THE AUTOMATED PATROL TELESCOPE

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ABSTRACT. A new astronomical system is nearing completion at U.N.S.W. in which a charge coupled device (CCD) array detector is matched to a Schmidt telescope, with the observations completely analyzed on-line. We have modified a Baker-Nunn satellite tracking camera, with its excellent 0.5m, f/1 super-Schmidt optics, converting it into a computer-controlled equatorially-mounted astronomical telescope. The telescope is expected to be located at Siding Spring Observatory in north-western New South Wales.

The Baker-Nunn telescope consists of a spherical primary mirror 0.76 m in diameter and a 3-element correcting lens 0.5 m across, giving an f/1 beam with a 55 degree corrected field. This section of the original camera remains intact, but substantial modifications were required to produce an economical drive system capable of accurate pointing and tracking.

Precision spherical roller bearings are used on both axes. The declination drive consists of the original worm gear, plus a precision harmonic drive. A separate gearing system eliminates backlash from the worm gear by exerting a constant torque to oppose or augment the main drive. The Right Ascension drive consists of a 1 metre diameter friction-driven disc, plus a precision harmonic drive. The advantages of the friction-driven disc are ease of fabrication, low cost (approximately $400), elimination of backlash, and high efficiency. One disadvantage is the limited torque that can be transmitted, which requires that the telescope be well balanced. Both axes have identical printed-armature d.c. motors. Position and velocity are sensed by incremental encoders, with a resolution of 0.12 arcsec in RA and 0.04 arcsec in Dec. These encoder signals are sent to two 6502 microprocessors which control the drive motors via 10-bit A/D converters, which cover the full range from tracking to slewing. An Apple IIe microcomputer down-loads the required positions to the microprocessors at a rate of 0.2 Hz, while sidereal rate tracking pulses are inserted at ~120 Hz.

J. B. Hearnshaw and P. L. Cottrell (eds.), Instrumentation and Research Programmes for Small Telescopes, 85–86.

The CCD is a GEC P8603, mounted on a thermoelectric cooler within a lightweight dewar. A field of 1.4 x 0.9 degrees results, recorded on the 385 x 576 9 arcsec pixels. Data is transferred via an IEEE-488 bus to an NEC APC III computer for processing. Transfer of a full frame takes about 11 seconds. After processing, the image can be transferred to the TV memory in about 1 second. Thereafter, the TV memory will provide a continuous display of the image.

There are three proposed modes of operating:

A) T.V. frame rate; limiting magnitude $m_v = 10$ in 20 msec.

B) Autoguiding; $m_v = 15$ in 1 second.

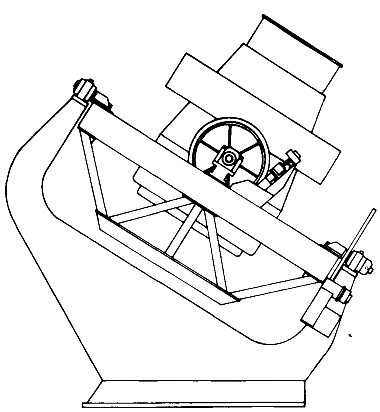
C) Deep Sky Search; $m_v = 19$ in 300 seconds.

(signal to noise ratio of 10:1 in each case). For photometry of variable stars, a 1% change in brightness should be detected at several sigma in an object as faint as $m_v = 15$.

The final system will be completely self-operating, slewing to any position in the sky within 80 secs. It will drive from one pre-specified position to another, observing and analysing over the one square degree field with the CCD. Several analysis modes will be possible: the field can be compared with a stored field from a previous observation and any difference recorded; a specified object could be identified and its brightness measured relative to other objects on the frame; the whole frame can be stored; or one part only of the CCD can be exposed to the sky and successive images shifted to other parts of the chip to give very high time resolution. Special features to be exploited are 1) it gives immediate feedback on transient events so that other observations can be initiated, 2) within limits, it allows searches over a fairly wide field with high time resolution, 3) by processing most of the incoming data on the spot it enables programs to be carried out that would otherwise be swamped in a mountain of data.

With this versatility we envisage a wide range of possible observing programs. These include conventional surface photometry utilizing the large field, supernova searches, monitoring interesting variable stars, and more speculative searches for the optical counterparts to γ-ray bursters.

We are particularly grateful to the Smithsonian Astrophysical Observatory for their donation of the original Baker-Nunn camera.



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