

A robust pedestrian navigation algorithm with low cost IMU

Yan Li, Xiang Luo and Jianguo Jack Wang
Faculty of Engineering and Information Technology
University of Technology, Sydney (UTS)
PO Box 123 Broadway, Ultimo, NSW 2007, Australia
Email: Yan.Li-11@student.uts.edu.au

ABSTRACT

Zero velocity update (ZUPT) is an effective way for inertial pedestrian navigation in GPS denied environment. The stance phase in each step provides zero velocity measurement into Kalman filter (KF) for inertial navigation error correction. Various zero velocity detectors (ZVDs) have been introduced for stance phase detection, some even using extra sensor. However, most ZVDs are only suitable for walking but not running. Comparing with walking, running has a short duration of stance phase and less conditional zero velocity. Therefore a detector for walking is not capable of running. Barely changing detection threshold for running is not an advisable solution which will also introduce false detection.

This paper presents a novel ZUPT algorithm which can achieve robust pedestrian navigation. It is not limit to walking, but also including running. Our stance phase detection consists of one footstep detector and two ZVDs. The footstep detector is used to mark each new step, and the first ZVD (ZVD1) can successfully detect zero velocity while walking by setting condition on both the measurements of accelerometer and gyroscope. The second ZVD (ZVD2) is introduced for running with relative larger threshold on gyroscope measurement only. It is no need to distinguish walking or running in the algorithm. After a new step has been detected, ZVD2 is applied within the first half of the step; simultaneously ZVD1 is applied to detect zero velocity once the condition of it is satisfied. As violent movement when running can cause IMU sensor overflow, adaptive Q matrix in KF is proposed to handle this situation. Experimental results show that most steps of walking and running are detected correctly; and the navigation accuracy of the new algorithm is as good as walking only cases.

KEYWORDS: Zero velocity update (ZUPT), inertial measurement unit (IMU), pedestrian navigation, zero velocity detectors (ZVDs), Kalman filter