



Navigation System for Multi-Floor Indoor Positioning during Urban Combat Operations using Geo-Magnetic Module

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Abstract: Indoor localization is of great importance for a range of pervasive applications, attracting many research efforts in the past decades. Numerous applications require a self contained personal navigation system that works in indoor and outdoor environments, does not require any infrastructure support, and is not susceptible to jamming. The sourceless nature of this technique makes possible full body posture tracking in an area of unlimited size with no supporting infrastructure. Such sensor modules contain three orthogonally mounted angular rate sensors, three orthogonal magnetometers. This paper describes the inertial navigation system. This technology that is much needed during urban combat situation like military seeking operation. The location and movement of all soldiers would be known to the military troop outside the building.

Keywords: Inertial navigation system (INS), Global positioning system (GPS), Micro electromechanical system (MEMS)

I. INTRODUCTION

Navigation system is a commercial application of military, scientific and commercial aircrafts application. This is usually attached on the body of the person and provides walking velocity and position. It can be applied to the location service of user in virtual reality, sports, games, military, ubiquitous health monitoring, etc. nowadays its demand is increasing.

INS (Inertial navigation system) provides a navigation solution by using inertial sensors such as accelerometer, pressure sensor and magnetometer irrespective of the location. INS is an appropriate method for personal navigation systems, because the blockage of the GPS signal occurs frequently in urban and forest areas. A small size and low-cost INS is required in consideration of it being attached to the user's body. This problem is solved by the development of MEMS type inertial sensors. However, INS exhibits errors that tend to increase with time in an unbounded manner because of integral processes. Therefore, an error compensation method is necessary. Most types of human movement including walking, side stepping, and running include repeated recognizable periods during which the velocity and acceleration of the foot are zero. These brief periods occur before entering the swing phase of the gait cycle each time the foot contacts the ground during the stance phase. Recognition of these periods allows determination of the drift error that occurred in between them. This allows precise corrections to be made to accelerometer data in either a forward or backward manner. The corrected accelerometer data combined with magnetic and angular rate data can then be used to calculate the direction and magnitude of displacement that occurs during each step. This allows accurate measurement of position relative to an initial starting point.

II. BACKGROUND

Many attempts were made in the inertial navigation system. In most cases, distance estimation errors when using more complex inertial sensor combinations have been only slightly better than those obtained using commercial pedometers. Simple pedometer focus on counting steps. The accuracy of the pedometer produced step count vary greatly and pedometer do not have the ability to differentiate between different types of gait such as running, shuffling and side stepping. The electronic pedometer in estimating step counts. Estimating of step is less accurate. A single triaxial accelerometer, measured leg length, and an algorithm based on an inverted pendulum model to predict the body center of mass trajectory during walking.

III. SYSTEM DESCRIPTION

The proposed system consists of an accelerometer, magnetometer, digital MEMS pressure sensor, transceiver and GSM module. The combination of the three sensors is digital MEMS geo-magnetic sensors.

The message that is transferred from soldier mote to monitoring mote by GSM module and monitored by the help of QVGA TFT COLOR LCD. This lcd have the option of touch screen interface and have the diagonal size of 3.2 . The display technology if TFT.

The pressure sensor is an ultra compact piezoresistive pressure sensor. It includes a IC interfaces able to take the

information from the sensing element and to provide a digital signal to the external world. The complete measurement chain is composed by a low-noise amplifier which converts the resistance unbalancing of the MEMS sensors (pressure and temperature) into an analog voltage that is finally available to the user by an analog-to-digital converter.

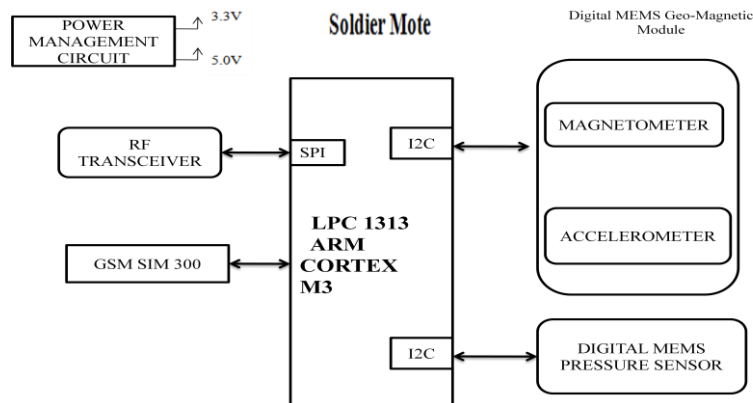


Fig. 1. Block diagram for INS

The pressure and temperature data may be accessed through an I²C/SPI interface thus making the device particularly suitable for direct interfacing with a microcontroller. These features are Data-Ready signal which indicates when a new set of measured pressure and temperature data are available thus simplifying data synchronization in the digital system that uses the device.



Fig. 2. Urban combat situation

IV. METHOD FOR TRACKING THE SOLDIER POSITION IN MULTIFLOOR BUILDING

The accelerometer sensors attached to the body are influenced not only by the acceleration of the body but also noise and other factors such as bias of the accelerometer, gravity, etc. The output of the accelerometer can be integrated twice to obtain displacement information. The position estimates based on double integration can diverge in a short time period lasting only a few seconds. Drift correction is thus essential for tracking position using low-cost accelerometers. In this section, a drift correction method is first described. An application of this method to position tracking of a walking person is then detailed.

A. Correcting Accelerometer Drift

An accelerometer is first placed on a level table top, and then is slid along a straight line for a distance of one meter. The initial and final velocities are zero. The velocity is obtained by integrating accelerometer measurements once, and the position is obtained by integrating the velocity. While the sensor actually moved a distance of one meter, the estimated distance obtained by double integration is 0.80m as seen in the lower-left plot. A close examination of the velocity in the middle-left plot indicates that the final estimated velocity is -0.23m/s at the end of the motion period, although the sensor stopped moving and the actual velocity was zero at this point. The error in the estimated velocity is due to drift in accelerometer measurements. Because the final velocity is known to be zero in this case, a drift correction can be applied to the accelerometer measurements so that the final estimated velocity is zero. Clearly, this drift correction method makes it possible to obtain accurate position information through double integration.

B. Position Tracking of a Person

Human gait motion is cyclic in nature. During walking, each gait cycle consists of two phases: a stance phase and a swing phase. The stance phase is the portion of the cycle during which a foot is in contact with the ground. The swing phase is the portion of the cycle during which the same foot is not in contact with the ground. The

stance phase takes approximately 60% of the gait cycle, and the swing phase takes the remaining 40%. During walking (rather than running or jumping), there are two periods of time in a single gait cycle when both feet are in contact with the ground. This period of double support occupies about 20% of the gait cycle. During the stance phase, the foot is in contact with the ground, and foot velocity is zero. If an inertial/magnetic sensor module is attached to a foot, drift in accelerometer measurements can be corrected each time the foot is in the stance phase of the gait cycle. If the estimated foot velocity is not zero, a drift correction can be applied to the accelerometer measurements. The inertial/magnetic sensor modules considered for this study contains triads of orthogonally mounted accelerometers angular rate sensors, and magnetometers. These inertial/magnetic sensor modules are primarily designed for tracking 3-dimensional orientation. Algorithms used by these sensor modules for processing accelerometer, angular rate, and magnetometer measurements to produce orientation output typically use a Kalman filter. In addition to providing orientation output in Euler angles and/or quaternions, some sensor modules also optionally provide scaled measurements of acceleration, angular rate, and magnetic field.

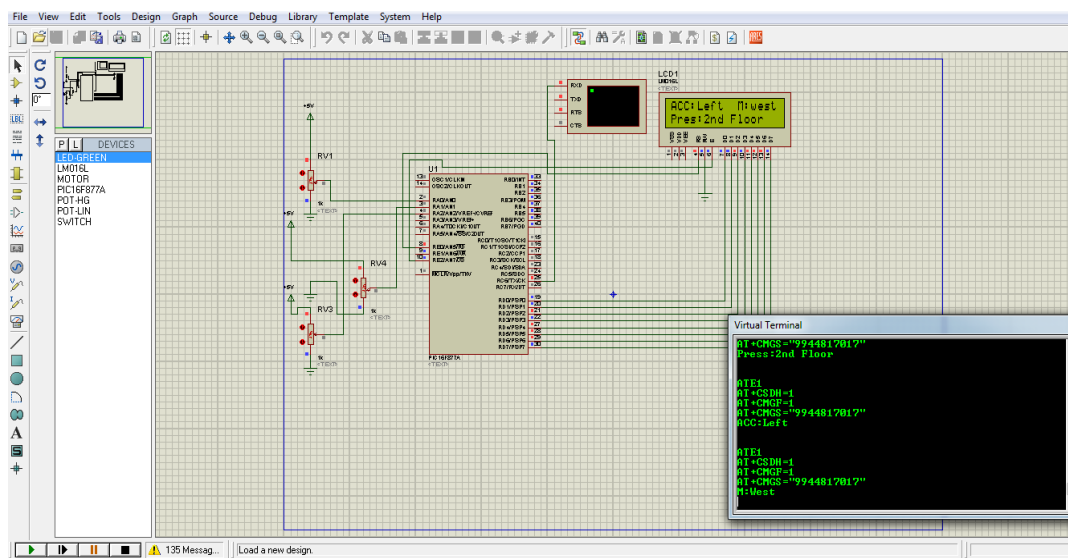


Fig. 3. Simulation result

C. Detecting Gait Events

While all three acceleration components exhibit a cyclical pattern, it can be observed that z-axis acceleration data provide the strongest indication of gait events. During the stance phase, acceleration is near zero. Since there are a number of zero-crossings during the swing phase, a zero threshold and a time heuristic must be applied to the acceleration data to detect stance phases. The time heuristic is required to avoid classifying any zero crossing in the swing phase as a stance phase. If the acceleration is within the threshold for a specified period of time, the foot is determined to be in the stance phase. Angular rate measurements also provide an indication of gait events. The angular rate in the sensor coordinates measuring ankle axis rotation is more prominent in differentiating the stance phase from the swing phase. The angular rate is near zero during the stance phase. A heuristic similar to the method discussed above can be applied to the angular rate data to detect the

V. CONCLUSION

Self-contained position tracking using data from inertial/magnetic modules has applicability to a wide number of applications. Preliminary experimental results presented in this paper document that this technique can be used to track three dimensional position during a variety of motion types. Thus the accurate position is determined by the inertial navigation system work is currently underway to further refinement.

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