Location Tracking with Accelerometers, Gyroscopes, and WiFi Anchor Points

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1 Introduction

With the ever increasing array of location aware smartphone applications the need for accurate positioning has never been higher. Traditional methods provided by global positioning systems (GPS) has major drawbacks in its power consumption and its ability to work inside large buildings. Alternative methods of location tracking, such as using accelerometer and gyroscope data, provide a low power solution at the cost of much higher error rates. Localization has also been explored as an alternative to GPS for locating devices inside buildings by determining distance between WiFi or other RF transmitting devices. In our project we propose a method of tracking a smartphone by using the internal accelerometer, gyroscope, and compass. To help correct the error that seems to be inherent in these types of systems we will use a process of learning the location of WiFi devices through a learning period and then using those as anchor points to correct our estimated position.

2 Motivation

Our motivation for trying this new method of location tracking is three fold. First, we want an improved method of tracking devices indoors. Second, we want to reduce the power consumed by location tracking systems. It is estimated that the GPS in smartphones uses 70 times more power than the accelerometer in the phone. Third, we want to create a localization system that can quickly learn new locations without large amounts of training

3 Design

Our project will be implemented as an Android application running on Android version 4.1. It will use the accelerometer in combination with the gyroscope and magnetic compass in order to track the change in position of the user. Because of the inherent error in accelerometer measurements we need a way to quickly reorient the position at certain locations. To do this we will look for WiFi access points that we know the location of and use those as anchor points to correct the estimated position. Because this method only works if we know the location of WiFi access points we also intend to implement a learning method that will use the GPS device in the phone to learn the physical location of unknown access points, which it will remember for later when the GPS is turned off. While the use of full WiFi localization methods could be used to provide more accurate tracking results when near an array of WiFi access points, we opt instead for a simpler system of using simple anchor points in order to reduce complexity of the algorithm and offer faster learning.

4 Implementation

We have developed a basic timetable for when we plan to have different aspects of the project completed, which can be seen in Table 1.

5 Related Work

The goal of the paper by Jackson et. al.[2] was similar to ours - to keep track of an object in an area using accelerometers. Useful information such as calibra-

Week	Goals
11-Feb	Finish Proposal, Setup Application Framework, Setup Git Repo
18-Feb	Get Accelerometer, Gyro, and GPS Data from Android API
25-Feb	Movement Tracking(w/GPS starting point)
4-Mar	Continue Work on Movement Tracking
11-Mar	Evaluation of Tracking Error
18-Mar	Pull WiFi Data from Android API and fingerprint hotspots
25-Mar	Continue Work on WiFi Data
1-Apr	Use WiFi Anchor points for Location Correction
8-Apr	Finish WiFi Anchor points for correction and Re-Evaluate
15-Apr	Add Dynamic Learning Algorithm for Anchor Points
22-Apr	Write Report and Work on Presentation
5-May	Paper and Presentation Due

Table 1: Detailed implementation plan.

tion, calculation and data retrieval were relevant topics discussed.

The goal of the paper by Liu et. al.[3] was to use multiple cell phone users in conjunction with Wi-Fi networks to help limit the error of a Wi-Fi only solution. This paper details the multiple deficiencies of Wi-Fi localization and will be useful when we try to calibrate for them.

The paper by Biswas et. al.[1] uses Wi-Fi localization to direct a robot around a building while avoiding static and dynamic obstacles. This relates to our project because we will also need to determine location based partially off of Wi-Fi localization.

The paper by Reuveny et. al.[4] was about a project that used an accelerometer and 2 gyroscopes in order to continually keep track of motion. This paper contains information about accelerometer and gyroscope properties and how to implement the tracking algorithm. This information is useful because we will need to be doing similar activities for our project.

References

[1] BISWAS, J., AND VELOSO, M. Wifi localization and navigation for autonomous indoor mobile robots. In *Robotics and Automation (ICRA), 2010 IEEE International Conference on* (May 2010), pp. 4379–4384.

[2] JACKSON, J. D., CALLAHAN, D. W., AND WANG, P. F. Location tracking of test vehicles using accelerometers. In *Proceedings of the 5th WSEAS International Conference on Circuits, Systems, Electronics, Control & Signal Processing* (Stevens Point, Wisconsin, USA, 2006), CSECS'06, World Scientific and Engineering Academy and Society (WSEAS), pp. 333–336.

[3] LIU, H., GAN, Y., YANG, J., SIDHOM, S., WANG, Y., CHEN, Y., AND YE, F. Push the limit of wifi based localization for smartphones. In *Proceedings of the 18th annual international conference on Mobile computing and networking* (New York, NY, USA, 2012), Mobicom '12, ACM, pp. 305–316.

[4] REUVENY, S., AND ZADIK, M. 3d motion tracking with gyroscope and accelerometer. a.