Optically Illuminated Directional Sensing for Guidance and Alignment Systems

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Optical guidance and alignment systems offer commercial applications in smart-home, elderly-aid and prosthetic systems. Conventional solutions that employ digital image processing for guidance and alignment are resource inefficient and thus costly to implement. This project explored the feasibility of using a common laser pointer for low-power, cost-effective optical guidance. In this vein, a compact electronic sensing system, capable of navigating a small land robot using a beam of laser light as a proof of concept, was developed. Primary emphasis was placed on the characterization, design and implementation of the electrical circuitry to facilitate accurate and reliable detection and processing of an optical signal from a laser point on the wall. The system comprised: a laser pointer modulated at 511Hz using a quadrature oscillator; four compact, low-cost photodiode sensors to detect the modulated light signature; and a comprehensive quadrature lock-in amplifier circuit to filter out ambient noise and undesired light interference. The demodulated analog signal was then digitized and sent to a microcontroller, where a self-developed algorithm was used to actuate the robot in the direction of the reflected light. The hardware prototype, containing the sensors, circuits, motors and a battery pack, was integrated onto a compact 500g, 16x16x18cm omnidirectional robotic platform for maneuverability. The final system implementation responded successfully to the direction of reflected light in our tests, with acceptable sensitivity and robust noise rejection. Our innovative system could potentially be adapted, with some enhancements, for guiding and directing smart-home robots, elderly-aid and prosthetic devices, motorized wheelchairs or vehicle parking.