OAdM Observatory: Towards Fully Unattended Control

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Abstract The Montsec Astronomical Observatory (OAdM) is a small-class observatory working on a completely unattended control, due to the isolation of the site. Robotic operation is, then, mandatory for its routine use. The level of robotization of an observatory is given by the confidence reached to respond to environment changes and by the required human interaction due to possible alarms. These two points establish a level of human attendance to ensure low risk at any time. There are key problems to solve when a robotic control is envisaged. Learned lessons and solutions to these issues at the OAdM are discussed here. We present a description of the general control software (SW) and several SW packages developed. They specially protect the system at the identified single points of failure and constitute a distributed control of any subsystem, which is able to respond independently when an alarm is triggered thanks to a top-down control flow. All together this compose a SW suite designed to reach the complete robotization of an observatory.

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1 Introduction

During the coming months, the OAdM, located in Sant Esteve de la Sarga, Serra del Montsec, 60 Km North of Lleida (Spain), will begin routine operations. The telescope and instrumentation are finishing their commissioning phases. The primary guideline of the project is to guarantee the robotic operation of the observatory in order to carry out astronomical observations. The design and development processes were focused on ensuring a reliable and efficient system while working in this operational mode. A general description of the observatory (site, instrumentation, science case, etc.) can be found in [1].

1.1 Project Technological Scope

The are numerous advantages in operating an astronomical observatory using a robotic control instead of human attendance. These have been widely described in publications [2] over the last decade and will not be discussed here. The OAdM was designed from the beginning with a concept in mind: ensuring a reliable, safe and efficient system while working in robotic mode. This mode of operation implies complex technology which is not usually used in classical ground-based observatories, where an experienced operator manages the work flux of all the instrumentation, but rather in space observatories or some industrial applications. Its use has been extended today to ground-based observatories thanks to the evolution of hardware (HW) and SW capabilities and motivated by the clear advantages it offers in terms of time optimization to maximize the scientific return. But, obtaining a secure setup is still an issue for most of these facilities that must be adapted to work on remote site locations and at extreme environment conditions. OAdM has been designed to achieve a high level robotic control, just to be serviced a few times per month. Specific SW solutions found are presented next.

2 OAdM Solutions

A few of the HW and SW solutions developed at the observatory are particular to OAdM needs, because they are subject to site or facility characteristics, but the rest could be applied to other robotic observatories.

2.1 SW Elements

A complex SW architecture, with several new developed applications, manages all observatory operations. A General Control Program (GCP) is in charge of the workflow control of the observatory, manages most of the database updating tasks and executes the system boot, shutdown and all the applications required during the operation process. Other developed packages are:

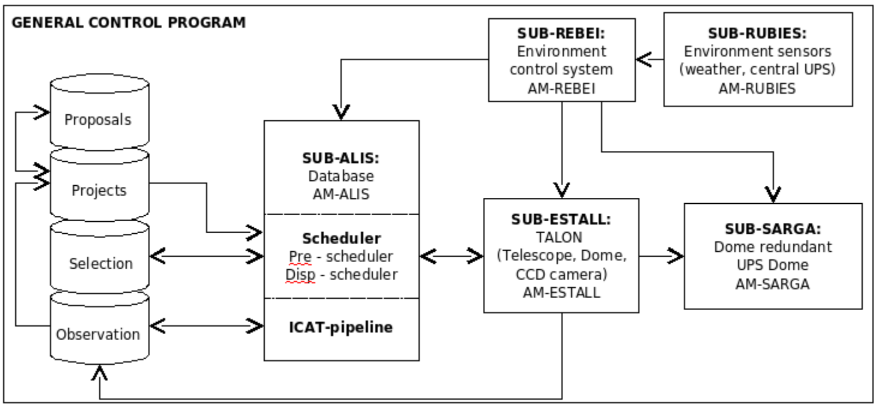

Fig. 1 OAdM general control diagram. The GCP manages the workflow of the observatory and the distribution of applications in five subsystems implements a top-down control structure.

Environment Control (EC) Package and Alarm Managers (AM) - The main scope of this system is to provide a set of tools to monitor the environmental conditions of the observatory and to manage and generate alarms according to these conditions. It is implemented using JAVA. The environment control system (ECS) is able to provide a reliable control mechanism assuring that when the environmental conditions become unsuitable to observation all the systems involved in it are able to act according to them. The system provides the following features: constant monitoring of the environmental conditions, information about the monitored elements, alarm generation and management and reliability. The ECS is composed of two main internal elements and many external elements: the environment monitor (EM), where all the sensors are connected to, which serves all the environmental data to the other elements of the system using a server-client architecture; the alarm manager (AM), element that generates and manages alarms according to the data received from the EM. There can be as many AMs as needed to and there should be at least one per observation facility. The AM uses the information of the EM and takes the appropriate actions according to the registered values. It is in charge of managing other alarms besides those produced by the EMS data. This package has critical relevance in the observatory management security. At OAdM, there is a distribution of AMs, each one running at a different computer and with routines subject just to a unique subsystem.

Scheduler - The scheduler's main task is the time optimization and it has a direct effect on the scientific return achieved by an observatory. Then, it is the core SW application for a robotic facility and it is required to be fast and reliable. The

OAdM scheduling is separated in two parts: a pre-scheduler that makes a temporal selection of objects according to their possibility of observation from those projects approved to be observed by the TAC, process done before the begining of the night following selection criteria; a dispatch-scheduler that is executed any time a target observation is over and a new one must be scheduled. This process is done in real time according to current environment conditions and the set of priorities. The dispatch-sheduler application uses the selected objects at the pre-scheduling process as input information and executes an algorithm that calculates the figure-of-merit of each object. Then, the object with the highest merit value is scheduled. The different effects that contribute to increase or reduce the global merit $m(t)$ per object are: observational conditions, environment conditions and proposal history. Other works with a similar approach to the scheduling problem can be found in the literature [3, 4].

ICAT Pipeline - Reliable and fast data calibration and analysis software is crucial to treat automatically the vast amount of images obtained at a robotic observatory. The IEEC Calibration and Analysis Tool (ICAT) software has been developed as a tool for robotic observatories with the objective of managing astronomical images to extract relevant scientific information in real time. Its general characteristics are: automatic management and treatment of FITS images according to database input information, high accuracy photometric and astrometric data extraction and real time execution. Reliable and fast data calibration and analysis is achieved using three SW packages: NOAO-IRAF, calibration and analysis SW; DAOPHOT, reliable PSF photometry package; and SExtractor, fast and good precision analysis SW, using flexible aperture photometry. For more information, see [5].

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