Title : *Performance evaluation of DC motor-driven mirror mount for automatic laser alignment system.*

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ABSTRACT

In Atomic, Molecular, and Optical (AMO) physics experiments, precise control of laser beam properties is essential for achieving high experimental fidelity. However, laser beam alignment in optical circuits often drifts over time due to mechanical instability and environmental fluctuations. This work presents the development of a direct current (DC) motor integrated with a kinematic mirror mount for automated laser alignment system. The system is controlled via an Arduino board generating programmable pulse signals, while a CMOS camera is employed for beam position monitoring.

The study focuses on evaluating the accuracy and precision of mirror-angle adjustments by applying pulse durations ranging from 10 to 500 ms. Beam displacement in both horizontal (x) and vertical (y) directions was characterized for forward and backward motions. Experimental results demonstrate strong linear correlations between beam displacement and pulse duration. For forward motion, the relationships are described by $x = 1.3682t + 4.0514$ ($R^2 = 0.9948$) and $y = 0.5896t + 5.0554$ ($R^2 = 0.9518$). For backward motion, the corresponding relations are $x = 1.4046t - 21.347$ ($R^2 = 0.9988$) and $y = 0.5861t - 8.6903$ ($R^2 = 0.9624$). The system achieves positioning errors below 5% when the pulse duration exceeds 100 ms.

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These results indicate that the DC motor–driven mirror mechanism exhibits predominantly linear behavior suitable for feedback-based beam stabilization systems, despite observable asymmetry between forward and backward motions. With further refinement, the proposed approach has strong potential for integration into automated laser alignment systems in AMO research, including quantum sensing, quantum simulation, and optical trapping of individual atoms.

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