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Laser scanners with rotational polygon mirrors: A multi-parameter optomechanical analysis and optimization

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Abstract: We analyse laser scanning heads with rotational polygonal mirrors (PMs) [1]. A comparison to the most common galvanometer scanners (GSs) is performed from the point of view of their non-linear scanning functions and variable scanning speeds [2-4]. The novel theory we developed for PM scanners is used [5]. A multi-parameter analysis of PMs is carried out, considering all their constructive and functional parameters, including the PM apothem, their number of facets, the eccentricity of the incident laser beam on the PM, the distance from this beam to the objective lens, and the rotational speed. The impact of these parameters on the non-linearity of the scanning function is studied, for applications that range from industrial measurements to high-end imaging systems [6,7]. Solutions are explored to decrease this non-linearity, including by employing supplemental mirrors. A Finite Element Analysis (FEA) of polygons is performed, and conclusions are drawn on their maximum rotational speed from the condition to preserve their structural integrity; this analysis considers both material characteristics and all PM and assembly dimensions. An optimized designing scheme that incorporates both optical and mechanical aspects concludes the study.

Keywords: laser scanners, optomechanics, mechatronics, polygon mirror, galvanometer scanners, scanning function, multi-parameter analysis, Finite Element Analysis (FEA), optimization.

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