

IMAGE DETECTION SYSTEM FOR SCHMIDT PLATES

Hideo Maehara
Kiso Observatory
Tokyo Astron. Observatory

Tomohiko Yamagata
Department of Astronomy
University of Tokyo

1. INTRODUCTION

A 14-inch Schmidt plate contains 10^9 photographic grains and 10^5 to 10^6 images of stars and galaxies on it. Such a quantity of data is too large to be handled in a conventional way even for a big computer.

There is, in general, an alternative method to solve this problem; one is to store the data of all pixels on intermediate medium (e.g., magnetic tape), and reduce them into image parameters afterwards. The other method is to do all the processing simultaneously with the measurement. The latter is very useful for the automated detection of celestial images on large Schmidt plates.

In this short note, we describe our system operated at the Kiso Observatory. We have built a machine capable of the former method, and are extending and improving it toward a high-speed automatic processing of Schmidt plates. The previous stages of the system were reported in Maehara and Watanabe (1980) and Maehara (1981).

2. HARDWARE AND SOFTWARE

A measuring machine (isophotometer) at Kiso is equipped with a linear CCD (CCD121H) composed of 1728 elements with a 13- μ m pitch. A plate is scanned perpendicular to the array of the detector with a 22-mm width. Transmission (T) values of all pixels are stored on a magnetic tape ranging from 0 to 1023.

The sampling speed attains up to 60 kHz, but it is usually limited to about 6 kHz due to the capability of the present mag. tape handler. The block diagram of the hardware is illustrated in Figure 1, where the measuring machine is to the left, the control computer is to the upper right, and the processing computer is to the lower right.

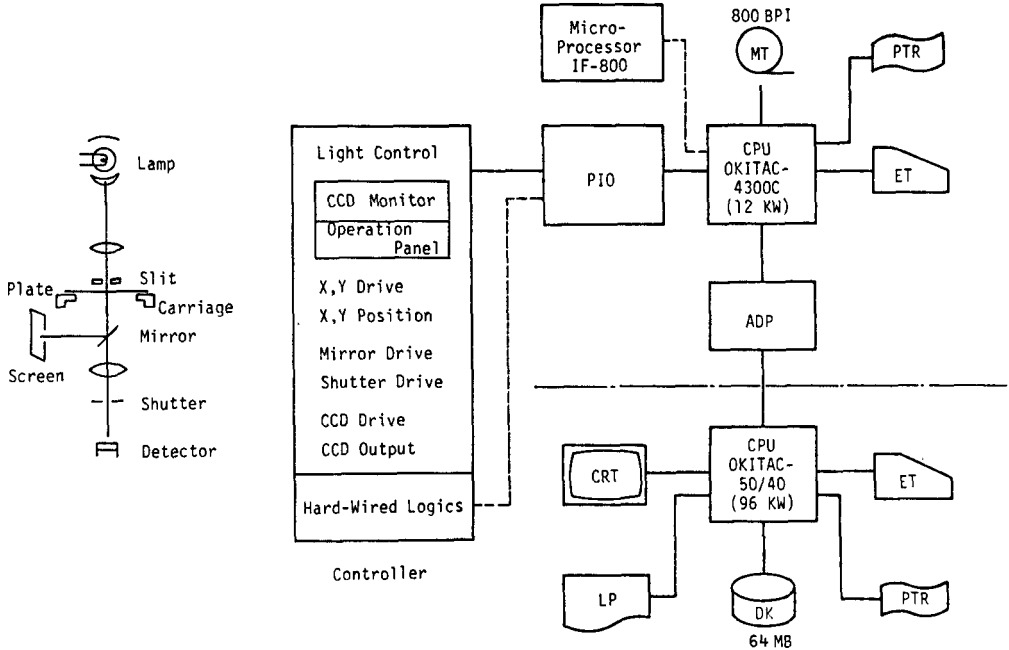


Figure 1. Block diagram of the hardware

The fundamental portion of the present line-up was built nearly ten years ago, and the successive extension of the capability has been followed. Recently, a module of hard-wired logic circuits has been attached to the system which corrects the non-uniformity of the sensitivity of detector elements, converts pixel data to intensity, and picks up image parameters along a scanning line. This module is being incorporated into the system by the software.

Two sets of processing programs are currently available to detect images from pixel data on a mag. tape. The former (Version 1) adopts a simple and straightforward algorithm suitable for the on-site mini-computers. It gives us several parameters including the central position, the fractional areas of some T ranges, and the magnitude parameter (Maehara 1981).

The other (Version 2) is a more sophisticated software for bigger computers which applies the moment analysis up to the second order of the pixel distribution (Stobie 1980). The discrimination of images among stars, galaxies, and overlapped objects is sufficiently achieved with the use of the moments and their combinations. Several kinds of image maps can be plotted in order to identify detected objects.

3. PERFORMANCE AND APPLICATION

The performance of the measuring machine was examined; the linearity and the reproducibility of pixel data are fairly good. Since the long-term stability of output values is affected by the variation of the source lamp, the calibration of the (absolute) sensitivity must be made every few hours. The spatial resolution of each detector element is not so high as its geometrical size. In this circumstance, the mechanism is being installed which is capable of putting narrow slits (0.1- to 0.6-mm width) in front of the plate.

The accuracy of image parameters is generally better for the software of Version 2. Its r.m.s. errors of the image position and the brightness are respectively about 0.2 arcsecond and 0.1 magnitude, though they depend on the plate quality. The reproducibility of these parameters are better than the above values.

This system has been used as an isophotometer to obtain isophotometric maps of nebulae and galaxies (e.g., Mizuno et al 1981, Watanabe et al 1982), though high-speed microdensitometers are frequently used for this purpose. In addition, it has been utilized to count stars and galaxies in selected areas of Schmidt plates.

Yamagata et al (1983) are working in the luminosity function of galaxies in poor clusters of galaxies. The determination of the cluster extension and the field correction is statistically carried out from the data in surrounding areas. The results thus obtained are discussed by comparison with rich clusters of galaxies. The scarcity of faint members characterizes these poor clusters.

A further improvement of this system will be made toward the fully automatic image detection for Schmidt plates.

The authors thank staff members of the Kiso Observatory for the assistance in setting up and examining the system.

REFERENCES

- Maehara, H. 1981, American Astron. Soc. Photo-Bulletin No. 26.
Maehara, H., and Watanabe, M. 1980, in "Optical and Infrared Telescopes for 1990's", (ed. A.Hewitt), p677.
Mizuno, S., Sakka, K., Sasaki, T., and Kogure, T. 1981, Astrophys. Space Sci. 78, 235.
Stobie, R. S. 1980, in "Applications of Digital Image Processing to Astronomy", (ed. D.A.Elliott), p208.
Watanabe, M., Kodaira, K., and Okamura, S. 1982, Astrophys. J. Suppl. 50, 1.
Yamagata, T., Maehara, H., Okamura, S., and Takase, B. 1983, in preparation.