Mode of transportation and ground property detection using accelerometer and gyroscope data from a Smartphone

Theodor Moeser Sebastian Klamt E-mail: theodor.moeser@stud.uni-goettingen.de, sebastian.klamt@stud.uni-goettingen.de

Abstract—The abstract goes here.

1 Project Description

THE goal of our project is to gather various information from the gait of a person using the accelerometer and gyroscope of a normal Smartphone. Foremost the aim is to identify persons by their gait as well as their way of carrying the phone. The different ways of carrying the phone will be classified by the piece of clothing the phone is stored in like different trousers pockets and jacket pocket as it has been done before in various papers like [7]. Also we want to differentiate the mode of their gait to get information about wether a person is standing still, walking or running, as well as on a flat surface, uphil or downhill. There are papers like [8] already using not only flat surfaces but more interesting and usual settings like ways including stairs and corners in hallways. Therefore a focus of this project will be to gather information about the quality of the underground the person is walking on, deciding if it is hard ground (beton/asphalt) or soft ground (grass/dirt/mulch).

To gather the necessary data we will use an app on a samsung S3 smartphone programmed in Python using Kivy http://kivy.org/#home. The rate of measurement is about 40 measurements per Second. The accelerometer used in the Samsung S3 is the LSM330DLC. The data will consist of a list of timestamps and the according values for the accelerometer and gyroscope values in three dimensions. Since the smartphone can not provide a realtime environment for measurements the measured values will be slightly irregular.

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2 Related Work

THERE has been a lot of work on human gait recognition. There are two main approaches to identify a person or a persons gender via human gait recognition: First there is the ”outer” approach where fixed sensors (mostly cameras) are used to gather the necessary information to compute the gait and thereby identify a person [10]. These were called vision-based by Gafurov [1] Secondly there is the ”inner” approach called sensor-based by Gafurov where sensors (mostly accelerometers and gyroscopes) are carried by the person which is to be identified.

As we plan to identify persons using a smartphone app our approach would be a ”sensor-based” gait recognition. There has been done work using more of the typical sensors of a modern day smartphone like GPS to differentiate between different modes of transport like walking or driving with a car [8].

While there seems to be little to no work on groundtype recognition via gait differences there has been studies analysing the impact a backpack weighting 4kg does on the ability of a classifier trained on persons not carrying such [2]. That particular paper [2] also uses sensors placed in the persons pocket. Another paper by Gafurov [1] uses accelerometer data to identify a person by their gait but this time via an sensor strapped on the leg near the ankle. The use of a gyroscope is claimed to be first used in [7] using a wii-remote controll featuring similiar measurement frequencies of 50Hz like while the other papers had frequencies well over 100Hz. Also [7] does generate data not only walking a straight hallway but walking with distorted speed or walking in different directions with stops inbetween, while [2][1] left out data right after the start of a walk defining it as ”not characteristic”. In paper [9] motion sensors are used in combination with voice recognition to authenticate users of smartphones or other mobile devices. The data was collected using 3D accelerometer data with a sensor in a hip pocket, a jacket pocket and a suitcase. The used learning algorithm was to store the training data and calculate a similarity score based on the difference in the forier transformation or the correlation between training and test data. Another approach on gait authentication can be seen in [6] they rely enteirely on acclerometer data collected with a phone in a poach attached to the side of the hip of the participants. The participants walked on a clearly defined path through a hallway so there was no random influence of the ground properties. The

algorithm used for classification was a Hidden Markov Model. Another possible application for gait analysis is the medical evaluation of diseases that lead to a change in gait like a dropped foot [5]. There are also previous works on locating a device worn on the body by accelerometer data [3] [4]. But in [3] instead of locating the device on a walking subject, the motion during different everyday tasks was used for this purpose.

REFERENCES

[1] Davrondzhon Gafurov, Kirsi Helkala, and Torkjel Sndrol. "Biometric gait authentication using accelerometer sensor". In: *Journal of computers* 1.7 (2006), pp. 51–59.

[2] Davrondzhon Gafurov, Einar Snekkenes, and Patrick Bours. "Gait authentication and identification using wearable accelerometer sensor". In: *Automatic Identification Advanced Technologies, 2007 IEEE Workshop on*. IEEE. 2007, pp. 220–225.

[3] Kai Kunze and Paul Lukowicz. "Using acceleration signatures from everyday activities for on-body device location". In: *Wearable Computers, 2007 11th IEEE International Symposium on*. IEEE. 2007, pp. 115–116.

[4] Kai Kunze et al. "Where am i: Recognizing on-body positions of wearable sensors". In: *Location- and context-awareness*. Springer, 2005, pp. 264–275.

[5] Hongyin Lau and Kaiyu Tong. "The reliability of using accelerometer and gyroscope for gait event identification on persons with dropped foot". In: *Gait & posture* 27.2 (2008), pp. 248–257.

[6] Claudia Nickel and Christoph Busch. "Classifying accelerometer data via hidden markov models to authenticate people by the way they walk". In: *Aerospace and Electronic Systems Magazine, IEEE* 28.10 (2013), pp. 29–35.

[7] Michael Fitzgerald Nowlan. "Human Identification via Gait Recognition Using Accelerometer Gyro Forces". In: *Yale Computer Science. http://www.cs.yale.edu/homes/mfn3/pub/mfn_gait_id.pdf* (2009).

[8] Leon Stenneth et al. "Transportation mode detection using mobile phones and GIS information". In: *Proceedings of the 19th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems*. ACM. 2011, pp. 54–63.

[9] Elena Vildjiounaite et al. "Unobtrusive multimodal biometrics for ensuring privacy and information security with personal devices". In: *Pervasive Computing*. Springer, 2006, pp. 187–201.

[10] Dong Xu et al. "Human gait recognition using patch distribution feature and locality-constrained group sparse representation". In: *Image Processing, IEEE Transactions on* 21.1 (2012), pp. 316–326.