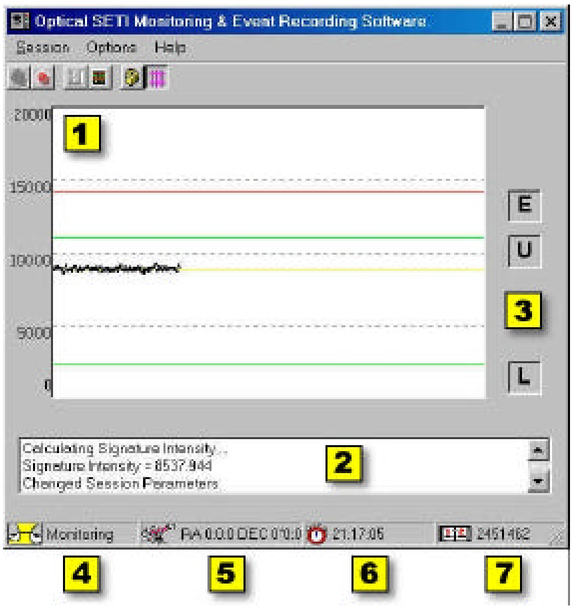
Optical Seti Monitoring & Event Recording System

The SETI Research Institute is an organization in search of the answer to the age-old question; “**Is there other intelligent life in the universe?**” There has always been ongoing speculation regarding the possibility of advanced civilisations living elsewhere in the cosmos. It is highly probable that life forms with comparable or higher intelligence than our own will follow a similar progression of technology. This predicts the discovery of electromagnetic waves for communication that may be detectable from Earth.



SETI has been monitoring radio waves since 1960 in the hope of discovering some intelligent signals emitted by other advanced cultures. There has however been little use of optical telescopes to search for laser-based communications. Laser transmission is regarded as a denotation of advanced technological capabilities; our own communication techniques have evolved from radio based to laser based. Laser communications are currently used for communication across the surface of our planet and are soon to be extended for intra-stellar purposes.

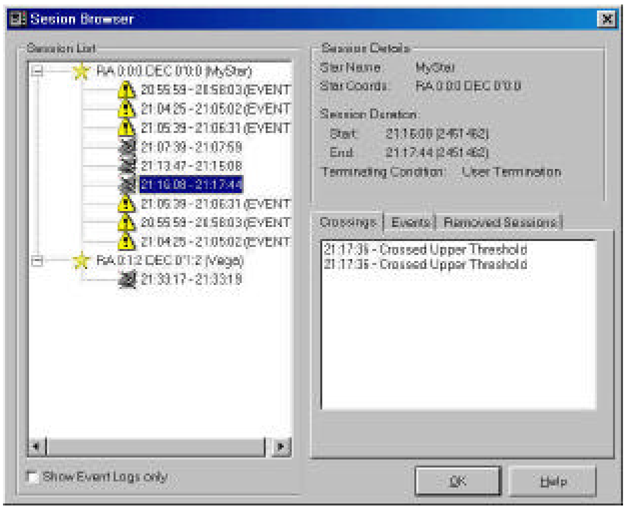
The Optical SETI venture endeavours to search for monochromatic laser light pulses and pulse trains, which could be generated by extra-terrestrial intelligence. The expected search radius for these signals is 200 light years. The telescope will be sensitive to wavelengths of light from infra-red through to ultra-violet. The Institute is building a computer-based system to capture, record and analyse data from an optical telescope even whilst unattended.

The intended users of the system will belong to the following organizations:

- The SETI Research & Community Development Institute Limited Brisbane Australia.
- The SETI League. Other chapters of the Seti League

The end users of the system will be researchers or operators under the supervision of researcher’s. These users can be assumed to have a technical background with definite astronomical knowledge. At this stage the software is only intended for use at the Australian chapter, but will be made available to other chapters free of charge when the product development reaches a stage where it is ready for use by other organizations or individuals.

Problem to be Solved



The Institute intends to perform a targeted search of the stars with an optical telescope. A targeted star search involves focusing the telescope onto a particular star and tracking it for a number of hours, before moving onto the next star. Software to allow the telescope to 'lock onto' and track a particular star currently exists and is available. While a star is being tracked, the optical telescope will continuously output light data. This will either be intensity magnitude or in frequency space, converted by a hardware spectrum analyzer. A "Target Frame" for each star in the search list will be recorded in the first round of observations. This reference frame will be used to compare subsequent frames for change or optical activity since the first frame was recorded. An increase in light intensity of the frame will trigger a recording event. A decrease in optical intensity compared to the reference frame will probably indicate an obscuration event such as clouds, fog or perhaps a bright sky that occurs during a moonlit night.

The purpose of the search is to detect and record the existence of extra-terrestrial communication networks that are based on optical technology. The existing telescope is capable of receiving such networks and thus the system need only provide a practical method to record their existence, should they be detected.

Recording the existence of extra-terrestrial communications is the major component of the problem to be solved. There are however some additional related problems that should logically be solved concurrently as outlined below:

a) Recording of selected data from the optical telescope that meets predefined criteria. These criteria would correspond to light pulses or pulse trains being received by the optical telescope, which in-turn could indicate communication from extra-terrestrials or some naturally occurring phenomena as yet to be described. It is possible that the system would be capable of detecting and cataloging astrophysical phenomena such as interstellar flares, super novas and perhaps pulsars that have an optical component.

b) Ability to 'play-back' a pre-recorded event and view extra information recorded, such as the position of the telescope at the time of the 'event' as well as astronomical date and time information. This "star-log" would be useful to use as a database of observations that resulted in the recording of an event over several observation runs.

c) Notification to selected SETI researchers that data of interest has been received. This would include an alert message on the terminal screen and an audible alert sent via the phone network to a pre-determined recipient. This option is regarded as a facility that will be included in the final release.

d) Visualization of data received from the telescope (preferably in real-time). This would include graphs displayed in frequency space as opposed to time space. This means that the operator would be able to have something to look at during on site visits.

e) Ability to make decisions as what the event detected actually was and to decided what course of action to follow. Eg. Detection of cloud obscuration events.

The hardware interface to the telescope will consist of two parts, the first is to read the current position of the telescope and the second is to read the data from the telescope.

The position interface to the telescope will use a standard RS-232 serial port. Full documentation on how to probe the telescope and decode the position is provided by the ECU (Earth Centred Universe) software that will be used to control the telescope.

The data interface is yet to be decided; three primary options are possible at this stage:

- Custom designed ISA or PCI card placed inside the computer. There will be custom drivers written to support with the card if this option is used.

- Existing 100% Sound Blaster compatible Sound Card. In this case, the standard system drivers would be implemented because they are well understood from a programming point of view.

- Parallel Port interface. This will require driver software to be written as part of the project. Data on how to communicate with the device will depend on the implementation of the port configuration. ie. bi-directional, SPP or ECP.

The data returned by the telescope will be either raw time domain data or frequency domain data from a spectrum analyser. The interface between the detector and computer interface is being tested at the moment and several prototypes are being tested.

The system will run on a conventional IBM compatible Personal Computer, running a Pentium class Intel, or compatible CPU.

The Institute does not require copyright to be placed on the software. This allows the software to be placed under the GNU public licence should the project group wish to use GNU software or code.

The Institute is also not concerned with intellectual property; the project team has the right to maintain ownership of the source code. The Institute requires the software to be free for use amongst members of SETI.

The system shall have a Graphical User Interface (GUI) and shall allow for the user to customise specific parameters. The exact specifications of the parameters are under review and will be discussed in more detail at a later time. However, the calibration of the “reference frame” from run to run will need to be manually calibrated in the first few releases of the software. This will allow the “researcher” to calibrate the system so that each time the target is re-visited, the database frame can be compared with the current observation measurements and corrected to be at a similar level of intensity. This will ensure that there are no wildly varying results that will cause false positives to be recorded.

The system is required to run on the Windows 95/98 operating system.

Technical System Complexity

- **The identified technical system complexity risks are**:
- The proposed software system has a potentially long operational lifetime. The lifetime of the software will correspond to the length of time the optical telescope is used in a targeted star search which could be years in duration.
- High quality requirements. The proposed software system will have high quality requirements for critical system functions such as the recording of data in real time and recording accurate positional information.
- Level of hardware dependence. The software system to be developed is largely hardware dependent. This dependence is due to the software system input data originating from the optical telescope and the continuous nature of this input.

- Limited availability of hardware resources. The optical telescope will not be available to the project team at all times due to its physical location on site. Lab testing using signal generators will provide some relief to the project teams development schedule.

- Unknown complexity of algorithmic processing. The complexity of processing to be performed on the input data by the software system has not yet been established. This is due to the format and physical interpretation of input data being currently unknown by the development team. In addition, real time processing places extra demands on the computing systems used to do the analysis.

- The use of new technology. The proposed system is to interface with an optical telescope that consists of technology that is new to both the Seti Research Institute and the project team. The amount of data collected for processing could be enormous. This is why it is necessary to place constraints on the upper and lower limits of the data acquisition algorithms

- Components of the system implementation may require the use of low-level languages, such as assembly. It is likely that these components will be related to the hardware interfaces or time critical software functions as they operate faster.

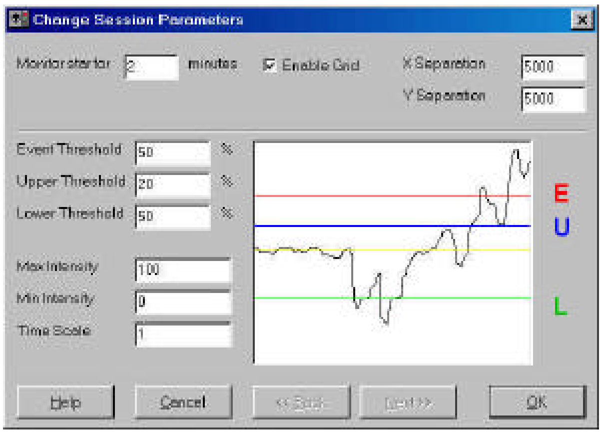
The system will be a graphical windows program that will interface with the optical telescope to receive both light data and position information. Users of the system will have the ability to display a screen to change important parameters. The software will have three distinct modes of operation: *Monitoring*, *Alert* and *Play-Back*.

Monitor Mode

In this mode the software monitors input from the telescope by comparing data levels with a pre-determined threshold criteria. While the system is monitoring, the data being received from the telescope will be displayed to the screen as a graph in frequency space. Sidereal Time and the Julian Date will also be displayed on-screen. These are standard measures of date and time used in astronomy. When the threshold criteria is met the system enters *Alert* mode.

Alert Mode

As soon as the system enters *Alert* mode, an alert message will be displayed on the terminal screen and an audible alert sent via the telephone network to a pre-determined recipient (not to be implemented until final release). The software will use a modem local to the host machine to access telephone networks. In *Alert* mode the raw data input by the telescope is recorded in real-time. Incoming data is checked against the threshold criteria periodically and data recording ends when the threshold criteria are no longer met. The system will package the recorded data along with the start and finish Sidereal Time and Julian Date into an “event” or star log. This event will be recorded to disk. The system then returns to *Monitor* mode. Visual data displays and alerts are secondary to the recording of incoming data in real-time.



Play-Back Mode

The user can initiate *Play-Back* mode from *Monitor* mode by selecting from a menu to open a previously recorded event. The user will then choose the event they wish to view from a list of previously recorded events. Once loaded, the event can be displayed to the screen using a variety of different visualization methods. The system exits *Play-Back* mode when the user has closed all open events. During *Play-Back* mode, data from the telescope is still being monitored in case the system needs to enter *Alert* mode. In this case the *Play-Back* session is immediately terminated and the system enters Alert mode. This allows the operator to check previously detected events even when analyzing new data in real time.

Development Progress

The development team has finished the first two versions of the software and tested it in the lab with a number of signal generators. The operation of the software was as expected and the final phase of the testing will be when the detector and telescope are finally mated together and trailed on site with dark skies. This will be later in 2001 when the telescope housing (building) is completed and the site has a better level of security that at present. Also more trials need to be completed on the optical detector unit and interface.

Stay Tuned for more.