GUIDELINES FOR AUTHORS PREPARING Extended abstracts FOR MMT Conference

Chunyang Yu a,\*, Naser El-Sheimy a

a Dept. of Geomatics Engineering, University of Calgary, Calgary, Canada (chunyang.yu, elsheimy)@ucalgary.ca

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ABSTRACT:

These guidelines are provided for preparation of extended abstracts submitted to MMT. Submitted Extended abstract must conform to these guidelines regarding the manuscript sections, page layout, font size, line spacing, and text format. Manuscripts should be prepared in Letter paper size with bottom, left and right margins of 0.75”. The rest of the document is a sample of anextended abstract to serve as a guideline.

This paper proposes a map-aided pedestrian navigation method, integrating indoor map information, MEMS-based inertial sensors to enhance the performance of indoor pedestrian navigation system (PNS). The map information is used as a probability distribution to constrain the INS-derived navigation solutions using Particle filter (PF) method. To improve the estimation speed of PF, an effective particle detection method is proposed to test the effectiveness of particles, and a novel two-layer PNS is presented to reduce the computational burden of PF by cutting down the update frequency of PF. Moreover, different kinds of PF, such as traditional sequential importance sampling (SIS) PF, Auxiliary PF (APF), and Backtracking PF (BPF) are designed and implemented in this paper to find a relative suitable filter for both instantaneity and accuracy. Real test experiments are conducted in this cascade connected integration system to evaluate the performance of the proposed method, and help the user to tradeoff and analyze the computational speed and accuracy.

Introduction/significance of this work:

Nowadays, as most people spend much more time indoors than outdoors, application requirement and market demand for indoor navigation is getting larger and broader. Therefore, more and more industrial companies, institutions and universities are focusing on the research of indoor PNS [1-2].

Inertial navigation systems are self-contained navigation technology, which is not susceptible to external environments. Also, MEMS inertial sensors are smaller in size, lighter in weight. However, the positioning performance derived by a standalone MEMS inertial sensors degrades quickly over time. To overcome this drawback, a series of aiding information, such as Wi-Fi network, Bluetooth, iBeacon, etc., are widely used to integrate with MEMS inertial sensors. But, the main reason against those methods is the obvious requirement of building dependent infrastructures and maintenance. In this research, considering that today Google MapTM,OpenstreetMapTM, and many other companies can provide open source indoor maps, and maps could be easily downloaded through scanning Quick Response codes or Internet using smart-devices, map information is used to constrain the navigation solution of MEMS sensors.

For almost all the current indoor navigation products, map information just severs to display position solution or destination in presentation layer of the algorithm, such as Indoo.rsTM, InfsoftTM,and Pole StarTM etc. However, it can also be further used in the navigation algorithms though Map Matching (MM)or map-aided/based data fusion techniques. The MM usually works as a binary constraint to preliminary navigation solutions for fixed routes or paths. Therefore, for unfixed indoor navigation, a PF based map-aided method is used. The PF is investigated and used because of its ability to adequately represent map information, using it to update particles weights. Considering that the major drawbacks of PF are high computational burden and low estimation speed, a novel two-layer structure PNS which contains high frequency KF in the lower filter and low frequency PF in the upper filter is proposed.

Objectives:

The objective of this paper is to provide a reliable low cost indoor navigation solution that enables continuous and accurate positioning information without increasing expenditures. This goal is achieved through using map information to re-correct MEMS-based inertial sensors results using a two-layer structure PF/KF algorithm. Also, to balance between the estimation accuracy and the computational speed, three PFs, including SIS PF, APF, and BPF are designed and implemented in this paper.

Methodology:

In summary, a Map-aided two-layer indoor navigation algorithm is proposed in this paper. The lower KF performs an update cycle according to the high rate inertial sensors measurements, and it uses Zero Velocity as inputs to correct the preliminary MEMS solution[3]; the upper PF updates through Pedestrian Dead Reckoning (PDR) method according to the step frequency calculated by KF solution. In upper PF,the previous known map information is considered as an external measurement to reset the weights of particles.To be specific, after system propagation, if the new particle passes the wall of the building without passing through the door, then this particle is invalid and its weight will be assigned as zero. For the PF measurement process, SIS PF, ASIR PF, and BPF are implemented in this paper.

Experiments and Conclusion:

The validity and feasibility of the proposed algorithm are validated through conducting ground experiments in the 3rd floor of CCIT building at the University of Calgary. Also, in order to get a reference trajectory to quantitatively show the performance of the proposed algorithm, the user’s walking heading for the PDR update is locked in a specific value according to the indoor map [4]. The capabilities of the three PFs are compared to tradeoff between estimation accuracy and computational speed. It is obvious that the proposed two-layer pedestrian navigation method can effectively improve the computational speed of the PF-based PNS; comparing the three PFs, ASIR method has a relative high accuracy at the expense of the computational efficiency. Different from ASIR, BPF has a high calculation speed, but the estimated accuracy is low, and by increasing the number of particles, it can improve a little but still worse than ASIR method.

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