A Web-Remote/Robotic/Scheduled Astronomical Data Acquisition System

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Abstract

Traditionally, remote/robotic observatory operating systems have been custom made for each observatory. While data reduction pipelines need to be tailored for each investigation, the data acquisition process (especially for stare-mode optical images) is often quite similar across investigations. Since 1999, DC-3 Dreams has focused on providing and supporting a remote/robotic observatory operating system which can be adapted to a wide variety of physical hardware and optics, while achieving the highest practical observing efficiency and safe/secure web browser user controls. Capabilities cover the needs of both science and art astronomy.

ACP Expert consists of three main subsystems: (1) a robotic list-driven data acquisition engine which controls all aspects of the observatory, (2) a constraint-driven dispatch scheduler with a long-term database of requests, and (3) a built-in "zero admin" web server and dynamic web pages which provide a remote capability for immediate execution and monitoring as well as entry and monitoring of dispatch-scheduled observing requests. No remote desktop login is necessary for observing, thus keeping the system safe and consistent. All routine operation is via the web browser. A wide variety of telescope mounts, CCD imagers, guiding sensors, filter selectors, focusers, instrument-package rotators, weather sensors, and dome control systems are supported via the ASCOM standardized device driver architecture.

Components

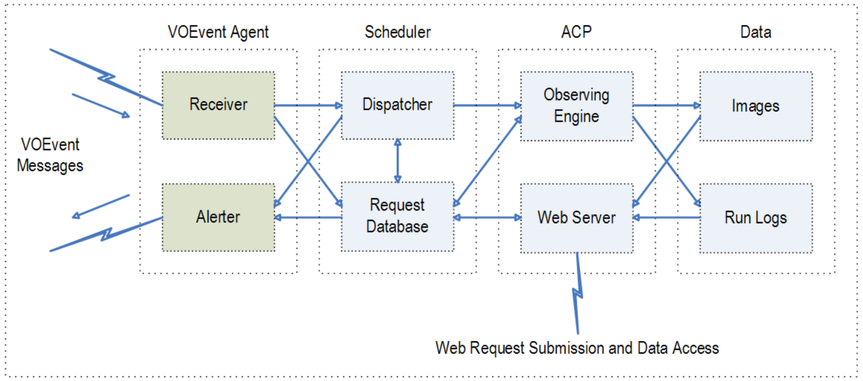
- **Remote Autonomous Observing Engine**
  - ✓ Executes observing requests from direct web submissions and the dispatch scheduler
  - ✓ Requests can be complex with waits and repeat loops at three levels
  - ✓ Controls *all* observatory components to achieve the request
  - ✓ 100% autonomous, no local operator monitoring or intervention is needed
  - ✓ Detailed run logging, visible live and saved for later analysis
  - ✓ Direct observing requests are in a simple declarative format, no scripting is needed
  - ✓ Guarantees target centering in field via automatic field astrometry and re-centering
  - ✓ Designed for observing efficiency with overlapping operations and process optimization
  - ✓ All observing logic is open source in script
  - ✓ Hooks for adding custom functions at several points in the observing process
- **Zero-Admin Web Server and Web 2.0 Dynamic Web User Interface**
  - ✓ Monitor the status of instruments and the progress of the observing process
  - ✓ Direct submission of immediate and manually scheduled observing requests
  - ✓ Submission and editing of requests in the dispatch scheduler database
  - ✓ Tabular display of scheduled requests including status, image counts, run time
  - ✓ HTTP and FTP access to acquired data and acquisition log files
  - ✓ Access to generated portfolios of data resulting from automatic VOEvent follow up
  - ✓ Server is integrated with observing engine, no install/admin of Apache, IIS, etc. needed
  - ✓ Micro-content-based wiki interface uses AJAX and JSON for live interaction
  - ✓ Wiki authoring feature including full documentation allows customization
- **Constraint-Driven Dispatch Scheduler**
  - ✓ Implements dynamic observing strategy during the night, including VOEvent triggers
  - ✓ Adjusts to changing sky conditions, doing the observing that's appropriate
  - ✓ Handles weather interrupts automatically, with good-weather-resume
  - ✓ Acquires calibration frames (sky flat, dark, bias) as a routine task
  - ✓ Capable of 24/7 hands-off remote operation including powering equipment up and down
- **VOEvent Agent**
  - ✓ Receives VOEvent messages, filtering to identify those of interest
  - ✓ Creates observing request appropriate for the type of VOEvent received
  - ✓ Submits request to dispatch scheduler and may interrupt observing for high priority target
  - ✓ Sends VOEvent message advising of availability of follow-up data
  - ✓Creates web pages containing data portfolios and download links

Live Remote Observing via ACP Expert Web Interface on Apple iPad

Recent First Light: TRAPPIST at ESO, La Silla

TRAPPIST (**TRA**nsiting **P**lanets and **P**lanitesI**m**als **S**mall **T**elescope) is a project driven by the Department of Astrophysics, Geophysics and Oceanography of the University of Liège (Belgium), in close collaboration with the Observatory of Geneva (Switzerland). Extensive use of commercial components and software (including ACP Expert) made it possible for this project to go from decision to first light in two years. First light was done from the Liège University downtown, 12,000 Km away, with Bernard Rentier the rector of the University, Didier Queloz from Geneva Observatory, the TRAPPIST team and journalists. This facility has been in routine operation for 8 months.

The TRAPPIST 0.6m remote/robotic telescope at ESO La Silla Observatory, Chile



Process Block Diagram of ACP Expert

Statistics: Remote/Robotic Telescopes

A recent tally of logged ACP system startups revealed that over 500 unique observatories were started up between January 2009 and February 2011. The number is a conservative estimate; it is clear that observatory names were changed, producing multiple counts for a single observatory. The raw count was 878. All of these are fully robotic and most are remote-capable. It is estimated that at least 200 of these observatories are running remote operations.

History and Support

ACP Expert has been available as off-the-shelf software since late 2008. The observing engine was first released in 2001, the dispatch scheduler in 2005, and the second generation web interface in 2007. All software components are fully supported with rapid-response first-person service from the developer and with new releases several times per year. Communication is via a dedicated forum system, telephone, and live login by the developer if needed.

Some Observatories Using ACP Expert (Scheduled)

- AAVSO Photometric All-Sky Survey (APASS, currently operating remotely at CTIO, Chile)
- Christian Perez, Swedish astro artist. 0.4m at New Mexico Skies, remote from Sweden
- Sonoita (AZ) Research Observatory. 0.35m shared photometry (AAVSO, SwRI, HRPO), remote
- Leonid Elenin, discovered Comet C/2010 X1 (Elenin). 0.46m at New Mexico Skies, remote (Russia)

Some Observatories Using ACP Direct Submission

- Tzec Maun Foundation, 8 telescopes in New Mexico and Australia, education and research
- Calvin College (MI), 0.4m OGS research-grade, remote at Rehoboth, NM, education and research
- Global Rent-a-Scope, 14 telescopes in Australia, Spain, New Mexico, rental for science and art
- Tel Aviv University, Palomar-type 1m f/4 Boller & Chivens, Negev Desert remote (direct imaging)

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Please feel free to contact me at any time. I will try to accommodate your schedule. I'm very interested in feedback and happy to answer questions.