THE RUTHERFORD-SAAO CCD CONTROLLERS AND THEIR APPLICATIONS

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1. THE DEVICE

We describe a versatile array controller developed at RAL and SAAO. The original concept was due to Waltham, van Breda and Newton (1990). A Transputer-based microcomputer forms the heart of the device.

The T225 Transputer offers the following advantages:

a) Fast output of 16-bit words using a "block move" command;
b) Built-in serial communication using Transputer links;
c) Possibility of parallel processing - useful in high-backgrounds such as may be encountered in infrared work.

The following cards have been developed:

a) Transputer microprocessor
b) Clock boards with potentiometer-controlled voltage levels
c) Clock boards with digitally controlled voltage levels
d) Video boards with eight-bit A/D for acquisition cameras
e) Two types of video boards with 16-bit A/D converters
f) Filter-wheel controller
g) Temperature, shutter and communications card.
h) Balanced pre-amplifier
i) Power supply in separate unit
j) Link/PC adaptor (with Transputer buffer)

The program and CCD drive waveforms are normally stored in EPROM on the Transputer board but can be downloaded over the link. Timing is controlled by the Transputer's own cycle and 16-bit instructions can be issued every 200 ns over the data bus. The instructions are decoded on the cards into clock and A/D control information.

The controllers can be regarded as independent devices which act on simple control codes received over the link, returning the digitized CCD output as well as certain engineering information. In our applications, each controller is connected by a single bi-directional

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fiber-optic link to a 486 PC which the observer operates and which stores the data on disk and DAT tape. As well as this, the PC can display the data on a Super-VGA screen and do low-level professing. The Transputer is programmed in OCCAM and the PC in Gnu C (the latter allows 32-bit addressing).

2. APPLICATIONS

64 x 64 Philips HgCdTe Infrared Camera: This detector is sensitive from 1 to 4 microns. Exposures in the L' band are read out twice per second and summed in the PC. The chip is of sandwich construction. Because of the chip's problems with high dark current in many pixels, poor pixel geometry, threshold effects and low quantum efficiency, this camera is only competitive in the L' band where its well depth of 10^7 electrons is very useful.

RCA 320 x 512 CCD: This liquid-nitrogen cooled CCD was originally controlled from a hard-wired controller and Nova minicomputer and was the main imaging instrument at SAAO. It has been upgraded to use one of the new controllers. Its noise ($85e^-$) is completely dominated by the chip. It is now semi-retired.

Tek 512 x 512 CCDs: These liquid-nitrogen cooled chips have replaced the RCA chip for most routine imaging at SAAO. Their read noise is 12-13 electrons for a complete read time of 20 sec. A camera using a Tek 1024 x 1024 chip is under development.

Acquisition TVs: The acquisition cameras make use of frame-transfer CCD detectors from the EEV CCD 02 - 06 range, having 385 x 288 pixels and are cooled to 228° K by 3-stage Peltier devices. Coated blue-sensitive chips have replaced the original commercial-grade sensors because of complaints from blue star observers. The VGA display is highly interactive, offering movable cursors and features such as seeing-size measurement. Sensitivity is altered by changing the exposure time and/or the color look-up table. Images can be saved to disk. Autoguiding can be performed on stellar images. There is no shutter and timing is accomplished by making use of frame transfers to define the start and stop times of the exposures.

PtSi Infrared Camera: A large format PtSi camera has recently been commissioned. This requires two clock cards and has four independent readout channels. It is described in the contribution of Glass et al. (1995) at this conference.

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