Poster: Odometer in the Pocket

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ABSTRACT

Some previous work has shown the feasibility of Pedestrian Dead Reckoning (PDR) using a mobile phone, but the estimation of length walked is still a big challenge. In this paper, we propose a formula for estimating walking velocity, which can be integrated to get distance.

Categories and Subject Descriptors

C.3 [**Special-Purpose and Application-Based Systems**]: Microprocessor/Microcomputer Applications; Signal Processing Systems

Keywords

Pedestrian dead reckoning, Mobile phone, Odometer, Length estimation

1. INTRODUCTION

PDR consists of length calculation and direction estimation. Our work focuses on length calculation. In this paper, we present an approach to estimate the length walked with accelerations collected by a mobile phone in a trouser pocket.

Researchers typically multiply stride length by stride number and the former is much more difficult to calculate. The method used by [1] for deriving stride length is to divide total length walked (obtained by RF fingerprinting and map matching) by stride number. The result will be used as an estimation of the pedestrian's stride length with random error. In [2], stride length was approximated through multiplying pedestrian's height by 0.413 (females) or 0.415 (males). An empirical equation was applied by [3], whose average error in total distance is 6% and can be reduced to 3% through calibration according to the author. In this paper, we propose a formula to estimate walking velocity directly without counting steps, and then integrate it over time to get distance. In this way, our approach has only one error source: error in estimating velocity.

2. APPROACH

First of all, we multiply 512 samples of acceleration by a hamming window. Then we make an 8192-point Fast Fourier Transformation (FFT) over the result to get the frequency spectrum (Vx(w), Vy(w) and Vz(w)) of acceleration. The gap W_{stride} between adjacent peaks is stride frequency. The formula to calculate walking velocity is as follows:

$$v = k * \left(\sum_{n=1}^{4} sqrt\left(V_x^{\frac{4}{3}}(n * W_{stride}) + V_y^{\frac{4}{3}}(n * W_{stride}) + V_z^{\frac{4}{3}}(n * W_{stride})\right) / n \,/ SampleCount^{2/3} - DC\right) \quad (1)$$

In the equation, k and DC varies slightly for different trousers and different people. The main reason may be that, the location of mobile phones is a little different in different trousers. Values of k and DC are about 2.8 and 0.2 respectively and they can be calibrated for different trousers and mobile phones automatically when combining PDR with absolute positioning methods. For convenience, the value of DC can be fixed and only adjust the value of k by the following equation:

$$\boldsymbol{k_{calibrated}} = \boldsymbol{k_{original}} * \frac{\boldsymbol{Distance_{true}}}{\boldsymbol{Distance_{estimated}}} \quad (2)$$

3. Evaluation

We evaluate our method with datasets recorded by an Android application running on mobile phones put in our left trouser pockets. For a sampling rate around 100 Hz (Huawei U8800 and Xiaomi M1) and walking speed from 4 km/h to 6 km/h, our method performs quite well with regard to standard deviation in estimating walking speed (standard deviation is around 2%) and total distance travelled (error is within 1%).

4. ACKNOWLEDGMENTS

This paper is supported in part by Important National Science & Technology Specific Projects under grant No.(2010ZX03006-002，2010ZX03006-007), the National Basic Research Program of China (973 Program) (No. 2011CB302803), and National Natural Science Foundation of China (NSFC) under grant No.(61173132,61003307). The authors alone are responsible for the content of the paper.

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MobiSys'13, June 25–28, 2013, Taipei, Taiwan.
ACM 978-1-4503-1672-9/13/06.