Pockets Mattering: Indoor Pedestrian Tracking with Commercial Smartphone

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ABSTRACT

Heading estimation is error-prone for indoor PDR systems. On one side, heading provided by magnetometers is in general not reliable for distortion of magnetic fields by mental and magnetic objects. On the other side, bias drift and other errors will be accumulated through integration, degrading orientation estimation accuracy when gyroscope is applied.

For PDR systems with smartphones in pockets, one new factor deteriorates heading estimation accuracy that mobile phones will swing a little during people movement. Such kind of errors is negligible for fixed inertial sensors e.g. Yaw reading of gyroscopes directly give the heading direction for foot-mounted DR systems. Converting gyroscope readings into the world axis systems will not help, for unreliable readings of magnetometers must be included for conversion.

Concentrating on trousers front pockets where mobile phones are usually carried, an interesting observation is found that swing of mobile phones will cause readings of gyroscopes lower than real angular velocity of person movement during turning or moving on curved paths. We call this fact Turn Insufficient Effect (TIE) and prove it with geometric analysis.

Taking TIE into account, this paper presents a Pedestrian tracking system using one Smartphone residing in trouser Pocket (PSP), only exploiting built-in accelerometers and gyroscopes. PSP extends feedback control system of HDE (Heuristic Drift Elimination), compensating not only for drift bias of gyroscopes but also for Turn Insufficient Effect. A prototype of PSP is deployed on two models of Android based smartphones and evaluated with two participants under an indoor trajectory, combining three sides of a rectangle of length 27m and a half circle of length 18.22m. The experimental results show that the average returning position error of PSP is reduced to 38% and 48% comparing to HDE approach and typical PDR approach that uses gyroscope readings directly.

KEYWORDS: dead reckoning; pedestrian tracking; smartphone; gyroscope; heading