A NOVEL SIX DEGREE-OF-FREEDOM SENSOR WITH APPLICATIONS IN DISTURBANCE COMPENSATION

by

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An Abstract of a Thesis Submitted to the Graduate
Faculty of Rensselaer Polytechnic Institute
in Partial Fulfillment of the
Requirements for the degree of
MASTER OF SCIENCE
Major Subject: ELECTRICAL ENGINEERING

The original of the complete thesis is on file
in the Rensselaer Polytechnic Institute Library

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Troy, New York

May, 2010
(For Graduation August 2010)

ABSTRACT

High-precision positional and angular measurements are important for a variety of tasks, including navigation, automation, and surveying. Such measurements are often obtained by measuring angles between fixed and moveable points. These angles can then be used to calculate the Cartesian coordinates of an object using simple trigonometric formulae.

The goal of this thesis is to present a prototype laser-based measurement system capable of resolving angular changes as small as 0.0005^{o} (0.5 millidegrees). Two pairs of angular measurements are made and used to compute the Cartesian coordinates of two moveable sensors. Based on this angular resolution, with laser measurement beacons spaced 15m apart covering a 15m square area, the x and y position of each sensor can be determined with an accuracy of ±0.5mm. These two sets of coordinates can then be used to determine the rotation of the sensors with respect to the measurement points. Each sensor is also capable of determining the location of an intercepting laser beam along its z-axis, with an accuracy of ±0.3mm. All of this data, coupled with two accelerometers which sense angles with respect to gravity, allows us to completely sense motion in all six degrees of freedom: x, y, z, pitch, roll, and yaw.

Finally, the sensing system described here will be tested through an application in disturbance compensation. A six degree of freedom (6-DOF) robotic arm provided by Stäubli Robotics will be mounted on an oscillating platform. Our sensors will measure its motion through space and send the necessary corrections to the controller. This will cause the robot's end effector to maintain a stable absolute position in space despite large movements of the base.