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Flexible Programmable Circuit Board Electromagnetic 1-D Scanning Micro-Mirror Laser Rangefinder by Active Triangulation

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Abstract : Scanners have been implemented within single point laser rangefinders, to determine the ranges within an environment by sweeping the laser spot across the surface of interest. The research motivation is to exploit a smaller and cheaper alternative scanning component for the emitting portion within current designs of laser rangefinders. This research implements an FPCB (Flexible Programmable Circuit Board) Electromagnetic 1-Dimensional scanning micro-mirror as a scanning component for laser rangefinding by means of triangulation. The prototype uses a laser module, micro-mirror, and receiver. The laser module is infrared (850 nm) with a power output of 4.5 mW. The receiver consists of a 50 mm convex lens and a 45mm 1-dimensional PSD (Position Sensitive Detector) placed at the focal length of the lens at 50 mm. The scanning component is an elliptical Micro-Mirror attached onto an FPCB Structure. The FPCB structure has two miniature magnets placed symmetrically underneath it on either side, which are then electromagnetically actuated by small solenoids, causing the FPCB to mechanically rotate about its torsion beams. The laser module projects a laser spot onto the micro-mirror surface, hence producing a scanning motion of the laser spot during the rotational actuation of the FPCB. The receiver is placed at a fixed distance from the micro-mirror scanner and is oriented to capture the scanning motion of the laser spot during operation. The elliptical aperture dimensions of the micro-mirror are 8mm by 5.5 mm. The micro-mirror is supported by an FPCB with two torsion beams with dimensions of 4mm by 0.5mm. The overall length of the FPCB is 23 mm. The voltage supplied to the solenoids is sinusoidal with an amplitude of 3.5 volts and 4.5 volts to achieve optical scanning angles of +/- 10 and +/- 17 degrees respectively. The operating scanning frequency during experiments was 5 Hz. For an optical angle of +/- 10 degrees, the prototype is capable of detecting objects within the ranges from 0.3-1.2 meters with an error of less than 15%. As for an optical angle of +/- 17 degrees the measuring range was from 0.3-0.7 meters with an error of 16% or less. Discrepancy between the experimental and actual data is possibly caused by misalignment of the components during experiments. Furthermore, the power of the laser spot collected by the receiver gradually decreased as the object was placed further from the sensor. A higher powered laser will be tested to potentially measure further distances more accurately. Moreover, a wide-angled lens will be used in future experiments when higher scanning angles are used. Modulation within the current and future higher powered lasers will be implemented to enable the operation of the laser rangefinder prototype without the use of safety goggles.

Keywords : FPCB electromagnetic 1-D scanning micro-mirror, laser rangefinder, position sensitive detector, PSD, triangulation
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