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TECHNICAL REPORT

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WARM Telescope control system (white light active region monitor Coelostat – KODAIKANAL)

ABSTRACT

A three axis control system for WARM telescope is developed. A four axis motion controller next move PCI from Balder Electric Company is used for controlling the three axes. The control code is developed in MINT V5 Software platform.

KEY WORDS : Coelostat, Servo Motors, Absolute Encoder, Limit Switches.

WARM telescope is fabricated and installed at Kodaikanal. The control system is designed and realized in the electronics lab in IIA Bangalore. This is a three Axis system, one track axis and two guide axes[1]. The control components are brushless AC Servo Motors, Microflex brushless AC Servo drives, four axis motion controller PCI add on board, break out board, MINT V5 Software Platform are procured from BALDOR USA.

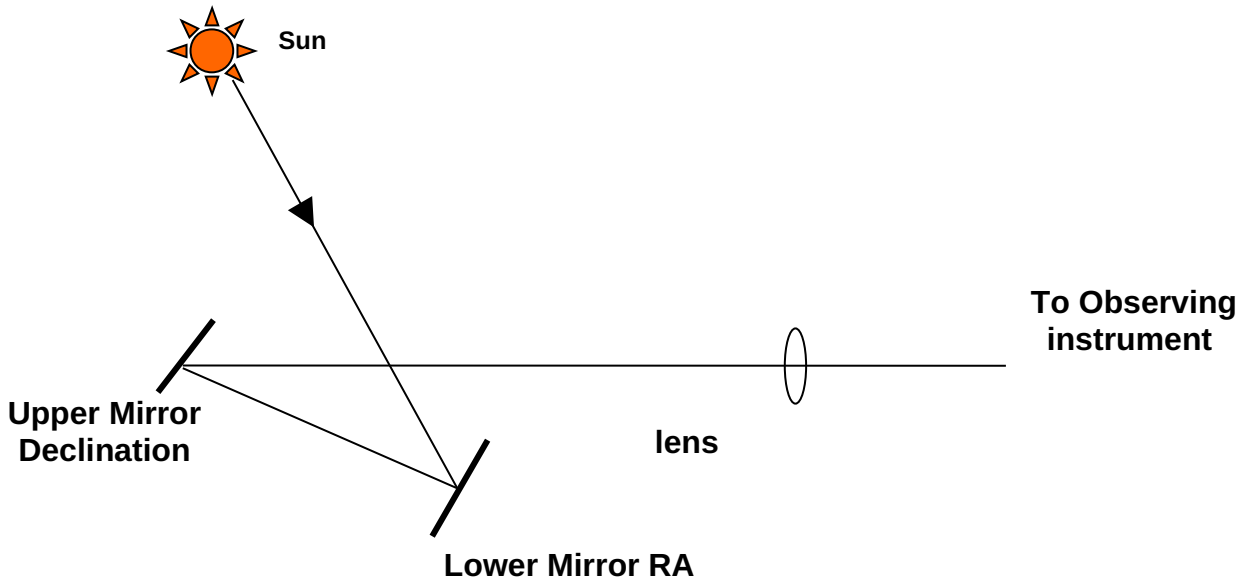


Figure – 1 Coelostat mirror arrangement

The first mirror M1 tracks the sun and second mirror guides the image in the image plane. There are three axes to be controlled one track axis and two Guide axes RA and DEC.

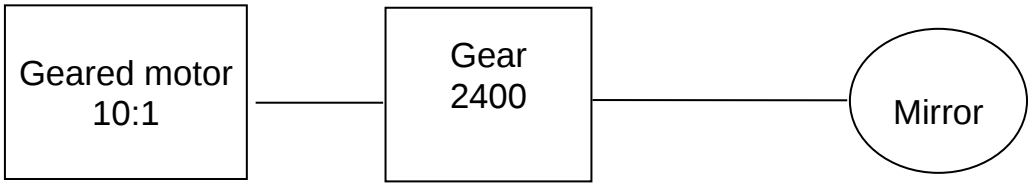


Figure – 2 Track Axis Gear Ratio

The specified pointing and tracking accuracies of the coelostat system [2].

Pointing accuracy = 10 arcsec

Tracking accuracy = 1 arcsec/sec

Microflex is a digital drive utilizing a high performance Digital Signal Processor (DSP) for motor control. With an encoder feedback from the AC servomotor maintains the fractional RPM

required for the tracking and pointing accuracies. Microflex supports digital filter, Proportional integral derivative (PID) control to help reduce resonance with in the machine.

As per technical specification of coelostat a gear ratio of 2400 is introduced in track and guide axes [2]. A 10:1 geared motor is used in three axes.

For a fine speed of 1 arcsec/sec and Guide (Slew) speed of 0.25 degree/Sec the gear ratio of 2400 is selected the selected motor model has a speed range of 0.5 – 10000 RPM. According to company RPM less than 0.5 the motor performance may not be guaranteed.

Motor speed (fine) at 1 arcsec/sec

1 RPS (mirror side) = 360 x 60 x 60 arcsec/sec

$$1 \text{ arcsec/sec} = \frac{1}{360 \times 60 \times 60} \text{ RPS}$$

Gear Ratio = 2400 x 10

$$\text{Motor Speed at 7.5 arcsec/sec} = \frac{1 \times 2400 \times 10 \times 60}{360 \times 60 \times 60} \times 7.5$$

$$= 8.333 \text{ RPM}$$

Second Mirror

Guide axis motor speed 1 degree/sec

$$= \frac{1 \times 2400 \times 10 \times 60}{360} = 4000 \text{ RPM}$$

At 0.25 degree/sec = 1000 RPM

Control system components

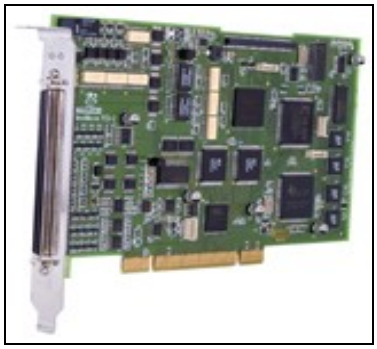
The selected motor is Brushless Ac servo motor from Baldor

MODEL - BSM 63N 133AS1

Motor speed 0-10000 RPM

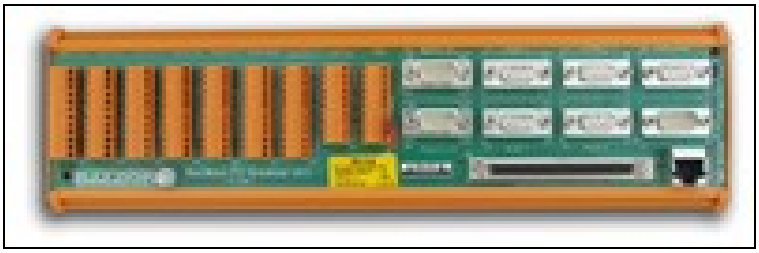
Encoder feed back

The selected Drive Brushless AC Servo drive from Baldor.



Four axis motion controller Next Move PCI is from Baldor

Break out board :



- Digital I/O
- ADC and DAC
- Encoder feed back connectors

The motion controller is connected to the breakout board using a three meter cable. The board has encoder feedback connectors,

digital I/O connector's analog in and drive enable signal for controllers.

Absolute Encoder

Absolute encoders are devices that convert a mechanical position into a representative electrical signal by means of a patterned disk, a light source and photosensitive elements. With proper interface electronics position can be derived. An absolute encoder model ROC 417 from Heiden hain is mounted on axis in the track axis to the coelostat. ROC417 is a 17 bit encoder, the track axis mirror can be positioned with a resolution of 9.8876 arcsec. the resolution of the built in encoder in BSM series motors is lower than the Rotary encoder ROC417.

2^{17} = 360 x 60 x 60 arcsec

$$1 \text{ bit} = \frac{360 \times 60 \times 60}{2^{17}}$$

= 9.8876 arcsec

Limit Switches :

Six limit switches are provided in primary and secondary mirrors. Two in the track axis and four in the guide axis. Limit switches are procured from Allen - Bradley 802 B Compact precision Rotary Arm low voltage/ current model No.802B-CSDAXSXC3. Limit switches are used to prevent the primary and secondary mirrors from moving out of range.

Figure – 3 Limit Switch

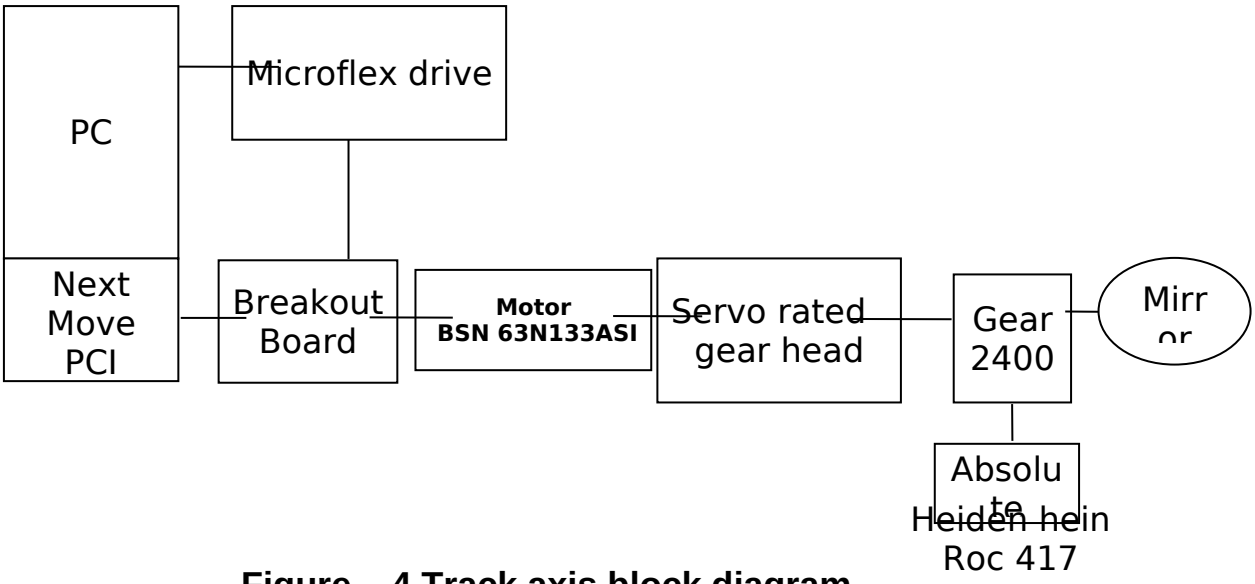


Figure – 4 Track axis block diagram

The track axis block diagram is shown above. The two guide axes also has the same components

The control system rack

The control system rack contains four bins. One track bin and two guide bins. The fourth bin DC power supply has six 24V DC and one 5 volt supply.

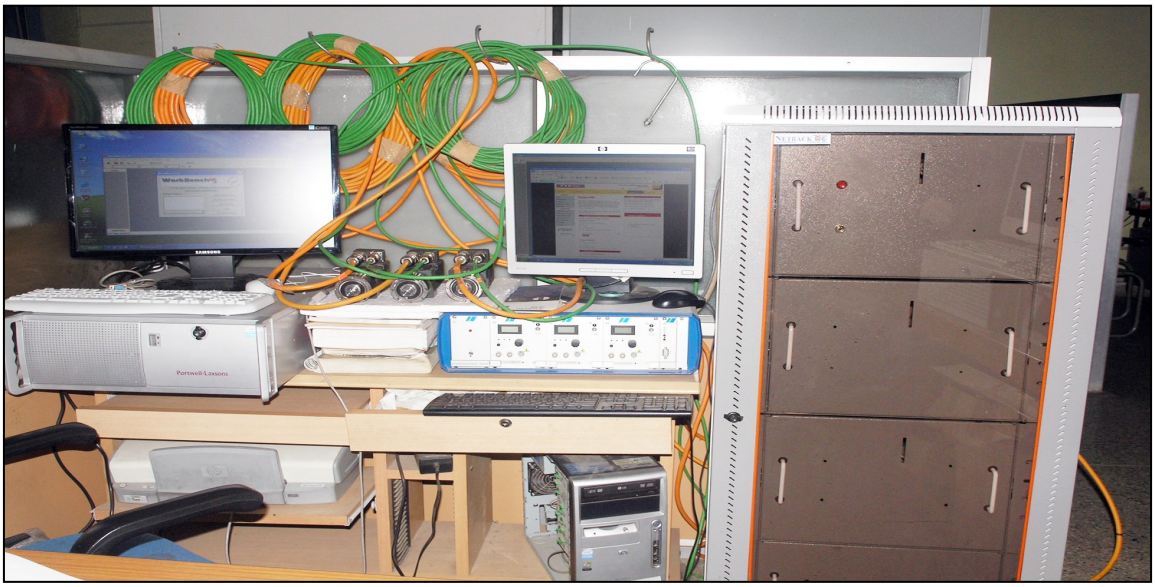
The mounting of drives MCB's, filters, dynamic brakes fixing of connectors, slots for cables etc in the bins done at IIA work shop.

The internal wiring of bins, bin to bin wiring carried out at Electronics lab. IIA Bangalore.

The factory (where the coelostat is fabricated) testing of mirror movements (three axes) with the coupling of the motors and drives are successfully carried out at factory premises in Peenya Bangalore India.

The laboratory testing of motor speed, torque, direction control in Mint V5 platform is under progress. The user interface is through a Microsoft visual basic application that uses Mint MT activeX control to communicate with Next move PCI controller.

The controller trouble shooting procedure is explained in the microflex servo control installation manual MN 1919. Balder electric company



Control System Testing in the Electronics Lab

CONCLUSION

The control system is developed with brushless AC servomotors, AC Servo drives and a motion controller. The motor has built in encoders. With the support of MINT and Active X software platforms very precision image tracking and a guiding is possible with the system.

ACKNOWLEDGEMENTS

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