THE NEW MLRS ENCODER SYSTEM: PROGRESS REPORT

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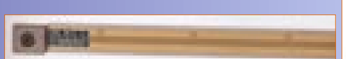
ABSTRACT

The McDonald Laser Ranging Station (MLRS), a part of the NASA SLR network, ranges to numerous artificial satellites and the Moon. Successful lunar data acquisition requires very accurate telescope pointing and tracking. At present, absolute encoders combined with physical mount modeling provides 1 arcsecond precision lunar tracking over several minutes and reproducible pointing at the few arcseconds level. However, since the manufacturer of the yoke axis encoder no longer provides bulbs for our model, we need to be prepared to replace the system. The cost of buying a new absolute encoder with the same 0.62 arcsecond precision and the required interface upgrades makes this approach unrealistic. Our solution is to mount a linear encoder tape on the "belly" of the yoke axis, with a stationary read head mounted on the telescope frame. This incremental encoder would send pulses indicating 0.1 arcsecond steps to the existing up-down counter, maintaining resolution for the servo system while improving resolution for the telescope pointing. Although the new encoder requires zeroing after each time the system is powered down, the computer assisted procedure would require about a minute of work by the observer. This is a reasonable trade off for the factor of 10 reduction in cost. Progress on this work will be presented at the meeting.



THE HEIDENHAIN ENCODER

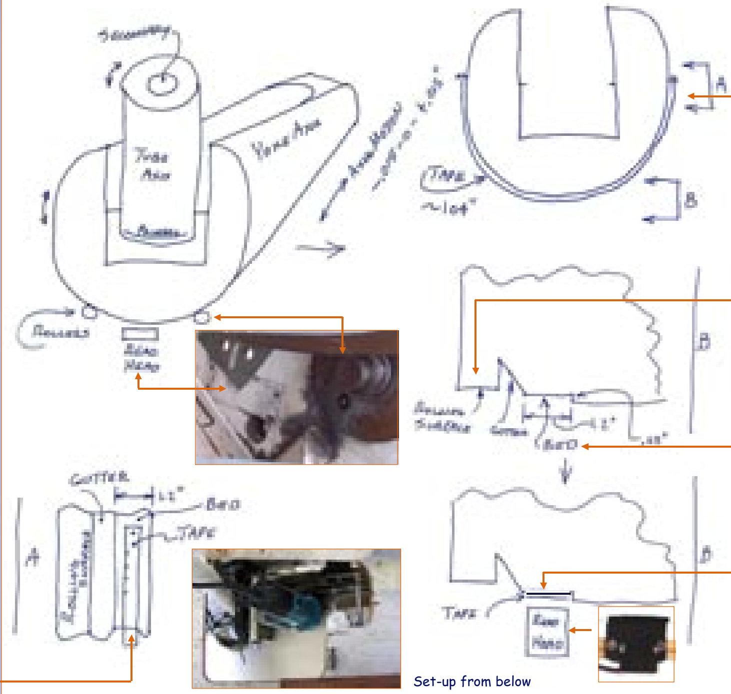
The heart of the new MLRS yoke axis encoder system is a 104 inch long,carrier-free, flexible steel tape with linear grating etched in gold center stripe. While the grating lines are 40 micron apart, the photoelectrical scanning reader allows the tape position to be determined to 0.4 micron, which translates to 0.1 arcsecond resolution in pointing. This allows it to interact with the original pointing hardware without further modification.

The encoder will be mounted on the belly of telescope tube, and will be exposed to weather. However, the tape will be tension mounted, thus always in contact with the telescope tube. it should expend or contract together with the tube and expected to be transparent to temperature variations.

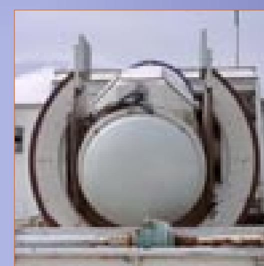
An additional feature of this linear encoder tape is the presence of distance markers next to the central grating. Each marker has a unique code, thus by moving the telescope between to neighboring mark (10 mm) its absolute pointing direction can be determined to 0.1 arcseconds. It is in essence also an absolute encoder, with better pointing resolution than the original absolute encoder (0.6 arcseconds) it is designed to replace.

The encoder system, including a separate calibration system to check that reader head is mounted correctly will cost less than $3000, which is substantial saving even over the original estimate for the replacement.

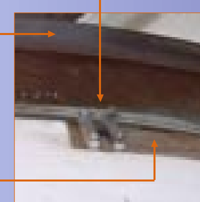
ENCODER SCHEMATICS



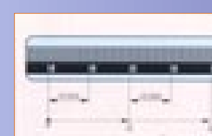
Set-up from below



Yoke axis end of the telescope



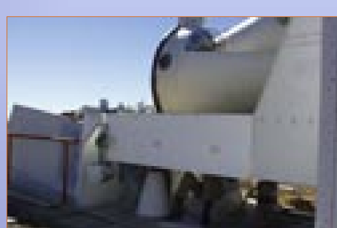
Tension-mount end of the tape bed



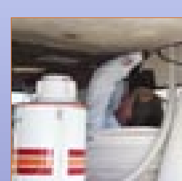
Distance coded reference marks on the optically scanned linear encoder

Photoelectric, single field scanning, using the imaging principle

The new encoder directly reads out the telescope position, thus eliminating systematic errors introduced by gears and bearings in the original incremental encoder.



Grinding set-up



The customized grinder

PREPARING THE ENCODER BED

Proper surface preparation was necessary to ensure that the encoder tape will always be at the same distance from a fixed point on the telescope frame (reader head). The telescope tube was not built according to such strict specifications, thus a 1.25 inch wide bed was ground on the yoke "belly".

I special, custom tool was built by J. Wiant to do the grinding. He mounted an electrical grinder on a three axis precision jig, which in turn was mounted on the telescope frame. The telescope was moved by a small amount each time the grinder finished across the width of the bed. A micrometer was used to gauge the progress of the grinding Eventually an about 9 foot long bed was ground, which is concentric with the yoke axis. The grinding, which took 200 hour to complete,, did not interfere with regular ranging operations.

Photo and graphics:

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Heidenhain product catalog