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Impacts of sensor layouts on the performance of a long-stroke nano-positioning stage

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Abstract

This article develops a long-stroke nano-positioning stage and discusses the impacts of sensor layouts on the positioning performance. The stage consists of a piezoelectric-transducer stage and a motor stage. First, we obtain the transfer functions of the two stages by experiments and design robust loop-shaping controllers to improve their performance. Second, we integrate the two stages and designed two sensor layouts, a local sensor layout using encoders and a global sensor layout using laser interferometers, to achieve precision positioning for large travels. Finally, we implement the designed controllers and sensor layouts for experimental verification. Based on the results, the proposed combined stage is deemed effective in accomplishing nano-positioning for long displacements. In addition, the local sensor layout can achieve high precision but with global misalignments, while the global sensor layout can eliminate the global misalignments but suffer large sensor noises. Therefore, we further constructed a modified sensor layout that can combine the merits and achieve precision positioning with a root-mean-square error of 5 nm and a misalignment error of 16 nm for a 10-cm travel