

## Exact non-linear scan patterns of laser scanners with rotational Risley prisms: mathematical analysis, simulations, and experiments

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*Abstract:* Rotational Risley prisms are one of the fastest two-dimensional (2D) laser scanning systems. Their drawback is the strong non-linearity of the scan patterns they produce, in contrast to the most common raster scanning generated with 2D dual axis galvanometer scanners (GSs) or with Micro-Electro-Mechanical Systems (MEMS) with oscillatory mirrors. The aim of this paper is to present the graphical method (that, to our knowledge, we have introduced) in order to determine, using commercially-available mechanical design programs, the exact scan patterns of pairs of rotational Risley prisms. These patterns are compared both with the common raster scanning and with the most recent spiral scanning — which are both slow, as they use 2D GSs or MEMS. A multi-parameter analysis is developed for this purpose — considering all the four possible configurations of Risley prisms scanners. Both the angular and the linear deviations through the prisms are deduced and their non-linear functions are studied. Various parameters of the prisms and of the assembly are considered: the prisms angles, their rotational speeds, as well as the distances between the prisms and from the system to the scanned plane. Experimental validations complete the mathematical analysis and the simulations.

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