UWB/IMU Tracking Validation using an Optical System

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1 Abstract

In this paper we report the results of a validation study of a 6DOF tracking system combining Ultra-Wideband measurements with low-cost MEMS inertial measurements. The tightly coupled system estimates position as well as orientation of the sensor unit. The comparison with the results from an optical system show robust and continuous tracking in a realistic indoor positioning scenario.

2 Introduction

Commercially available Ultra-Wideband (UWB) systems typically consist of a network of synchronized UWB receivers which track a large number of small, battery powered and inexpensive UWB transmitters. Reported indoor position accuracies lie in the order of decimetres, but suffer from multipath effects and non-line-of-sight (NLOS) conditions. These effects are most prominent while tracking moving objects or persons and give rise to distorted and bumpy trajectories. Although the obtained performance is often sufficient for the aforementioned applications, many potential application areas have higher performance requirements.

To improve the tracking performance (especially the positioning accuracy) we propose to combine UWB with a low-cost micro electro mechanical system (MEMS) inertial measurement unit (IMU) consisting of a 3D rate gyroscope and a 3D accelerometer. The main justification for adding an IMU — providing accurate position tracking for short periods of time, but drift prone for longer timescales — is to obtain a robust system, capable of detecting and rejecting multipath effects and NLOS situations. Additional benefits of adding an IMU include improved tracking results, especially for dynamic quantities like velocity, and that the orientation becomes observable as well. This results in a system providing a 6 degrees of freedom (DOF) general purpose tracking solution for indoor applications.

In our previous work [1] we reported a full 6DOF tracker estimating both position and orientation based on tightly coupled fusion of UWB and inertial sensors. In this paper we present the results of a comparison with an optical system.

3 Results

The UWB/IMU tracking system setup has been used in a room of 8 x 8 x 3 m in size, in which also an optical tracking system (Vicon) is present. The UWB setup consisted of a total of 10 receivers; 5 are placed on the floor and 5 are mounted to the ceiling. The inertial sensor with integrated UWB transmitter has been equipped with an optical cluster. Hence the

[1] J. D. Hol, F. Dijkstra, H. Luinge, and T. B. Schön. Tightly coupled UWB/IMU pose estimation. In *Proceedings of IEEE International Conference on Ultra-Wideband*, pages 688-692, Vancouver, Canada, Sept. 2009

estimated position and orientation trajectories can (after time synchronization and alignment) be compared to those of the optical system.

Figure 1 shows the tracking results for a 60 s trial where the sensor has been moved through the (limited) optical tracking volume at moderate speeds. It shows that the two systems agree very well, with a RMSE of 0.6 degrees in orientation and 5 cm in position.

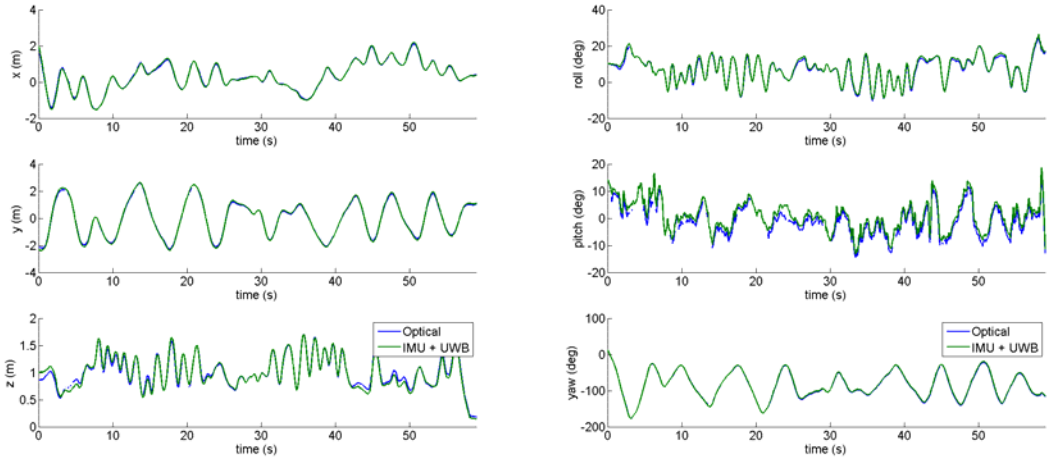

Figure 1: Position and orientation trajectories from UWB/IMU and

4 Conclusions

In this paper a 6DOF tracking algorithm estimating both position and orientation based on tightly coupled fusion of UWB and inertial sensors is compared against an optical system. Experiments show that a robust and accurate system is obtained.