High-precision steering and pointing control of a satellite/lunar laser ranging telescope

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\section*{ABSTRACT}

A dual Satellite/Lunar Laser Ranging (S/LLR) is being developed by HartRAO in collaboration with 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. We report on the development of a high-precision steering and pointing control system for the LLR telescope. The S/LLR telescope must acquire and track retro-reflector arrays on the Moon’s surface with high accuracy as well as satellites. We aim to achieve pointing accuracy of 1 arc-second. This requires advanced tracking software, high quality servo control systems and drive motors. The software is being developed in-house and will initially be tested on a test-bed telescope. It is planned to migrate this system to the S/LLR telescope after initial developments are completed. An advanced pointing model will be incorporated into the software to model out any pointing errors. Thermal transducers, managed by a microcontroller, will aid in characterizing mechanical deformation which affects pointing accuracy. A thorough analysis of the telescope’s mechanical systems is being undertaken at HartRAO. Gear ratios, backlash and torque values have been measured. Suitable motors and drives for the azimuth and elevation axes have been identified. Preliminary designs for the implementation of tape encoders have been made; these will have to be custom adapted to suit the telescope. Performance simulations to optimise the system to control speed, acceleration limits, overshoot, maximum speed and settling time have been initiated. A decision matrix has been compiled to determine whether a graphical programming language such as National Instruments LabView linked to a compactRIO or a C++ microprocessor based system should be employed for overall control. Determining factors include the ability to develop in-house software, ease of use when programming and interfacing with hardware, condition monitoring with error conditions and also cost implications.

\textbf{KEYWORDS:} lunar laser ranging, telescope control