Poster: You Driving? Talk to You Later

Hon Lung Chu, Vijay Raman, Jeffrey Shen,
Romit Roy Choudhury
Duke University
Durham, NC 27705
{hc57, vraman3, ss194, romit.rc}@duke.edu

Aman Kansal, Victor Bahl
Microsoft Research
Redmond, WA 98052
{kansal, bahl}@microsoft.com

1. INTRODUCTION

We present a phone based sensing system, referred to as driver detection system (DDS), to determine if a user in a moving vehicle is a driver or a passenger. We realize this goal using various user micro-movements that can be detected using just the mobile phone sensors without relying on additional wearable sensors or custom instrumentation in the vehicle. The detection is based on inferring which part of the vehicle the user is present in, such as passenger side vs. driver side or front vs. rear, as well as some key activities performed by the driver. We foresee several useful applications for the DDS including, delivery of notifications (e.g., voice calls, emails, ads, etc.) based on availability of user attention, feeding the detection results into systems to compute commuting carbon footprints or for tracking reckless driving behavior, etc.

2. SOLUTION DESIGN

The design of DDS is based on the observation that there are multiple micro-movements that differ between a driver and a passenger. For instance, the driver and the front seat passenger enter the car on different sides, which can result in a difference in the direction of their sideways movement at entry. Further, a driver and passenger use different legs to enter the car (driver-right, passenger-left). Detecting which leg enters first can help determine if the gas pedal signature is likely to be detectable for the current user, since it is only detected if the phone is in the driver's right pants pocket. When the phone is in a different pocket, additional signatures may be required to detect a driver. For instance, the directions in which the driver and a right side passenger reach for a seatbelt and wears it are different. While the above signatures help in detecting if the user is in left/right side of the car, processing in-car noise using a microphone and a back-end cloud service may be useful in differentiating the front seat driver from a back seat passenger or when the phone is in a handbag. None of these patterns suffices by itself since each is limited to certain phone positions on the body, and so many of these patterns has to be combined for driver detection.

Figure 1 presents a systematic combination of multiple patterns or sensor signal signatures that can be inferred from the phone sensor data, to determine if the user is a passenger or a driver. The sensor data collection and inference methods do not run continuously on the phone but use specific trigger events, to minimize the impact on the phone's battery. We use a duty-cycled approach for activating the sensors and collect data required for detection between two main trigger events, namely walk detection and vehicular motion detection, both of which can be performed using the accelerometer.

MobiSys'11, June 28–July 1, 2011, Bethesda, Maryland, USA.
ACM 978-1-4503-0643-0/11/06.

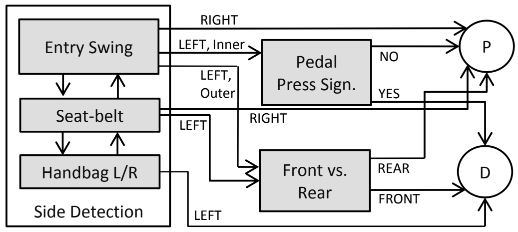

Figure 1: Using sensor data to determine if the mobile user is a driver or a passenger. P = passenger, and D = driver.

3. EVALUATION AND RESULTS

The DDS system is evaluated with sensor data collected on the Android OS 2.2 based Nexus Ones and iPhone OS 4.0 based iPods. The sensor data used comes from the accelerometer, gyroscope, and the microphone. Phone sensor data was recorded from three distinct users with the phone carried in different positions on their body or in a handbag, without controlling the phone orientation. The car was driven on routine routes that those users take. Multiple data traces were collected from each user, leading to 40 or more samples for each micro-movement. The various mean detection accuracy for each of the blocks in Figure 1 is shown in Table 1.

Component name	Mean Accuracy
Entry swing	84.81 %
Seat belt	91.08 %
Pedal press	89.78 %
Front vs. rear	95.83 %
Overall	76.23 to 91.08 % (depends on phone position)

Table 1: Detection accuracy for various blocks.

We also evaluated the impact on the phone's battery energy when the DDS system is run. We observed that, for a typical scenario that involved all the phone sensors, the DDS consumed 155J, which is just 1.1% of the total battery capacity.

4. CONCLUSION

We briefly discussed DDS, a system to identify if a mobile user is a driver or a passenger. Experimental evaluations on real user traces showed that DDS achieves a practically useful accuracy without requiring training on an individual user basis. The design also uses trigger events to significantly reduce the energy overhead of such sensing on the phone's battery, illustrating a useful design principle for phone based sensing applications that need to operate continuously in the background.