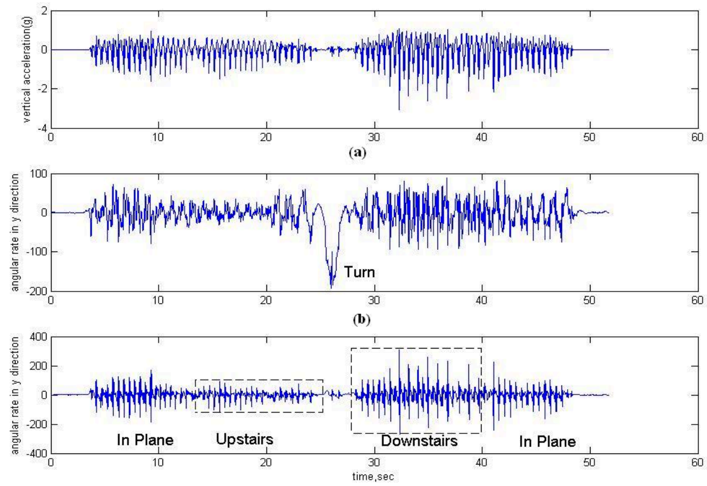
Case Study

Purdue University Uses MicroStrain Inertial Sensor for Precise Virtual Pedometry

Self-Contained Personal Navigation Made Cost-Effective



Dead-reckoning estimates using MicroStrain inertial sensor are overlaid on map of Purdue mall. Researchers calculated position by exploiting step pulses measure by triaxial accelerometers.

Personal navigation systems provide a valuable resource for individuals maneuvering in complex environments. Yet, commercial solutions continue to remain limited to outdoor settings. System reliance on external referencing sources, such as GPS, prevents operators from realizing comprehensive positioning capabilities. The development of an affordable, self-contained personal navigation system would provide users with access to continuous localization information regardless of local settings and structures. Research engineers at Purdue University used MicroStrain devices to implement a high accuracy, integrated inertial pedometer. The solution enabled precise indoor and outdoor navigation in a small, cost-effective platform.

APPLICATION OVERVIEW

Industry: Robotics

Partner: Purdue University

Market: Virtual Pedometry, Personal Navigation

Related Products: 3DM-GX®2, 3DM-GX3®-25

Measured: Triaxial Acceleration, Triaxial Angular Rate, Triaxial Magnetic Field, and Temperature

In principal, a personal navigation system would deliver localization data at any time, regardless of setting. However, the accuracy in pedestrian position estimation systems is limited if the global positioning system (GPS) signal is blocked or degraded. Self-contained technologies are available and include exotic systems such as fiber optic rings and ring laser gyros. The adoption of these technologies in both pedestrian navigation applications face ITAR and price restrictions. Tracking the position of dynamic individuals such as soldiers and firefighters demands the accuracy of exotic solutions while maintaining the price point of conventional systems.

Temperature Compensated Orientation

Recent advancements in micro-electromechanical systems (MEMS) help close the gap between system accuracy and solution price. MicroStrain's 3DM-GX®2 inertial sensor offered a low-cost, high-performance MEMS platform for Mechanical Engineers at Purdue to develop their virtual pedometer. The 3DM-GX2 supports a range of fully calibrated inertial output data quantities with a tri-axis accelerometer, gyro, and magnetometer.

Additionally, computed orientation provides a precise rotation matrix to distinguish three-dimensional routes. All quantities on MicroStrain's inertial device are fully temperature compensated and are mathematically aligned to an orthogonal coordinate system for enhanced, repeatable capability.

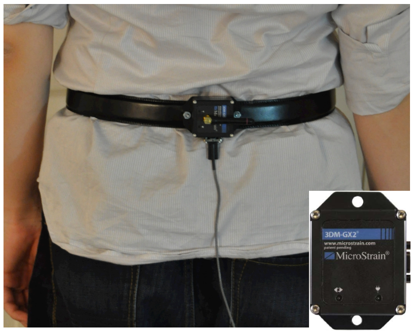


Figure 2 – MicroStrain 3DM-GX2 instrumented at center of gravity

Assistant Professor of Mechanical Engineering, Kartik Ariyur, led the development project. Mr. Ariyur and his team instrumented the 3DM-GX2 device on the subject's center of gravity, and from this location they were able to exploit pulses recorded by the tri-axial accelerometer during each step. (See Figure 2) Known biomechanical constraints, such as leg length, were used as inputs into the self-calibrated system. A corrected relationship between stride interval and stride length was developed and integrated for position estimating in long time walking and running tests.

High Accuracy Dead-Reckoning

Purdue demonstrated a sensor-based system that achieved accurate positioning in both two-dimensional and three-dimensional domains. In two dimension test settings, the positioning error experienced while using MicroStrain's inertial sensor was less than 1% of the total distance traveled. In three-dimensional environments the maximum localization error was less than 5% of the total distance traveled.

Current Market Need

Advances in the accuracy and reliability of low-cost inertial navigation devices will help facilitate the deployment of personal systems in both military and commercial markets. Purdue's work using MicroStrain inertial sensors can help provide markets with a more accessible solution. One market of particular interest involves supporting deployed soldier with adequate navigation and localization tools for urban environments. Historically, the adoption of soldier navigations systems by the military has largely been limited by cost concerns. Effective systems can cost in excess of $100,000 per unit. MicroStrain's sensors support effective navigation at a fraction of the cost.

Figure 1 – Real-time, customizable acceleration and angular rate readout on MicroStrain's Inertia-Link software

Estimated position is often limited inertial measurement bias. At Purdue, researchers successfully demonstrated the ability to control the impact of inertial measurement bias through the use of advanced filters. The innovation of their work includes both the accuracy of their filter methodology, as well as the commercial implications of a competitively priced personnel tracking platform.

Acknowledgements

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