Simulating an Autonomous and Global Robotic Telescope Network

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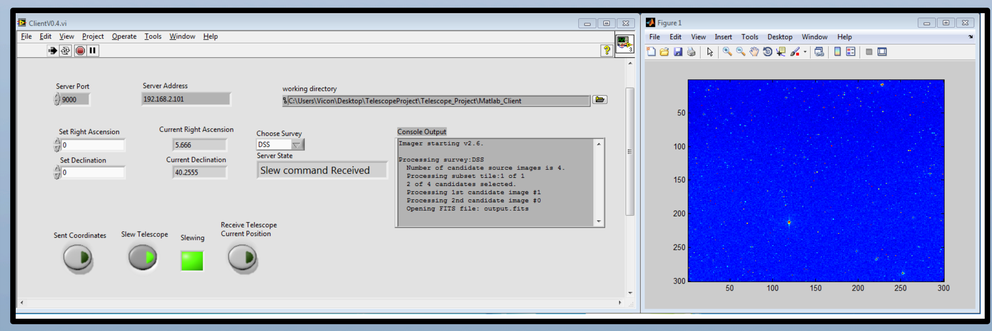
Introduction

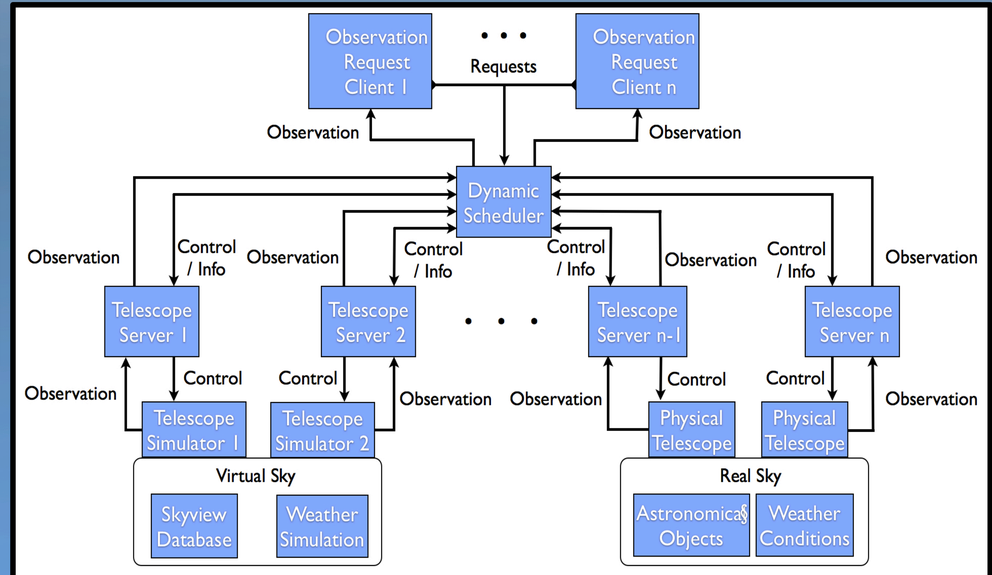
One of the best ways to vastly increase the scientific output of a telescope is to incorporate it into a network of telescopes. If the network is of global reach then it could be considered as a single instrument which is free from classic limiting factors such as target visibility (e.g. daylight, location restrictions, etc) or meteorological conditions. An additional factor that may also limit the amount of useful scientific data coming from such an instrument is human interaction. Depending on the type of observations, the efficiency of the network can be improved simply by eliminating human input at various stages (i.e. telescope & instrument control, data acquisition, etc). Currently there is a number of robotic telescope networks operating a wide range of telescope sizes and types (ROTSE, WET, HATNet, Robonet, Monet, LCGOT) with various degrees of human interaction involved in their operation. The purpose of our simulation is to explore and streamline the interaction between the various network components (telescopes, computers, humans) on a wide range of activities (e.g. surveys, monitoring, ToOs).

System Architecture

The simulator is built using existing open source software. The open source Stellarium software is used to simulate the telescope movement and track the telescope locations on the sky. A simulated FITS image of the sky is produced by processing an original Digital Sky Survey image (DSS) which is then passed on to a MATLAB routine for processing. A final output image is produced simulating the view from the telescope. The observations are dynamically scheduled and the scheduler allocates appropriate resources (telescope selection) to maximize the efficiency and the data quality of the network.



The above image (left) shows a client window representing a telescope control unit of a telescope node of the network. The node has slewed into position and acquired an image (right). The image is then processed to simulate the view of a small aperture telescope, weather conditions, etc. On the far right we see a visualization of the sky of the telescope field of view and pointing using the Stellarium virtual observatory software.



Dynamic Scheduler

The simulator can be used as a test-bed for user-provided schedulers, but also contains a basic scheduler as part of the package. Multiple servicing options are being introduced; including priority-based, open-time, timeslice-supported scheduling, as well as dynamic rescheduling given changes in availability, new incoming service requests as well as data quality requirements.

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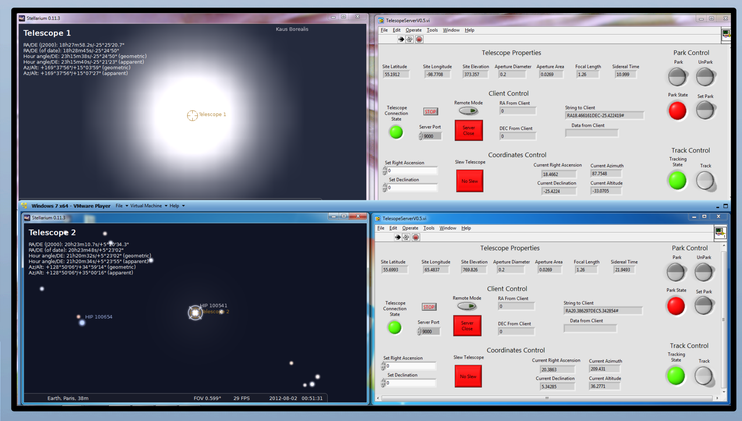
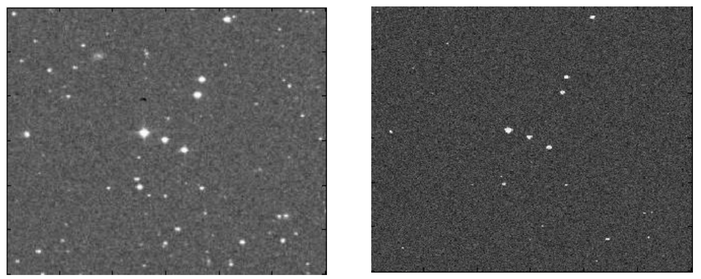


Image Processing

In order to be able to simulate the effects of weather and sky conditions to the simulated sky images, we employ a number of techniques including gaussian filtering as well as artificial noise floor modulation.



The above image on the left is an original DSS image while the image on the right is the processed image simulating the view of a small aperture telescope.

Future Work

The simulated network presented here is a work in progress. In the near future we plan to implement a simulation of real time weather conditions, improve data reduction procedures, introduce a data reduction pipeline as well as an object identification algorithm. The final goal is to ultimately test the system on a real life telescope network.