TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Use of Smartphones for Tracking and Trip Recording

Esmond Mok*, Guenther Retscher**, Donggen Wang***, Linyuan Xia****

* Department of Land Surveying and Geo-Informatics, Hong Kong Polytechnic University
** Institute of Geodesy and Geophysics, Vienna University of Technology, Austria
*** Department of Geography, Hong Kong Baptist University
**** School of Geographical Sciences and Urban Planning, Sun Yat-Sen Univ., Guangzhou, PR China

Outline

- Introduction and Motivation
- Sensors, Geosensors in Modern Smartphones
- Use of Smartphones for Trip Recording
- Case Study: Field Experiments in Dense Urban Environments
- Concluding Remarks and Outlook

Introduction and Motivation

Nowadays positional information is very important and it is needed almost everywhere all the time.

Smartphones provide communication convenience for people in their daily life but also offer opportunities to collect data for scientific research and they provide location capabilities.

Conventionally, for tracking and trip recording the location determination of the user relies mainly on a GPS data logger.

Disadvantages of using a GPS data logger are that in challenging urban environments where GNSS signals are frequently blocked the GPS data loggers may not be able to provide sufficient coverage for tracking of a user and trip recording. In addition, carrying a GPS data logger may impose some additional burden to individuals.

Therefore the use of smartphones is investigated in this study.

Sensors, Geosensors in Modern Smartphones

MEMS (**M**icro-**E**lectro-**M**echanical-**S**ystems) and other sensors are built-in to provide new features or services to end-users.

Types of sensors:

- *GPS;*
- *Accelerometers;*
- *Digital compass and gyros;*
- *Barometric pressure sensors;*
- *Digital cameras (stereo cameras).*

Other positioning methods:

- *Cellular phone positioning;*
- *WiFi (e.g. Skyhook WPS);*
- *Indoor location systems (e.g. RFID).*

Use of Smartphones for Trip Recording

Due to the use of the in-built sensors in smartphones it is possible to determine the trajectory of the user for trip recording in combined indoor/outdoor environments.

Using the accelerometers the current movement state of the user (e.g. standing, walking, or fast moving in a car or public transportation) can be determined. Furthermore they can be used to detect the steps of the user.

The orientation or heading is measured by the magnetometer (or digital compass) and/or gyro.

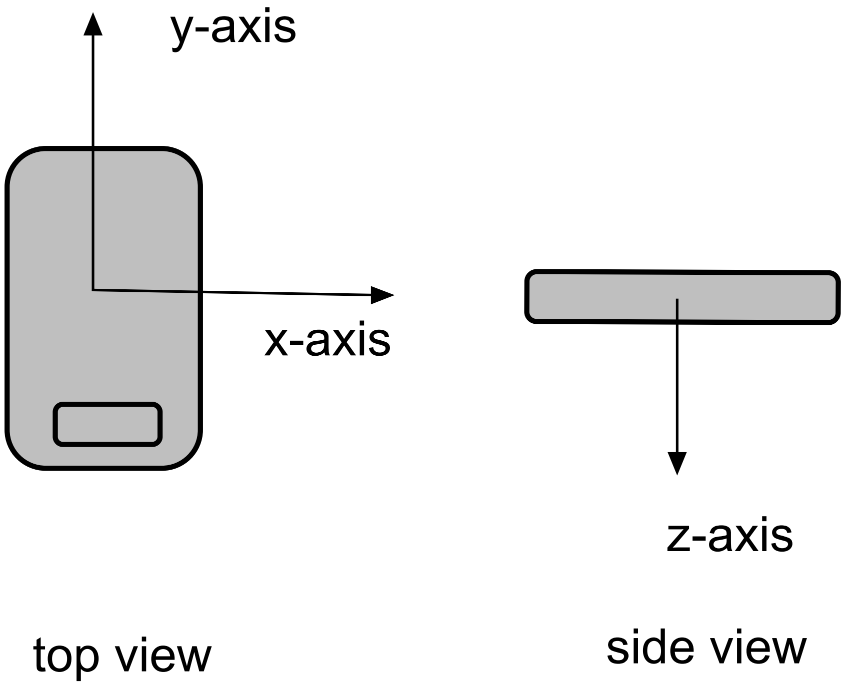
Then dead reckoning (DR) can be employed to estimate the current position and the trajectory.

Digital cameras can be used for vision-based positioning indoors and outdoors.

Field Experiments

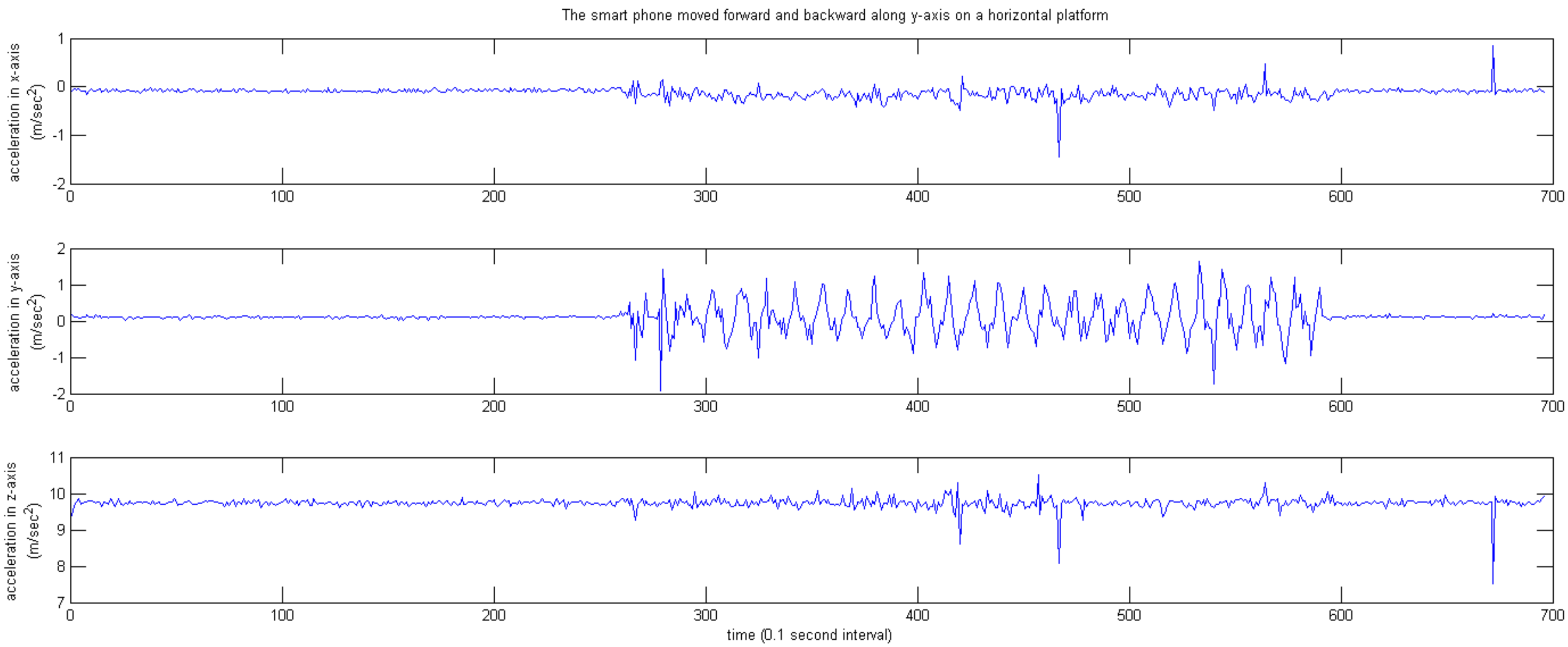
The tests were carried out in two phases.

The first phase aimed to understand the data output behavior of the smart phone under test, and the second phase was the investigation on the feasibility of position prediction with sensor data.



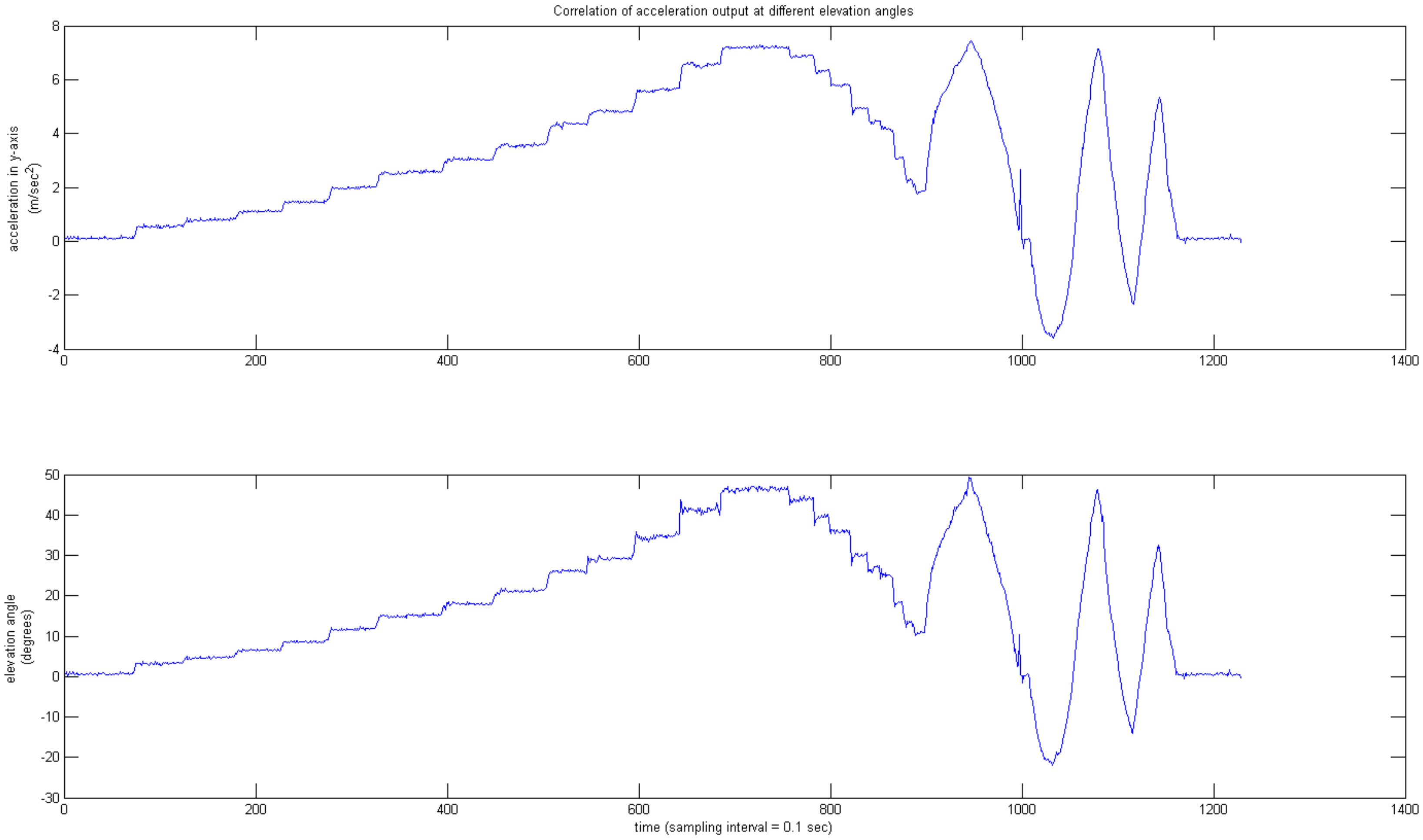
Axes definition adopted by the smartphone

Field Experiments: Phase 1



Data showing the acceleration of the three axes when the phone was static and moved in the direction of the y-axis

Field Experiments: Phase 1

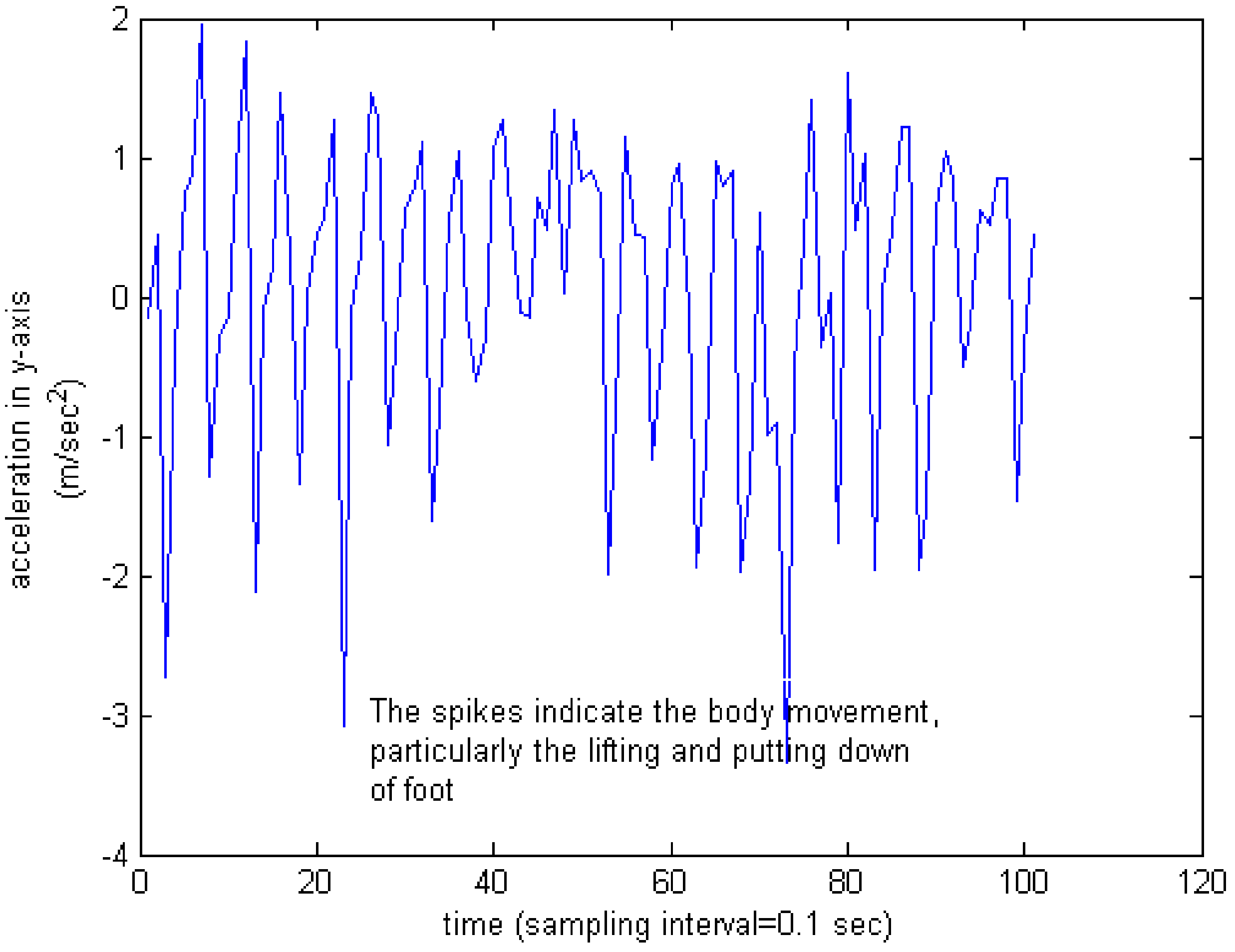


Response of acceleration with the change of elevation angle about the x-axis

Field Experiments: Phase 2

GPS positioning result

Field Experiments: Phase 2



A closer inspection of acceleration data from 0 to 10 seconds

Field Experiments: Phase 2

Positions predicted from step counts and digital compass orientation outputs without the application of orientation corrections

Field Experiments: Phase 2

Positions predicted from step counts and digital compass orientation outputs with the application of orientation corrections

Concluding Remarks and Outlook

The body movements and the phone orientation will have significant effects on the acceleration data outputs along the x-, y- and z-axis.

The number of steps can be clearly reflected from the spikes appearing in the major movement axis.

With the integration of the calibrated orientation from the digital compass reasonable positional prediction can be obtained.

Further investigations on the performance of digital compass under different environments will be needed, particularly in areas likely with high magnetic interference. The use of a magnetic flux sensor to indicate the quality of orientation data will be investigated.

Future work consist more field tests where the smartphone positioning capabilities are investigated in comparison to the data provided by GPS data loggers.

Case studies will be conducted to collect data by both devices. From those data the spatial temporal trajectories are derived and trips are identified.

Findings of this study will contribute to the growing literature on GPS-based data collection for location-based services.

IAG Sub-Commission SC 4.1 Alternatives and Backups to GNSS

Main Objectives:

- To follow the technical advances in navigation sensors and algorithms;
- To investigate positioning sensors and techniques integrated in modern smart phones and other mobile devices;
- To study and report on the performance of stand alone and integrated navigation systems.

Contact:

Guenther Retscher: gretsch@pop.tuwien.ac.at