The Astrophysics of Cataclysmic Variables and Related Objects
ASP Conference Series, Vol. 330, 2005
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BART - Burst Alert Robotic Telescope

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Abstract. BART is a small intelligent robotic CCD telescope, devoted to rapid observation of prompt gamma ray burst transients. During its operation since early 2001, it had several prompt observations with world-competitive response time. The constraints to object magnitude were estimated and published in GCN circulars. Telescope is located in Astronomical Institute of the Czech Academy of Sciences in Ondřejov. This paper describes also its new control system, named RTS2, which is in service since February 2003.

1. Introduction

Automatic operation of the telescope includes observing, dark and flat field obtaining, roof operation, basic image analysis, creation of the archive and also camera temperature maintenance, device switch-offs during non-observing periods or heating the optics for dew prevention when needed. There are four separate optical systems used for detection of an optical emission with CCD: Main tube, 25 cm Schmidt Cassegrain equipped with filter wheel and field of view 22 arc minutes; two identical WF (7°x5°) cameras using different filters (I,R) and a 300 mm lens with field of view about 2 degrees. BART is well suited to provide follow-up optical observations of GRBs detected by INTEGRAL and other satellites. The experiment is also capable to provide simultaneous and quasisimultaneous optical data for selected targets observed by INTEGRAL, with focus of Cataclysmic Variables and blazars.

BART was observing in Ondřejov since April 2001, using it's old software called RTS until February 2003, when the new, completely rewritten version came into service. System is running there in semi-automatic mode, with staff available to check it 24 hours a day. The restriction is given by the lack of weather sensors, thus the need of person to watch the weather nightly.

2. RTS2 - the operating software

RTS2, the operating software, is designed as a networked system for driving robotic telescopes. It is composed of several device servers, central server and various observational clients cooperating over a TCP network. Observation entries, requests and results are kept in database. Positions of GRBs are received from the Internet and observed either in prompt mode, or added to list of observation targets, depending on weather and other conditions influencing the observation. The idle time, when there is not any request for GRB observations,

spends the telescope monitoring various objects focussing on CVs and blazars. The database lookup entry point is at http://lascaux.asu.cas.cz/bartdb.

The system consists of three kinds of programs: **central server**, **server/ client programs** for accessing and controlling devices like cameras, telescope or weather controller paired with dome/roof controller, and **client programs** to control an observation - currently there is scheduler client for regular observations, gamma ray burst client for prompt observations of GRB optical transients, console based monitoring client, stream based monitoring client and focus client for camera focusing. Central server holds list of all connected devices and clients. Every new device register to central server in order to be accessible to clients, and every client connect and authorise itself to central server in order to be able to access devices. Access to devices is priority-based - only client with the highest priority can access state-changing functions of a device - such as mount moving, or exposing and readout of camera. During a long-running operation, if a client loses priority, the operation is cancelled and devices are able to serve a new request of a client having higher priority. That is important for GRB observing, where the lowest response time is the most tentative criteria.

Priority requests are being sent from clients to the central server. It holds a list of priorities of all connected clients. If it finds that the priority has to be changed, it informs all connected devices about such change. We are able to control whole family of SBIG parallel port based CCD cameras. We work on USB based SBIG, Apogee and FLIcam CCDs. We are able to control LX200 family of telescopes by Meade, and we have an alpha level driver for the Paramount. Implementing a driver-layer of nearly any device daemon should be relatively easy thanks to a well-elaborated design of the upper layers.

Main scheduler takes care of obtaining pictures for flat-fields during dusk and dawn. It also obtains dark-frames at predefined time interval. Composition of system can be at best understand from an example. On Figures 2 and 3 is described current configuration of Ondřejov BART. Lascaux is an 2GHz Intel Celeron PC compatible computer running Debian GNU Linux. There resides central server, database, web server for database access and from there observations clients are usually run. Other PCs are low-end Pentium or 486 class computers. They run stripped-down Debian, which occupies vast majority of theirs hard-drive.

The whole RTS2 package is available on request to download, with complete source code included. There is slow progress on manual pages for whole system, but we expect to improve manuals as we don't have to track any errors now. The code is covered by GNU license, which enables anybody under modify it, if certain conditions are being held. The system development is tracked in CVS versioning system. RTS2 uses GNU automake and autoconf tools for Makefile creation.

Acknowledgments. We acknowledge the support provided by the ESA Prodex Project 14527. Some aspects (of the Optical Transient analyses) were supported by the grant A3003206 provided by the Grant Agency of the Academy of Sciences of the Czech Republic.