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Author: Mr. Nathaniel Shearer
The University of Adelaide, Australia, a1669023@student.adelaide.edu.au

Mr. Luke Heffernan
The University of Adelaide, Australia, luke.heffernan@student.adelaide.edu.au
Mr. Jayden Inglis
University of Adelaide, Australia, jayden.inglis@hotmail.com
Mr. Zachary Holmes
The University of Adelaide, Australia, zac.holmes.94@gmail.com

QUAD STAGE RISLEY PRISM FOR FINE AND COARSE CONTROL

Abstract

Directional control of a laser beam for tracking applications involves acquisition of a target and tracking thereafter. Once the target is acquired, the magnitude of the pointing error that must be corrected for is small, relative to the Field-Of-View (FOV); if the target is lost, however, the pointing error may become a significant proportion of the FOV. Directing the beam through two consecutive stages of dual Risley prism control, separates overall control into two regimes, requiring less effort from each individual actuator, as the sensors can operate within a suitable dynamic range for their respective error correction regime. This allows precise acquisition and tracking to be performed as quickly and efficiently as possible.

The ability for a Risley Prism to deflect a laser beam is directly related to the angle of its face. A set of Risley Prisms with large angled faces produces a large FOV for tracking and fast scanning of the laser, whereas a set of small angled Risley Prisms constricts the FOV and scanning speed but increases the precision of the beam scanning. To construct the two stage beam steering, a 1064 nm laser was passed through a set of prisms with a 2^o face angle, providing the fine control, then through a set of prisms with a 10^o face angle, providing the course control. The described setup was then tested through a variety of scanning patterns to characterize the speed and precision.

Our results showed that Multi stage control was preferable for acquisition and tracking in free space optical communications applications. After preliminary lab based testing, this system of fine and coarse control, compared to using a single set of Risley Prisms, allowed for much more intricate scanning patterns to be followed. However, combining the two stages accentuated the error. At large deflection in the course stage, systematic error appeared in the fine tracking.

Utilizing two sets of Risley Prisms, with different face angles, proved effective at creating fine and course stage control. For the preliminary tests performed only a simple optical model was developed and used for the controller. Further analysis must be done to increase the fidelity of this model in an attempt to find the source of systematic error and improve the controller.