TROBAR: Robotic Astronomy in València

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The Telescopi ROBotic de ARas (TROBAR) is a new robotic facility built at Aras de Los Olmos (València-Spain). This is a 60cm telescope equipped with a 4kx4k optical camera, corresponding to 30x30 arcmin² FoV, and it will be primarily used for a systematic search of Hα emitting stars in the galactic plane to a depth of ≈14mag. Both data acquisition and reduction will be performed automatically. The robotization of data acquisition is now entering its final coding phases while the development of the data reduction pipeline has just started.

Introduction

Galactic Hα emitting objects are tracers of pre and post main sequence stars as well as of nebulae, cataclysmic variables, Be stars and other more exotic objects like Luminous Blue Variables (LBV) and Wolf-Rayet stars. IPHAS, the most complete survey of the galactic plane carried out so far, is complete in the magnitude range r'=13 to 20 for -5<|b|<5. The classical surveys, mostly based on objective-prism photographic observations, are complete up to magnitude 9. In this context, the main aim of our project is to carry out a photometric survey covering the existing gap down to r'≈14 with observations and data reduction automatically performed.

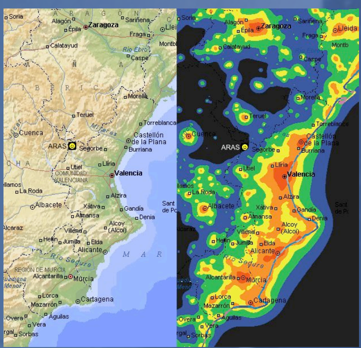

Figure 1: On the left: in this map of the eastern region of Spain, the location of the Observatory is identified by the smiley. On the right: false scale map by the Istituto di Scienza e Tecnologia dell'Inquinamento Luminoso (ISTIL) of the same area showing zenithal light contamination (red to black, for highest to lowest light pollution). The Observatory (smiley) is located in one of the darkest regions.

Telescope and location

TROBAR is located at the Observatori Astronòmic de Aras (OAA), approximately 100Km north-west of Valencia, at an altitude of 1330m, in a region of low light pollution (see Figure 1).

The telescope has a classical Ritchey-Chrétien optical scheme, in Nasmyth configuration, realized by Teleskoptechnik Halfmann.
Table 1 lists the main features of the telescope.

The telescope can be both remotely controlled and robotically operated. Here we will outline its robotic capabilities.

M1 Diameter	60cm
F	4800mm f/8
Mount	Alt-Az – Nasmyth focus
Slewing speed	10 deg/sec (maximum)
Camera	4Kx4K optical camera
FoV	30'x30'
Filters	Johnson V, R, I, Stroemgren u, b, v, y Hα (narrow+medium band)

Table 1: TROBAR main features

System description

The operations which can be performed by the telescope comprise the acquisition of calibration frames (bias, darks, sky flat field and focus) and the observation of scientific targets.

All the software is written in python, with the Object Oriented paradigm. Astronomical calculations are performed through the pyephem libraries.

The routine operations are managed by a set of 3 main programs, in communication one with the other through TCP/IP connection, thus allowing a complete independence of the software from the running machine (see Figure 2).

These 3 main programs are:
• Meteo manager: takes care of reading the local meteo station, evaluating if current meteo conditions are sufficiently safe for operations. This consists in evaluating the current rain rate, humidity, wind speed and atmospheric pressure.
• Dome manager: takes care of opening/closing the dome, depending on sun altitude and meteo conditions
- Observation manager: when the dome is open, executes the most suitable observation, depending on sky conditions.

Each one of the above processes is coupled to an isAlive program. This is a crontab regulated job periodically checking that the corresponding process is running and, if this is not the case, re-starting it.

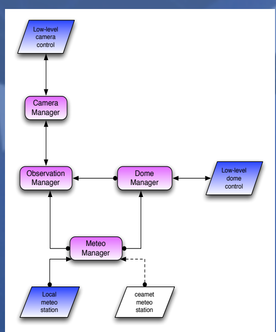

Figure 2: Schematic of the processes involved in the robotic management of the telescope (pink rectangles) and software modules communicating with low level hardware (blue rectangles). See above text for more details.

References

The INT Photometric Hα Survey of the Northern Galactic Plane (IPHAS), Drew J. et al. 2005, MNRAS 362, 753
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pyraf: http://www.stsci.edu/resources/software_hardware/pyraf

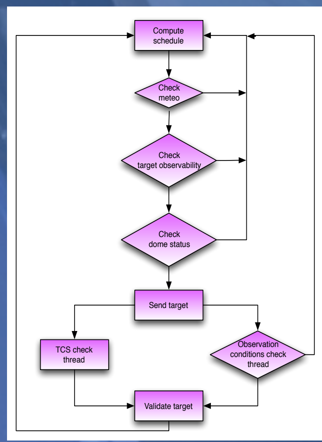

Figure 3: Main loop scheme of the observation manager. The system stays idle until a suitable target is available.

Target scheduling and observation management

Figure 3 shows a schematic diagram of the Observation Manager. The system continuously checks if there is a target to be observed. If this is the case, then two threads start, one checking the tracking status of the telescope and the other checking that all the environmental conditions are fulfilled during the whole observation. This information is then used at the end of the exposure for target validation.

Target selection (scheduling) is left to an independent process. The set of targets is organized in a MySQL table. The main algorithm is based on a figure of merit which takes into account airmass constraints, target priority, exposure time and remaining time before the target sets. Beside this, the scheduling process takes into account other common constraints such as moon fraction, periodicity of observation and, in the future, seeing and sky transparency.

Current status and future prospects

The coding is now complete at the 80% level and we foresee to complete it by the end of the year.
In parallel we started to develop a pipeline for the reduction of the survey data. This will make extensive use of the pyraf environment for the pre-reduction processes (bias subtraction, flat field correction etc.). Detection of the objects on each image will be managed by SExtractor; its mag_auto value will be used as a first estimation of the flux, which will then be used by DoPhot to derive psf magnitudes.

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