictures with an ATIK 314L or a SBIG ST-2000XM CCD camera.

3. CONCLUSIONS

We have reported preliminary efforts made towards having a network of small university observatories spread across terrestrial longitudes capable of continuous robotic observations of variable stars and transient follow-ups. Most of the observatory components and sub-systems have been tested individually at two locations for further integration. The small aperture robotic telescopes will provide a useful resource for undergraduate research. It is hoped that more observatories will join this effort. We welcome contacts with persons who can join this effort by replicating the effort at their university. Experienced individuals may also contribute to the effort by advising us on the way forward.
ACKNOWLEDGMENTS

RG and HPS thank the organizers of the 12th APRIM for partial support for attending the meeting. Support from the Indo-US Science and Technology Forum (IUSSTF) towards the Indo-US Joint Center on the Analysis of Variable Star Data is gratefully acknowledged. CD and AS thank the Lemaker company for supporting us with two Banana Pi boards for testing purpose.