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Jiangtao Yu
yu14n@uwindsor.ca

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Jiangtao Yu, Matthew Straeten, Dr. Jalal Ahamed
Mechanical, Automotive and Materials Engineering, University of Windsor

Microelectromechanical Systems (MEMS) based inertial sensors are finding greater applications in sensing position, orientation and motion in automotives, aerospace and consumer electronics [1]-[2]. One particular MEMS inertial sensor is an inertial measurement unit (IMU), which is an integrated chip consisting of a tri-axis gyroscope and tri-axis accelerometer. A gyroscope can sense rate of rotation in a particular axis while an accelerometer can measure the acceleration in an axis. IMUs are used to find the complete motion data which can be processed with appropriate algorithm to find orientation or navigation [3]. The focus of this research is to use a MEMS IMU to find the rotational velocity of a sphere and its axis of rotation. This research aims to build a model using detected motion data from the IMU then use it to calculate the rotation vector (speed and orientation) of an object, so that a great quantity of applications could be achieved. One of these applications we are researching is to detect the rotation of a sphere. Rotation about an arbitrary axis had been researched, however, to calculate the rotation axis from the detected IMU motion data is challenging and has not been addressed in the literature. To solve the problem, we used linear algebra as the tool to calculate the rotation matrix by dividing a 3-D rotation into several pieces of 2-D rotation [4]. The rotation motions were represented as a matrix, which could simplify the process of calculation. Simultaneous orthogonal rotation angle (SORA) concept was also important in this research because it is well-suited to calculate real-time rotation vectors [5]. As 3-D rotations in general are not commutative, the results of an improper sequential addition of the 3 rotation motions in 3-D would lead to a wrong orientation. However, only if the rotation angle is infinitely small, then the error could negligible because they are nearly commutative. Therefore, we divided the rotation angles into infinitesimally small rotations then we integrated the three rotations together. In the experiments, an IMU was placed on a spherical object and mounted on top of a rotating table. The information from IMU was sampled at 375Hz and was collected by a coupled microprocessor. The IMU data provided raw information about dynamic motion in all three axes. Using the IMU data and SORA algorithm the rotational axis and velocity of a moving rotational sphere was found. The outcome of this research achieved to detect rotation axis based on IMU sensors, which was impossible in the past.

Key words: MEMS, IMU, SORA, Gyroscope

Reference

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