ENGINEERING DEVELOPMENT OF TELESCOPE CONTROL SYSTEMS

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ABSTRACT. The engineering development of some variants of computer aided (automatic) control systems is presented for moderate telescopes with step–by–step drives as duty elements and with pulse sensors of BE–198 type as angular sensors.

Key words: Instrumentation: Telescope control system.

Two variants of a controller managing a step–by–step motor provide the use of a control computer in IBM PC standard. They permit to transfer information from sensors through a buffer into a unibus PC and provided software control of step–by–step drives of telescope.

Third variant is the independent module, which provides clock conducting of telescope, setting it in accordance with giving coordinates and output of real position of telescope to digital indicators.

Throughout a number of years, at the Odessa Astronomical observatory moderate telescopes with a mirror up to 1 meter in diameter have been engineered and manufactured. At present several such telescopes are working at the observatories of the Ukraine, countries of CIS and Eastern Europe. To a greater extent telescope operating performances are determined by its control system. The development and modernization of similar systems towards setting is enhanced, and functional possibilities are broadened.

Odessa telescopes are equipped with stepping executive mechanisms by turning a motor rotor by 1.5 degree per step that in using mechanical reductors with the reduction coefficient of 21600/1 provides rotation of a clock axis in steps by 0.25".

The motor control is carried out by an electronic drive with a quartz oscillator, a frequency divider with a variable division coefficient, a phase distributor and a power amplifier with the circuit of forcing phase currents.

The use of divider with a variable division coefficient permits to obtain some fixed rates of driving relative to a clock frequency F (for example, 0.1F, 2F, 10F) and to use them us rates of fast and slow corrections. The control circuit provides the deciphering of commands entering from the outboard control console or from the front panel of the device. The phase distributor with the account of reverse commands forms a three–phase sequence of pulses which after amplifying in power are fed into a stepping motor.

The multidigital divider (quantity of digits is determined by frequency of a master oscillator and a reduction factor) permits to set the rate of clock driving with high precision. For example, at oscillator frequency of 1050 kHz, a 24–digit divider and a reduction factor of 21600/1, the rate of clock driving is set in range from 0 to 600 steps/s with precision of 0.07 steps/s or 0.01"/s. With rise in oscillator frequency and increase in quantity of digits of a divider, one can decrease the value of its less significant digit and respectively increase precision of setting rate.

Because of mass application of computer technique and microprocessor set–ups, a real possibility has arisen of developing and introducing system if control of automated moderate telescopes.

At the Odessa Astronomical Observatory some variants if such automated system with step–by–step drives as executive elements and pulse sensors of BE–198 type as angular sensors have been developed. Sensors of this type provide formation of four–phase sequence of pulses on TTL levels with 90000 pulses in every phase per shaft revolution. In taking account of all the four phases it gives a value of one pulse from the sensor equal to 3.6". The sensors are installed on the telescope axes.

Using personal computers (PC) rather widely spread as control computers is of prospect for similar tracking systems.

At present two variants of a controller have been developed of stepping motors for the telescope by using as the basic PC type IBM AT–286.

Structurally, a controller represents a plate inserted into a connector of the unibus on a mother board of PC. With that, connectors are led into the PC back panel for switching on angle sensors, an outboard control console and power supply unit.

The first variant of the controller permits to transfer information from a sensor to a buffer and transmit it to a common bus of PC, to receive from the common bus and to transmit to a stepping drive the frequency of steps and the reverse signal. On the controller board,which that, a decipherer of address and commands, a buffer, a receiver and a transmitter to line are located. The control program should determine direction of rotation, calculate a turning angle and new telescope coordinates according to observational program, form a necessary step frequency and a signal of the reverse.

The second variant of the controller is constructed on the basis of a programmable timer K580BI53. One of the timer counters (C1) is used for forming pulse frequencies for a step–by–step motor, two others (C1 and C2) are for counting the number of pulses from the angle sensor in rotating towards one side and the other respectively. On the controller board, besides these, there are located a circuit of identifying rotation direction, a register of command signals and an oscillator. In other respects it is analogous to the first variant. The control program should periodically check the contents of registers of counters C1 and C2, determine a current angle, change, if necessary, the division coefficient of C0 and form signal of the reverse.

This variant of a controller is more complicated but it can be served by a compact resident program leaving a possibility of executing any other tasks for the computer.

A module of telescope control is developed and is being tested, it excludes using a control computer. Functionally, it works in the following way.

Signals from sensors are transformed into values of angular displacements in a digital code and are transmitted to indicators and to a comparison circuit. The set value of an hour angle is generated by an oscillator of hour angle and is also transmitted to indicators and to the comparison circuit. The comparison circuit gives a difference between the set hour angle and a current position of the telescope axis. This discordance taking account of its sing is controlling for an executive stepping drive.

As discreteness of a sensor of angular displacements is 14.4" in one phase, the telescope axis rotates in corresponding steps. One can decrease the discreteness by choosing frequency of a stepping drive, with that the smoothness of clock driving being improved.

The module of digital telescope control without using computers is structurally complicated incorporating over 80 packages of microcircuits of medium–scale integration but it can really be made under the conditions of astronomical observatories.