High precision steering and pointing control of a Lunar/Satellite Laser Ranging telescope

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Research Project

• A dual Satellite lunar Laser Ranging (S/LLR) is being developed by HartRAO in collaboration with the Observatoire de la Côte d’Azur (OCA) and NASA as part of geodetic instrumentation to be located at a new fundamental space geodetic station for South Africa.

• Develop and implement high-precision steering & pointing control of LLR telescope
• Additional tests to be done while the telescope is refurbished
• Software is being developed in-house and will initially be tested on a test-bed telescope
• Require high quality servo control systems, drive motors, encoders and gearboxes
• Evaluate existing equipment
• Identify the most suitable equipment
• Incorporate safety aspects into design of control circuitry
Mechanical aspects of the existing drive trains

The elevation gearbox had to be removed with an overhead crane and disassembled. Virtually no mechanical drawings exist of the telescope assembly, which complicated the process of safely removing the gearboxes. An hydraulic lifting platform was purchased to safely remove the azimuth gearbox, which is located under the telescope azimuth-elevation mount.
Gearboxes

All gearboxes had to be removed, stripped and inspected before reassembly and reinstallation. Clutch tensioning springs had to be refurbished and all seals were replaced.

Oil in the gearboxes were tested to find matching modern alternatives.
Equipment Used for Tests

- Equipment set up in laboratory
- Equipment adapted to use on telescope
- Vagon 3-phase VSD with linear 1024 pulse encoder
- Backlash measurements
Mechanical Influences

- Set clock to zero. Motor moves 1000 turns in one direction and then returns to home position. Backlash measured as 0.018 mm.
- Torque tests
Test bed telescope control system. Software is being developed which will enable accurate tracking of either satellites, the Moon or calibration stars.
Servo controls and power supply (left) and microcontroller (right) of the test-bed telescope. The system is accessed via a small dual core PC, which has solid state memory and no fans for cooling to eliminate vibrations.
Total Electrical Retrofit

- Design new control circuitry
- New sensors and monitoring equipment
- Positioning of encoders and motors
The Way Forward

• While the refurbishing of the telescope is taking place several additional tests will be done.

• Control simulations linked to the mechanical specifications based on the test results will determine the required specifications of the motors, variable speed drives, position encoders and the required safety interlocks.

• Analysis of required equipment

• Simulation and modelling

• Paper on mechanical characteristics of the telescope
Conclusion

Thank you for your interest. Any Questions?