

UPGRADING THE UNIVERSITY OF HAWAII'S QUICK INFRARED CAMERA (QUIRC) FOR USE IN THE INFRARED IMAGING SURVEY IN CHILE

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ABSTRACT

As part of the upgrade work to prepare the University of Hawaii's Quick InfraRed Camera (QUIRC) for a new assignment in Chile, AutoCAD drawings were made of a shield, and two filter wheel assemblies. Also, the process of upgrading the filter wheel stepper motor electronics control system is described. The main body of the project was centered on the electronics 'black box' attached to the side of QUIRC. All of the old electronics hardware was removed to make room for a Pontech STP100 Stepper Motor Controller, Hall Effect sensor amplifier circuit board, and a B&B Electronics Model: FOSTCDR (RS232 to Fiber Optic Converter). A connector table was created to identify proper wiring elements in interfaces between the Hall Effect Sensor, Filter Wheel Motor, the new hardware in the 'black box', QUIRC power supply, and computer. A successful test of the electronics system was made by wiring all the hardware together and running a C-program that calculated the home position and allowed the user to select which filter to use.

INTRODUCTION

The University of Hawaii (UH) is working in partnership with the Astronomical Institute of the Ruhr-University Bochum (AIRUB), Germany, to conduct an InfraRed Imaging Survey (IRIS) at Cerro Armazones, Chile. Currently the Universidad Catolica Del Norte in Antofagasta works in collaboration with AIRUB to operate a 1.5m telescope observatory at the Cerro Armazones site. AIRUB will add a new 0.8m robotic telescope to support IRIS at this site, while UH will contribute a wide field infrared camera, two Rockwell Science 1024 x 1024 pixel HgCdTe Astronomical Wide Area Infrared Imaging (HAWAII) arrays, detector electronics, and the optics design for both the telescope and camera (Hodapp et al., 2007).

The University of Hawaii's Quick InfraRed Camera (QUIRC) was decommissioned from the UH 2.2m telescope in 2004 to make room for a much wider field Ultra Low Background Camera (ULBCam), a prototype camera for NASA's James Webb Space Telescope. A recent NSF proposal has been approved to re-commission QUIRC as a wide field infrared camera to support the IRIS project with Klaus W. Hodapp (UH) as the principle investigator and Bo Reipurth (UH) and Rolf Chini (AIRUB) as co-investigators. The upgrade work to prepare QUIRC for IRIS called for a redesign of the optics and cooling systems, an upgrade of old electronics hardware, and the implementation three new software packages (the same used for the VYSOS project). The aspects of the refurbishment dealt with herein is making AutoCAD drawings to help in the new design for QUIRC and upgrading the filter wheel stepper motor electronics control system.

The refurbishment of QUIRC to operational status has a direct link to NASA's Science Goals. In the preamble to the current NASA Science Plan, it states that NASA research is an

essential part of national and international efforts to employ Earth observations and scientific understanding. The IRIS project involves three countries (Germany, Chile, and the United States) and will make earth observations to study the universe. More specifically part three of NASA's Strategic Goal 3.4 is to progress in understanding how individual stars form and how those processes ultimately affect the formation of planetary systems. A major part of the science program for IRIS calls for long-term monitoring study of all known massive young stars south of declination $+40^\circ$ and brighter than $K=15$ in order to discover the massive young eclipsing binaries, and subsequently analyze the light curves to deduce fundamental parameters for the components (Hodapp et al., 2007).

AUTOCAD DRAWINGS

At the beginning of the project AutoCAD drawings were made of QUIRC Shield-1 and two interchangeable filter wheels (Figure 1). The software used to create the drawings is a student version of Autodesk AutoCAD LT 2007. The measurements were taken using a digital micrometer to the nearest hundredth of an inch. These component drawings were imported to a master AutoCAD drawing of QUIRC.

Another aspect of the project requires the cryogenic motor from filter wheel II to be integrated with filter wheel I. These drawings will serve as an important starting point in creating the design in AutoCAD before making any adjustments to components.

FILTER WHEEL STEPPER MOTOR ELECTRONICS CONTROL SYSTEM

A solid design for the filter wheel stepper motor electronics control system was made and tested outside of the QUIRC main housing by summer 2007 REU student, Taylor Chonis. The design incorporated a new Hall-Effect amplifier circuit to boost voltage to readable levels for the Pontech STP 100 Stepper Motor Controller Analog to Digital Converter. The old circuit components had simply become outdated. The Hall-Effect Sensor is a circuit that uses the QUIRC power supply voltage of $\pm 15\text{VDC}$ to detect a change in voltage caused by two magnets, one stationary and the other on the rotating wheel. When they are directly aligned a slight surge on the order of a few milli-volts is caused by the Hall-Effect. The A/D converter converts 0-5 volts to a 0-255 scale. A few milli-volts would not read even one on the digital scale, so an AD521 Instrumentation Amplifier was used in cohort with a potentiometer to boost the signal. The digital signal can then be read into a C-program via RS-232 cable. By recording the maximum change in voltage one can 'home' the filter wheel from any position. The C-programming language was chosen because of the ease of portability into the future software package (Chonis, 2007). After finding the home position, the program console interface displays a menu for the user. The menu choices are any of the eight filters, to re-home the filter wheel or exit.

Validating what Chonis had done approximately 8 months earlier was the next step in the project. After following the documentation to make the necessary wiring configurations, the C-program produced a check cabling error. Troubleshooting revealed quite a few problems; a bad solder connection on the amplifier circuit board, the A/D converter wires reversed, the wrong voltage entering the STP Pontech Controller, and the buffer size in the C-program too small. With all of these issues remedied, the C-program ran well.



Figure 1: AutoCAD drawings for three components of QUIRC; 'Shield 1' (top), Filter Wheel Assembly I (middle), Filter Wheel Assembly II (bottom).

BLACK BOX INSTALLATION

The next step in the project was to completely strip the QUIRC Electronics Utility or 'black box' that housed the old stepper motor and Hall-effect sensor hardware. By following schematics each connection was checked and labeled before removing all hardware. There were four main cables that attached to the 'black box' via military connectors of various sizes. One connector was completely removed because all hardware on the other end will be taken out as well. The port for this connector will be used for the fiber optic cables. Another connector acted as a conduit for the temperature sensor. This system will be upgraded soon. The next connector was to the power supply. A new pair was soldered on here to run the B&B Electronics Model: FOSTCDR RS232 to fiber optic converter (+ 15 VDC, common). The existing wires were used to power the Pontech Controller (+15 VDC, common), AD521 Amplifier circuit board (+/- 15 VDC) and routed through the last connector to the Hall-Effect sensor on the QUIRC filter wheel (+/-15 VDC). In addition to routing the voltage directly into QUIRC for the Hall-Effect sensor, the last connector also connected four leads for the Cryogenic Filter Wheel Stepper Motor.



Figure 2: The QUIRC Electronics 'black box' that now houses the electronics to control the filter wheel. The hardware includes a Hall-Effect Amplifier circuit board (top), Pontech STP Stepper Motor Controller (bottom right) and B&B Electronics RS 232 to Fiber Optic Converter.

The Black box has a ¼ inch bottom plate that is used to mount electronics. This plate was recycled and transferred into an AutoCAD drawing to draw the threaded screw holes that needed to be made for each piece of new hardware. The screw holes were completed on a Bridgeport drill press at the Institute for Astronomy-Hilo machine shop.

Dr. Hodapp suggested using a fiber optic cabling system between the computer and black box because it will reduce electromagnetic interference and increase the range of the cable. Following his advice, the B&B Electronics Model: FOSTCDR RS232 to fiber optic converter was chosen because of the low temperature operating range (-40 deg. F) and low cost.

Other work that was completed was a fresh coat of paint, the creation of two replacement amplifier circuits (components were picked up off the shelf and ordered off the internet from Radio Shack), and wiring male to female connectors to easily replace hardware. With the black box prepared (Figure 2) and fiber optic converters in place, the next step was to trace out the wires through QUIRC to make sure the inside connections were correct. By removing and soldering an existing connector from Filter Wheel I, it was now possible to run a final test of the system.

RESULTS

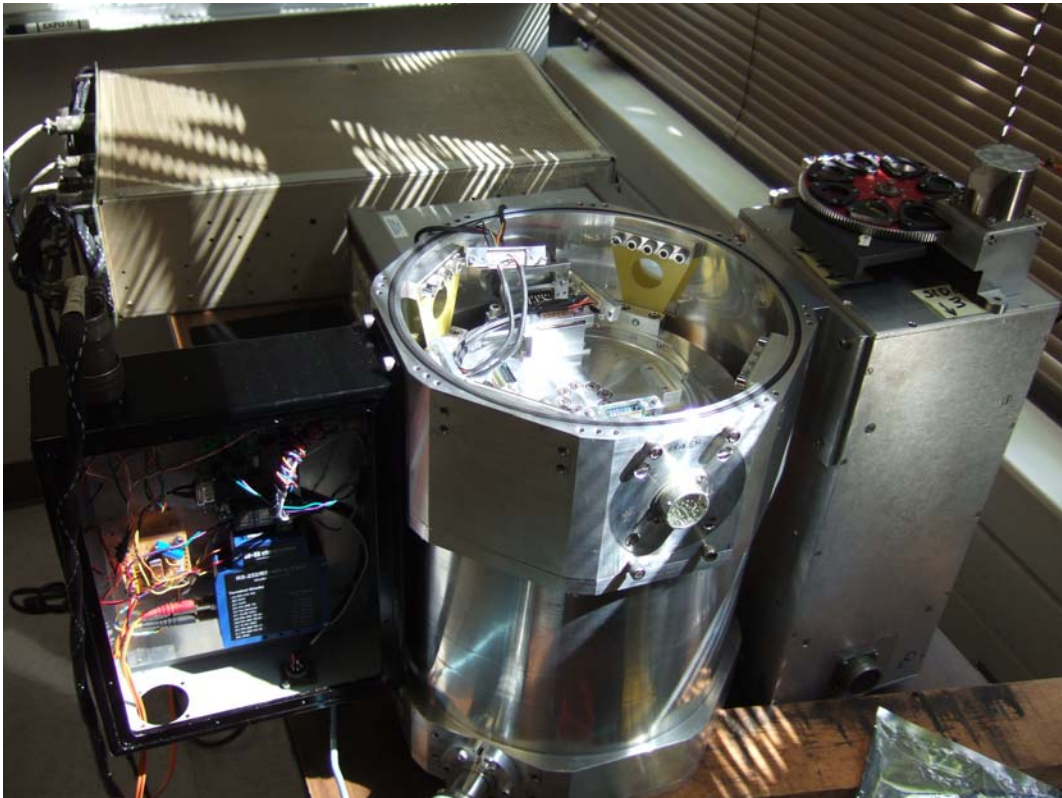


Figure 3: Final test set up for the Filter Wheel Electronics system. Shown is the QUIRC power supply (back), black box(left), QUIRC main body (center), and Filter Wheel Assembly II (top right).

The final test was made by running the C-program with all components in place. The first attempt was unsuccessful. After troubleshooting the circuit, the problem was isolated to the FOSTCDR. A close inspection revealed two wires crossed between the converter and RS232 cable. When this was remedied a successful test was made of the entire system. Figure 3 shows the final test set up.

CONCLUSION

The new electronics for the QUIRC filter wheel will meet the requirements for the ISIS project. An important document was prepared to highlight the electrical connections for all interfaces between hardware. It is in the form of a table and can be easily adjusted to reflect additions or changes. This will be especially helpful when working on the temperature system. The idea of upgrading QUIRC and letting undergraduates play a role in the process is very innovative. Not only is experience and knowledge gained about astronomical instrumentation, but also a new and improved wide field infrared camera is the result.

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