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CCD AT BELGRADE LARGE TRANSIT INSTRUMENT

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Abstract. A project for the installation of CCD electrooptical sensors on the Large Transit Instrument (LTI) of Belgrade Observatory is given. The basic task is the realization of the hardware and software with the selection of the optimal CCD sensor and standard personal computer for the purpose of functional verification of the entire system.

1. SELECTION OF THE CCD ELECTROOPTICAL SENSOR

The first phase of the project related to the installation of the CCD electrooptical sensor on LTI ought to provide functional verification of the hardware and software. Having this fact in mind, the basic criterion for the selection of the CCD sensor is to satisfy requirements for meridian observations. The basic parameters, which the sensor has to satisfy are determined by the characteristics of the LTI (f=2578 mm,O=190 mm). The working observation area is 3 to 4 mm and the illumination at the place of CCD sensor, according to the magnitude of the observed star, is :

m = 0	5 lx
m = 8	3×10^{-3} lx
m =10	$0{,}5 \times 10^{-3}$ lx

On the other hand, the minimal number of pixels in the working area which is needed for time registration is 100. Comparing the given requirements with the characteristics of the commercial CCD sensors, one comes to the conclusion that the only problem is the noise level at the ambiental temperature above the 0°C. For example, the FT 800P sensor has the entire width of the sensor field of 5,044 mm. The effective number of the pixels horizontally is 774 and vertically 580. In the working area there are more than 300 pixels which also exceeds the required task. The sensitivity of the of FT 800P sensor for the spectral region of the light which corresponds to the light of observed stars is 30mV/lx or 30μV/mlx. This would be completely satisfactory for stars up to 10th magnitude. With certain software averaging the observations of fainter objects would be possible.

2. ELEMENTS OF THE HARDWARE OF CCD OPTICAL SENSORS

In the first phase of installing of CCD optical sensors on LTI, the use of standard components are envisaged, mostly the existing elements with only a few new most

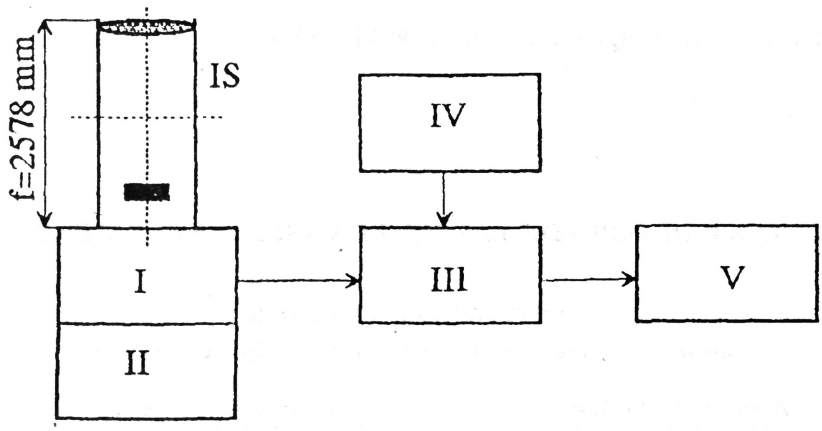

Fig. 1. IS - LTI, I - CCD camera, II - cooling, thermostat, temperature control, device against fogging, III - interface block, IV - main clock, V - personal computer and equipment.

necessary devices. The general block scheme of the proposed system is given in Fig. 1.

The CCD camera and cooling device (thermostat, temperature measuring and control of the CCD sensor, heater against fogging) are installed directly on the eye-piece end of the LTI tube and connected with the interface device. As the LTI is not provided for photometry nor spectroscopy but only for the registration of star transits, it is logical to apply binary monochromatic system of CCD camera (Fig.2).

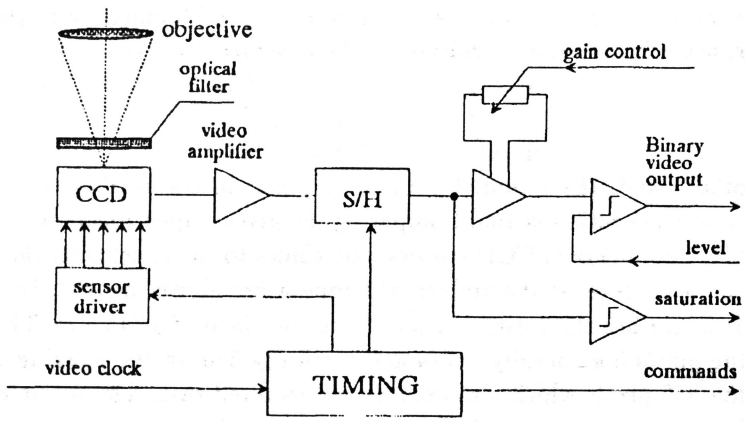

Fig. 2. The scheme of CCD camera system.

The basic commands which arrive at CCD camera are the video clock and comparison level. The video clock determines the CCD scanning regime which depends on the observation object. From the video camera the signal goes to time interface device (Fig. 3)

The basic function of time interface device is to determine the binary (BCD) time code to the serial video signal and to send such signal by serial RS-232 connection to PC input.

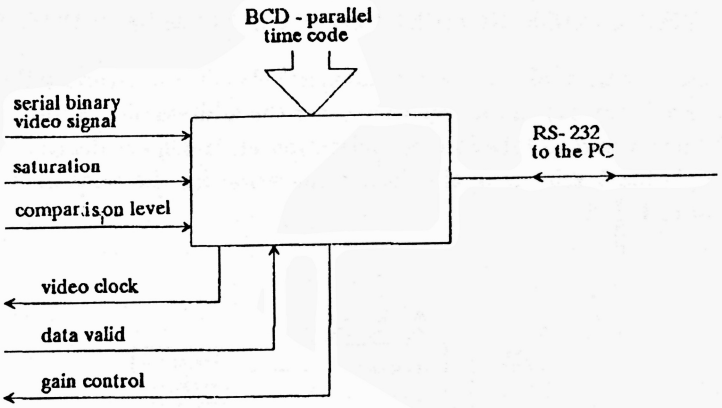

Fig. 3. The time interface device.

3. THE PRINCIPLES OF THE CONSTRUCTION OF CCD CAMERA FOR FUNCTIONING IN THE REAL TIME

The functioning in the real time during star observations with the Large Transit Instrument supposes the establishment of the correspondence between each illuminated pixel of CCD sensor and the time t(UTC) obtained from the local T/P standard. The moment of illumination of each individual pixel, the interval of integration time of the illuminated pixel, intensity of the illumination, velocity and direction of star-image motion across matrix of pixels and jitter of the star-image are the basic parameters (excluding LTI instrumental errors) for time determination of meridian passages. To define the basic conception for functioning in real time t(UTC) it is necessary firstly to analyse the basic structure of the concrete CCD sensor. Simplified structure of the sensor is shown in Fig.4.

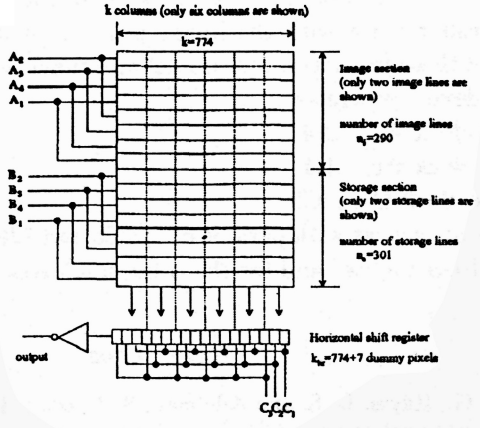

Fig. 4. FT 800P simplified diagram.

4. THE BLOCK SCHEME OF CCD CAMERA FOR LTI

For the determination of the correspondence between local time t(UTC) and the image of observed star, it is necessary to register the address of each illuminated pixel in the CCD matrix and to take into consideration all transport delays.

The principle block scheme of the data preparation for the treatment in the computer is given in Fig. 5.

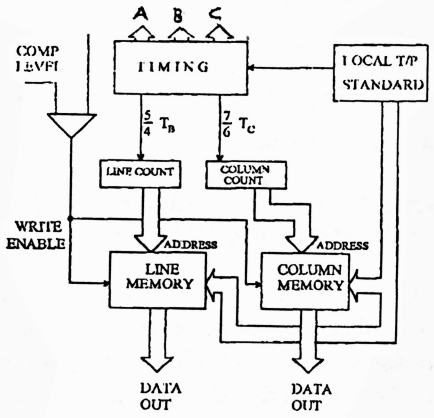

Fig. 5. FT 800P simplified diagram.

From the local T/P standard the device for the timing is incited and the parallel BCD code, which represents the code of the local time t(UTC), is carried out. This code is in correspondence with the image position in line and column memories so that the data of these memories contain definite functional dependence with t(UTC).

The timing device generates :

- four phase clock A1,...,A4
- four phase clock B1,...,B4
- three phase clock C1,...,C3
- the impulse sequences with periods of 5/4Tb and 7/6Tc which represent the clock for the line address counter and for the column address counter.

References

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