TWO-DIMENSIONAL TELEVISION SYSTEM: APPLICATION FOR DIRECT ACQUISITION OF IMAGES AND SPECKLE INTERFEROMETRY.

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ABSTRACT: A two-dimensional photon counting and analog television system has been developed at the Special Astrophysical Observatory of the Academy of Sciences, USSR, for morphological investigations and photometry of faint extended objects, spectrophotometry and speckle interferometry.

The basic functional block for the acquisition and processing of images is shown in Figure 1. The detector used for photon counting comprises a microchannel plate electrostatically focussed image intensifier coupled by fiber optics to a SIT television tube. We also have had some experience in the application of 3-stage image intensifiers. The general amplification of these cameras is large enough to detect individual photoelectrons.

The frame rate of the television system is 60 Hz for an image size 256 x 256 pixels, and 30 Hz for 128 x 512 pixel images. With the television camera operating as an analog device, the video signal is sent to a fast analog/digital converter which digitizes the image on 5 bits and sends it to the acquisition system. In the photon counting mode, the video pulses are transformed into binary code and processed in a special logic device to compute the exact location of the centres of events. In this case the centroiding electronics send the addresses of photon centres to the integration memory and the corresponding word is incremented. The system operates with an integration memory of 64K x 12 bits built using ferrite elements; a solid state memory for 512 x 512 x 24 bit images is also under preparation, and in the near future will be applied to increase the capability of the system for image processing. In addition, the system provides real time integration and visualization, allowing one to see the image building up as it is displayed on the monitor.

C. M. Humphries (ed.), Instrumentation for Astronomy with Large Optical Telescopes, 279–281.

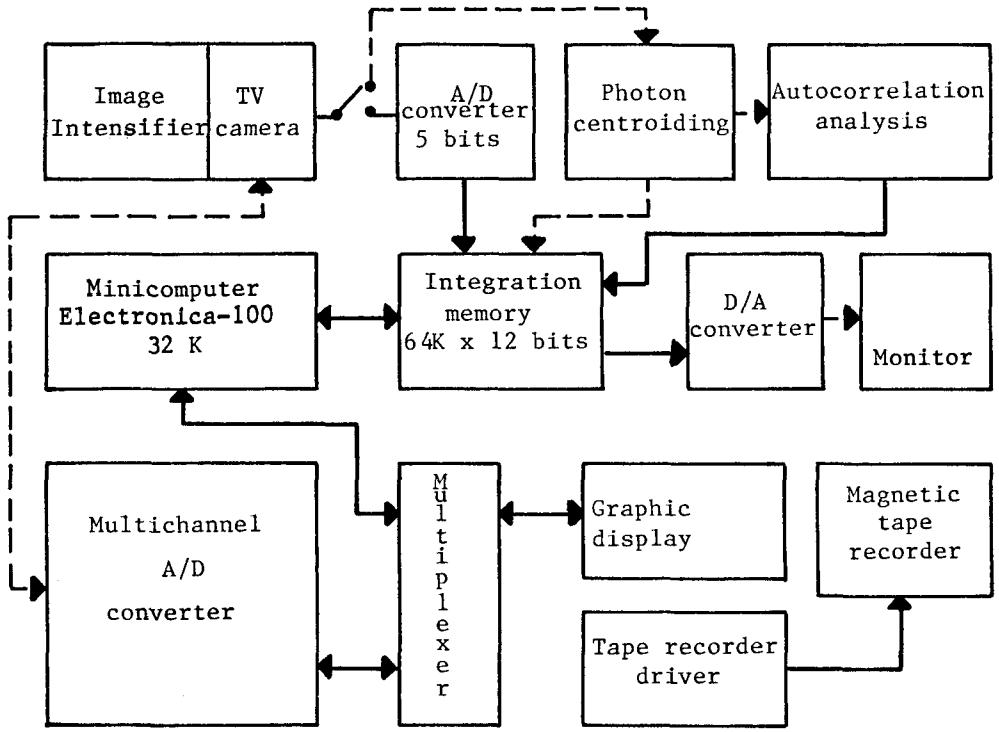

Figure 1. The basic functional block of the real-time acquisition and processing of television images.

The system includes an Electronica-100 Computer which is connected through a multiplexer to the following devices: a graphic display for dialogue between an astronomer and the computer, a multichannel analog/digital converter to receive data from the system's control points, and a digital tape recorder to store the images. The coordinates of the centres of photon events are recorded in parallel on the magnetic tape together with the times of arrival.

There are also program controlled cursors for interaction with the observer. The movement of the cursor over the image is controlled through the display keyboard in 8 directions. The position of the cursor and pixel content at that position are displayed on the screen.

As shown by Blazit et al. (1975), the image photon counting system can be successfully applied to speckle interferometry of faint objects. The processing of images is performed in real time by computation of the histogram of vector differences of coordinates for all photons recorded in each frame. The result is integrated in a small external 128 x 128 x 16 bit memory and continuously displayed during the acquisition.

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The digital approach in current use becomes saturated for bright images corresponding to light fluxes larger than 128 photons per pixel per frame. In this case the remainder of the events are not processed. The commissioning of the processor was first carried out with observations of visual binary stars at the 0.6-m telescope of our observatory (Balega et al. 1981).

At present we are paying attention to the development of the system's software. The main problems to be solved are the following:
(1) removal of those pixels in which parasitic flashes are observed;
(2) suppressing residual artefacts originating from the SIT camera through comparison of adjacent frames;
(3) improvement of the system taking into account only these frames obtained in the best seeing conditions;
(4) compensation for the non-uniform response of the camera;
(5) corrections of small displacements of the image during the acquisition which can occur due to scanning and guiding instabilities.
Algorithms for image reduction using powerful computers are also under development.

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