M.A.M.A. PROJECT: A NEW MEASURING MACHINE IN PARIS

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SUMMARY. A new photographic measuring machine is under construction at Paris Observatory. The amount of transmitted light is measured by a linear array of 1024 photodiodes. Carriage control, data acquisition and on line processing are performed by microprocessors, a S.E.L. 32/27 computer, and an AP 120-B Array Processor. It is expected that a Schmidt telescope plate of size 360 mm square will be scanned in about one hour with pixel size of ten microns.

I. THE MICRODENSITOMETER

The microdensitometer combines a X-Y movable carriage, a quasi monochromatic illumination source, and a multichannel photometer. High scanning speed and flexibility in machine control and data processing are expected from the design of hardware logic and choice of the computer system which includes a parallel processor and a real time oriented mini computer.

Mechanical design

The base is a granite block (1.8 x 1.1 x 0.3 m), plane to within 3 microns. The X-Y carriage consists of two superposed frames with independent perpendicular motions. Each frame is supported and guided by SCHNEEBERGER roller bearings travelling on rectangular ways, and is driven by a feedback loop controlled motor through a ball screw. The positional information is derived from incremental linear moiré fringe transducers (MINILID 300) from HEIDENHAIN. An overall repeatability of 1 micron is expected. The glass table accepts plates of size 550 x 550 mm with maximum thickness 6.35 mm. It can be rotated with respect to the upper carriage in view of some specific applications requiring proper orientation of the plate. The working area being 50 cm in diameter, a whole 360 x 360 mm Schmidt photograph can be measured with only one positioning.

M. Capaccioli (ed.), Astronomy with Schmidt-Type Telescopes, 165–167.

Optical configuration

A regulated quartz-iodine lamp illuminates the slit image plane through a hot half-condenser, a broad-band interference filter, a set of neutral densities, and a cold half condenser. The light is quasi-monochromatic, with wavelength: 633 ± 25 mm. A beam splitter allows a small fraction of the light to be measured by a photodiode for the purpose of flux stability control. The illumination lens forms an image of the slit onto the photographic plate. Finally, the projection lens projects the plate area to be measured onto the 1024 element RETICON linear photodiode array. This array can be replaced by a T.V. camera in view of visual examination.

Two magnifications of 1.6 and 1/1.6 (obtained by rotating the projection lens) associate, to each photodiode, a plate element of 10 x 10 or 25 x 25 microns respectively. The field depth is 16 microns for a numerical aperture of 0.2. The system can be operated by remote control. Automatic or programmable focussing is also being considered to compensate for the variation in plate thickness.

II. MACHINE CONTROL AND DATA ACQUISITION AND PROCESSING

The configuration comprises two subsets :

- The host-computer, array processor, and standard peripherals (for data acquisition and processing).
- The microcomputer system (for management of the microdensitometer automatisms).

The host-computer is a S.E.L. 32/27, with 1 Mbyte memory, hardware floating point, input/ouput processor (IOP), two 80 Mbytes disk units, one 45 ips 800-1600 BPI tape unit, line printer, and consoles.

The AP- 120 B Array Processor (167 ns cycle), with 64 K 38 bits words memory is linked to the acquisition module by a GPIOP (General Purpose Input Output Processor) interface. Due to the parallel organization of the AP-120 B, floating point adds, floating point multiplies, control arithmetic operations, memory access, host/array processor and peripheral input/output data exchanges can all be overlapped in time.

The microcomputer system is essentially composed of :
. The acquisition module ;
. The 6809 master microprocessor which coordinates the different elements of the process (focussing, data acquisition...).
. two slave microprocessors in charge of the X and Y motions.

Data circulation

The output of the reticon array is fed into the analog to digital converter ; the data are then corrected for dark current and sensitivity differences from one photodiode to the other, for the inhomogeneities of

illumination due to the optical system and for the fluctuations of the source of light.

After a transit through the GPIOP, the output of the acquisition module is compressed by the Array Processor which transmits it to the host computer.

III.OPERATING MODES

X as well as Y motions can be performed at velocities as high as 8 mm/sec in measurement mode, and 40 mm/ $_2$sec in pointing mode. The acceleration will be limited to 0.5 m /sec^2, and the standard velocity taken equal to 3.6 mm/sec. With a 10 micron step, this corresponds for the whole set of 1024 photodiodes to a rate of 360,000 measurements per second. At this speed, a 35 x 35 cm plate is scanned in lanes of 10 mm in about one hour.

Each sample being coded with 10 bits, the raw data for the whole plate amount to about 10^{10} bits. Until storage devices of this class have become available and easy to operate, it is clear that one of the two following kinds of operating modes will have to be used :

- scanning of selected areas within the plate, either around successive positions, or along a curve.
- complete scanning of the plate (or of a significant part of the plate), with on-line data compression performed by the array processor.

We are currently investigating the algorithms best suited to these two kinds of data collection, as well as the processing techniques to be used downstream.

REFERENCE

T. Danguy, I.A.U. Working Group on Photographic Problems, meeting on "Astronomical Photography 1981", Nice, 1981, J.L. Heudier and E. Sim Eds.

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