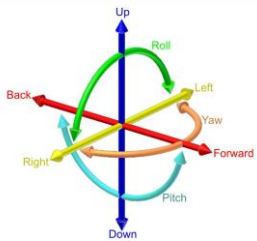
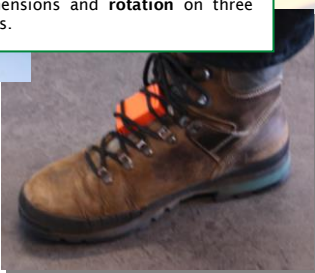


Improving indoor localisation of firefighters based on inertial measurements



Materials

We used an Xsens MTw sensor attached to the top of the shoe. An MTw is a small wireless inertial Measurement Unit (IMU) that measures **acceleration** in three dimensions and **rotation** on three axes.



Sensor Output

Zero Velocity Update

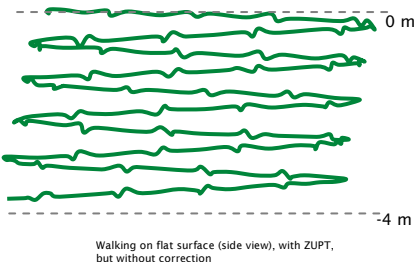
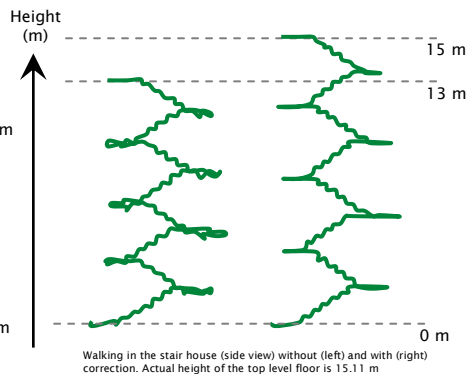
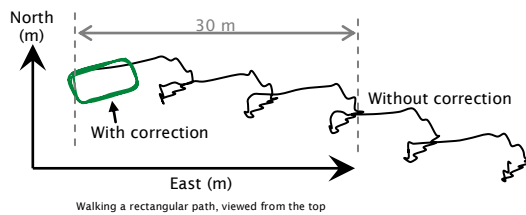
Velocity & Height Correction

Location Estimation

Our Solution

The Zero Velocity Update (ZUPT) algorithm entails that when measurements suggest that the sensor is not moving, the estimated velocity is forced to zero.

To improve ZUPT, we introduced a correction step, based on the following observation: when a zero velocity is detected while the estimated velocity is not zero, we assume that there has been an error and that this error can be compensated for retrospectively. Thus, all estimations up to the last detected ZUPT are updated, resulting in a new estimation for the current location.



Problem Description

Traditional localization techniques do not work well indoors. Inertial sensors (IMUs) measure acceleration and rotation and can be used indoors and under extreme conditions.

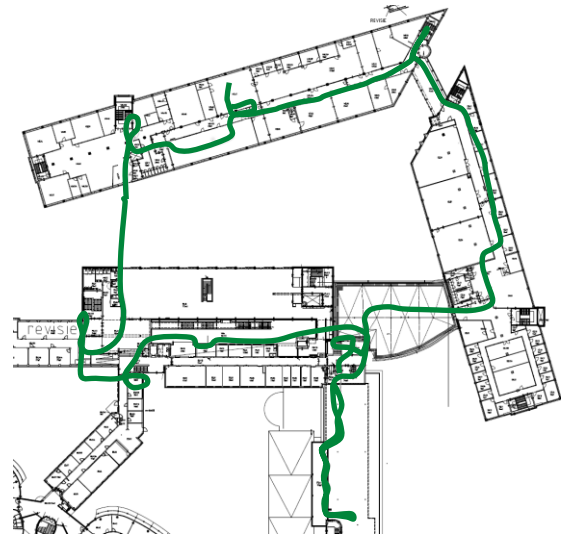
To determine the position based on orientation and acceleration, the measurement data is integrated twice (from acceleration to speed to location).

With this double integration technique, small errors in the measurements are blown up to enormous errors in the estimated location. A naive approach leads to errors of several meters after seconds of measuring and errors in the order of kilometers after minutes of measuring.

Measurements

We performed several measurement trials. The figure in the middle shows the estimated location of the same data using two algorithms: with and without correction.

The figure below shows the location estimations during a long walk in the Saxion building with velocity and height correction.



Results & Conclusions

Estimation of sensor's location without any enhancements resulted in an accuracy of 10 meters after several seconds of measurements. Applying the conventional ZUPT dramatically improved the accuracy, especially in the lateral directions. However, errors in the height estimations were still in the order of meters after several seconds of measurements. Application of our proposed extension to ZUPT resulted in an acceptable accuracy in both the lateral directions (5 m) and in the height (2 m) after ten minutes of measuring.

We can predict the location of a person after a ten-minute's walk with an accuracy of a few meters. Our results demonstrate the potential of IMU only measurements with intelligent software filters and algorithms. Although we did not meet our goal of 4 meters after 18 minutes of measurement yet, we are halfway the project, and we think that the initial goal is feasible. Our proposed solution can be used in situations where conventional localization technologies, such as GPS, do not work and where it is important to know the location of a person, such as in emergency situations, sports and training, logistics, research and many more domains.

FireBee project

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