Marine Physical Laboratory

Service Support for the Phillips Laboratory Whole Sky Imager

Janet E. Shields, Monette Karr and Richard W. Johnson

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Abstract

The Whole Sky Imager (WSI) is a ground-based digital imaging system for assessment of cloud cover over the full upper hemisphere. Using a fisheye lens and a slow scan CCD sensor, it acquires imagery under daylight, moonlight and starlight conditions. This contract funding enabled Marine Physical Laboratory to provide additional software development and documentation support for a new Whole Sky Imager which was delivered to the Air Force in December 95. The primary enhancements included several additions to the networking options, and delivery of a new "Operations Manual" and "Theory of Operations".

Research Summary

The Day/Night Whole Sky Imager is an automated digital imaging system for acquiring imagery of the full upper hemisphere during both day and night. The WSI was developed by the Marine Physical Laboratory, based on many years experience with earlier daytime-only WSIs, which were also developed at MPL. At the time of the initiation of this contract, MPL had developed and fielded five Day/Night WSI units under funding from Air Force, DOE, Army, and Navy. The most recently delivered instrument was delivered to the Air Force's Philips Laboratory, under Contract N00014-93-D-0141-D11. The current contract enabled

MPL to develop additional networking capabilities, and deliver additional documentation.

Research Objectives

The contract was designed to allow MPL to complete an "Operations Manual" and "Theory of Operations Manual", and to enhance the features of the networking portions of the WSI archival software. Some of the documentation was originally funded in an earlier contract, but at the request of the sponsor, the work on this documentation was deferred to the present contract, and in return MPL provided software development well beyond the scope of the original contract. The enhancements to the networking software will be discussed below.

Discussion of the Results

This section discusses the new software and documentation which were delivered under this contract.

Software Development

At the beginning of this contract, the networking software was capable of transferring images to a remote display computer, transferring status information to the display computer, and receiving instructions from the display computer. The instructions allowed the user at the remote display computer to select which images were transferred, choose the archival interval (such as 10 min or 2 min between image sets), turn the tape archival feature on and off, and turn the processing options such as image ratio and cloud decision image on and off.

The Statement of Work was intentionally left flexible, so that MPL could meet changing needs as they developed, up to the limit of the available funding. As a result, the changes were made in several steps; the first requests were completed, and the program delivered, and then additional requests were completed as they developed. The primary changes are described below.

The flux control algorithm on the WSI normally determines the choice of filters and camera exposure, depending on ambient lighting conditions. This algorithm takes into account the position of the sun, and the position, phase, and relative brightness of the moon. It is fast enought to choose appropriate settings even during sunrise and sunset when brightness levels are changing rapidly. While this algorithm is successful in choosing reasonable exposures, there are conditions in which the user might wish to change the exposure. For example, if monitoring a quickly changing event, the user might prefer shorter exposure times, which will yield poorer signal-to-noise statistics but better time response. The WSI was changed so that a user at the instrument can multiply the exposure time chosen by the algorithm by factors such as 10 or 0.1. By using a factor in this way, the algorithm still chooses a new exposure as the lighting conditions change (especially at sunrise and sunset), but the user can adjust the system to optimize image quality or time response.

The 16-bit raw data are normally displayed in 8-bit resolution on the monitor. A windowing algorithm chooses a reasonable range within the original 65,536 levels to map into the 256 levels inherent in the 8-bit image. The range selected by the algorithm is now written into the 16-bit image header, so that when the 16-bit image is transferred to the display system, the display system may use the same display range.

Two options were added for faster response. The program had previously allowed only two minute intervals as the minimum. This was changed to a one minute minimum. In addition, a fast grab feature was added, which allows the WSI to go as fast as it can (depending on the selected features), without waiting for an integer minute interval. The actual speed can be increased by turning off features such as archival to tape and cloud image processing, and it can be further enhanced by decreasing the exposure times. An additional feature was added, in which the WSI can be set to save every nth image set to the tape archive. This is used when the user wishes to save sample data, but also wants the fast response time.

Several options for occultor performance were added. The occultor can be set to disable the trolley drive functions; this could be used if the trolley is mechanically disabled. Another option allows the user to stow the occultor and not update the position of either the arc or the trolley. This has been used under starlight to block lights - the occultor is moved to the desired position manually, and then set to stay in place. A third change is that the occultor now goes to the east when there is no sun or moon.

The program has the option to use either the WWV clock or a GPS clock. An additional change was to allow the above options to be changed not just at the WSI, but also via the Scramnet from the display computer.

Making these software changes was somewhat challenging, because the system was no longer available to the personnel at MPL. Similar systems were available part of the time, but at no time was a system with Scramnet available. As a result, the programs had to be delivered with less than optimal testing. In spite of this limitation, the upgrades were made successfully with very few corrections required.

Documentation Enhancements

The new documentation delivered under this contract includes a new "Operations Manual", a "Theory of Operations", and documentation of the new software. The Operations Manual, Tech Note 240, includes new descriptions of the various subsystems and how they are designed to work, discussions of instrument operation, and setup instructions. This tech note was partially funded by another sponsor. The "Theory of Operations and Interactive Optimization", Tech Note 243, discusses the general theory of operations, the program sequence of events and timing, the flux control algorithm, the input file and hot key options, the cloud algorithm and derivation of its inputs, and the calibration theory. These Tech Notes are fairly substantial, with approximately 100 pages of documentation in each Tech Note.

Conclusion

The Whole Sky Imager software has been further developed to enable more interactive control of the instrument, both at the instrument controller and from a remote computer. The documentation has been upgraded to provide the user with a better understanding of the instrument and its use. Our understanding is that the sponsor is very pleased with both of these enhancements.

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