

# Monitoring Driver Behavior by Using Android Devices

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## Abstract

The new technological advancements and increasing propagation of mobile android devices pose great opportunities for engineers and traffic accidents experts. These gadgets are compact hybrid devices integrating the capabilities of personal digital assistant (PDA), personal computer (PC), mobile phone, camera, music player, FM radio, Global Positioning System (GPS) and so on. They have standard computing facilities and advanced communication features including HSPA+ 21Mbps/ HSUPA 5.76Mbps, EDGE/ GPRS, wireless and Bluetooth.

This paper concentrates on the development of real - time driver monitoring system using Android device camera, accelerometer and gyroscope, together with GPS and proximity signals. We have used also small compact cameras for driver video monitoring. The main goals of the paper are:

- Car driver behavior data acquisition (with reasonable degree of confidence) and synchronize in the specific traffic context;
- Correlate car driver maneuvers with vehicle movement dynamic and geographic (in traffic) position, with real time out off car images synchronization;
- Estimate driver behavior and crash risks by processing all data collected.

## Zusammenfassung

Die neue technologische Fortschritte und die zunehmende Verbreitung von mobilen android-Geräte stellen große Chancen für Ingenieure und Verkehr Unfälle Experten. Diese Gadgets sind kompakte Hybrid-Geräte, die Integration der Funktionen des Personal Digital Assistant (PDA), Personal-Computer (PC), Handy, Kamera, Musik-Player, FM Radio, Global Positioning System (GPS) und so weiter. Sie haben standard EDV-Einrichtungen und erweiterte Kommunikationsfunktionen einschließlich HSPA + 21Mbps / HSUPA 5.76Mbps, EDGE / GPRS, wireless und Bluetooth. Dieses Dokument konzentriert sich auf die Entwicklung von Real - Mal Fahrer Überwachungssystem mit Android Handy Kamera, Beschleunigungsmesser und Kreisel, zusammen mit GPS und Nähe Signale. Wir waren verwendeten auch kleine Kompaktkameras für Treiber Videoüberwachung. Die Hauptziele des Papiers sind:

- Auto Treiber Verhalten Datenerfassung (mit vernünftigen Maß an Vertrauen) und Synchronize im Zusammenhang mit bestimmten Datenverkehr;
- Auto Fahrer Manöver zu korrelieren, Fahrzeug-Bewegung, dynamische und geographische (im Straßenverkehr) Position, mit real Time Out aus Auto Bilder Synchronisation; Treiber-Verhalten und Crash-Risiken durch die Verarbeitung alle gesammelten Daten zu schätzen;

## 1. Introduction

Driving behavior models describe drivers' decisions with respect to their vehicle movement under different traffic conditions. These models include speed/acceleration models, which describe the movement of the vehicle in the longitudinal direction, and lane changing models, which describe drivers'

lane selection and gap acceptance behaviors.

Driving behavior models are an important component of microscopic traffic simulation tools. They are also important to several other fields of transportation science and engineering such as safety studies and capacity analysis, in which aggregate traffic flow characteristics may be deduced from the behaviors of individual drivers. For

example, the capacities of different road facilities may be determined by studying the relations between two vehicles, a leader and a follower, traveling through the facility [1]. State-of-the-art driving behavior models do not capture drivers' planning capabilities and proactive behaviors. Implementation of these models in micro-simulation tools may lead to unrealistic traffic flow characteristics: underestimation of bottleneck capacities and over-estimation of congestion. Hence, there is a need to develop more realistic driving behavior models that will capture the complexity of human decision-making processes.

Also, the traffic accident reconstruction activity can use a lot of data obtained by monitoring the driver behavior.

This paper is based on development of the research for mobile Android (and not only) devices used in transportation monitoring and traffic accident reconstruction, research carried out on the Automotive and Transportation Department of Transilvania University of Brasov.

## 2. Theoretical model description

We are assuming the theoretical model describe in paper [1].

The driving task is a hierarchical process with three levels of performance:

1. Navigation or Planning (Strategic): Route choice and trip schedule decisions drivers make pre-trip and en-route. These decisions are affected by the driver's knowledge of and familiarity with the transportation network and traffic conditions as well as real-time information available to the driver.

2. Guidance (Tactical): Determination of the two dimensional movement of the vehicle in traffic. These decisions are affected by the vehicle's driving environment and by strategic considerations. This behavior is driven by goals that include safety, adhering to the path plan and a desire to maintain an acceptable driving experience in terms of speed and comfort.

3. Control (Operational): Continuous activities the driver performs to control and direct the vehicle (e.g. steering, throttle, braking).

These activities are skill-based and mostly done automatically with little conscious effort. Interactions between the different driving tasks are shown in Figure 1. The driver makes strategic decisions: chooses a path and determines a schedule for the trip (e.g. in terms of desired arrival time). Tactical decisions are affected by the vehicle's driving neighborhood and by the strategic considerations: the driver has to be in the correct lanes in order to follow the path plan; the trip schedule affects desired speeds. If the trip schedule is not kept or in the presence of traffic information the driver may decide to re-evaluate the path plan and switch paths.

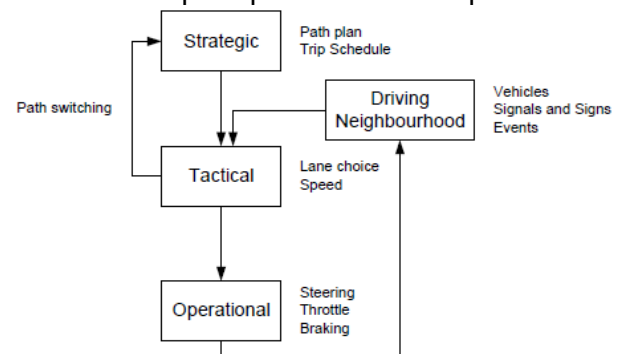


Fig. 1 Interactions between the driving tasks. [1]

Travel behavior researchers study drivers' strategic choices. The operational behavior is studied in human factors research. Driving behavior models capture tactical decisions. The most notable driving behavior models are acceleration and lane changing models. Other important driving behaviors include negotiation of intersections and merging areas and response to signals and signs.



shutter button is half-pressed, and then save up to the 30 most recent frames from immediately before the shutter button was pressed. A Lag Correction mode allows you to specify a time between the time you wanted the photo taken, and the time that the shutter button is pressed--and then the camera reaches back into its buffer and automatically saves the nearest image to that moment. A High Speed Best Selection mode, meanwhile, will automatically choose the ideal photo from a burst--judging images based on the amount of blurring, and whether your subject is blinking or smiling.

A new High-Speed Lighting mode captures three images with varying exposure, and then combines them in-camera into a single image with increased dynamic range. Finally, High-Speed Anti-Shake, High-Speed Portrait, and High-Speed Night Scene modes combine multiple high-speed shots that prevent blurring, resulting in one final image with proper exposure, a mode that Casio feels will allow for great low-light shots without a tripod. Better still, the Casio EX-FH100 also includes a sensor-shift mechanism, providing true mechanical image stabilization!

The speed advantage of the Casio FH100 isn't just felt in still image mode, either. In movie mode, the Casio EXILIM EX-FH100 can capture high-definition 720p (1,280 x 720 pixel) video at 30 frames per second. It's also possible to opt for higher frame rates of 240, 420, or even 1,000 frames per second at reduced resolution, and even to switch the framerate from 30fps to 240fps during the recording of a movie. There's a dedicated button for movie recording, and the Casio EX-FH100 includes a stereo microphone.

A 3.0-inch LCD display with 230,400 dot resolution offers the Casio EX-FH100's only option for framing and reviewing images, as there's no optical viewfinder on this model. The Casio EX-FH100 records images on SD / SDHC cards or 89.5MB of built-in memory, and offers USB 2.0 High Speed data and both standard composite / high definition

HDMI video connectivity. Power comes from a proprietary NP-90 lithium-ion battery.

5. HD HERO 2: Wearable and gear mountable, waterproof to 197' (60m), capable of capturing professional full 170° wide angle 1080p video and 11 megapixel photos at a rate of 10 photos per second; Professional 11MP Sensor 2x Faster Image Processor and Sharper Glass Lens; Professional Low Light Performance; Full 170°, Medium 127°, Narrow 90° FOV in 1080p /120 fps WVGA, 60 fps 720p, 48 fps 960p, 30 fps 1080p Video Full 170° and Medium 127° FOV Photos; 10 11MP Photos Per Second Burst 11MP Photo Every 0.5 Sec; Timelapse Mode 3.5mm External Stereo Microphone Input Simple Language- The HTC smartphone was used for sensing left driver leg movements and Samsung Gyo was used for right driver leg movement.

One of Samsung Galaxy S2 smartphone was detect and was log the GPS car position and speed and another was log car accelerations.

HC HERO 2 camera was mounted into front of driver head and Casio camera was mounted to right B pillar of the car.

All Android devices were synchronized by usig ClockSync android application. The times for video cameras were fixing from smartphones time.

For a better synchronize we were used an hard car brake triggering semnal to the beginning of experimental trip.

In the figure 3 was presented a typical snapshot from HD HERO 2 camera and in figure 4 a frame from Casio B pillar mounted video shoot. In the figure 5, we shows, for a time lapse, the values of driver left leg accelerations accelerations on X, Y, Z directions and as resultant vector. The similar parameters, for same time lapse, for driver right leg, were showed in the figure 6.

Accelerations directions for driver legs are variables and, for the proposals goals of this papers, these are not important. Will be uses only resultant acceleration values with respect of driver legs movement sensing.



Fig. 3 Frame from HD HERO 2 movie.



Fig. 4 Snapshot from Casio video.

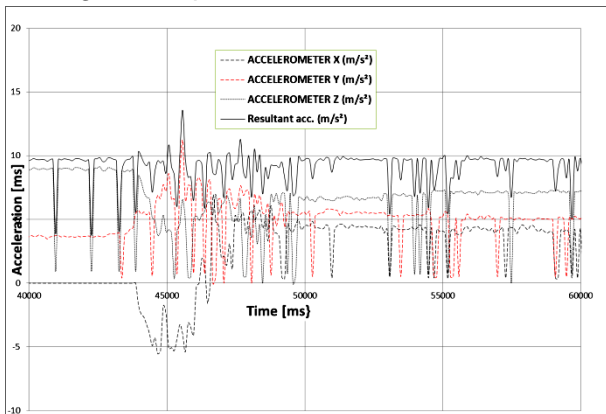


Fig. 5 Acceleration of driver left leg (HTC smartphone)

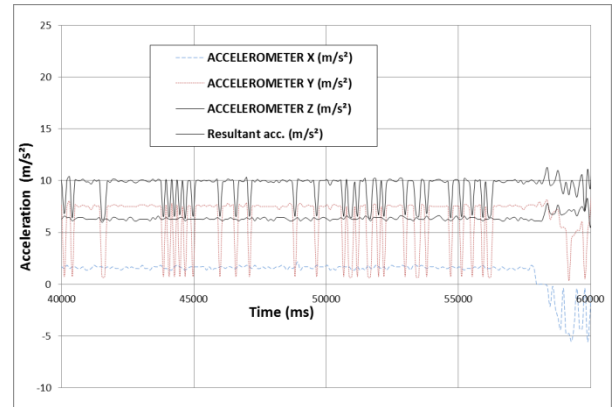


Fig. 6 Acceleration of driver right leg (Samsung Gyo smartphone)

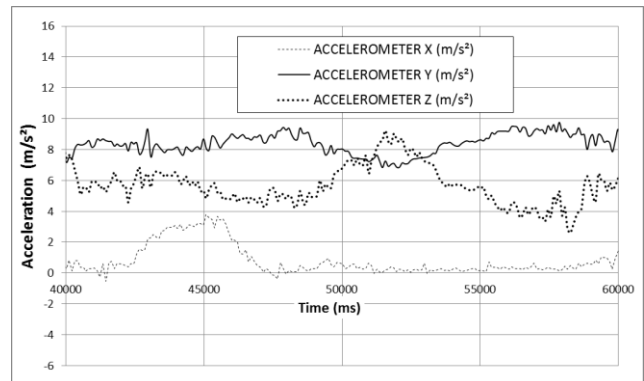


Fig. 7 Car accelerations for same time lapse.

For the same time lapse, in figure 7 we present the car accelerations with Y as longitudinal car axis, Z as vertical car axis and X as normal to Y and Z axis.

#### 4. Conclusion

1. This paper was based on development of the research for mobile Android (and not only) devices uses in transportation monitoring and traffic accident reconstruction, research carried out on the Automotive and Transportation Department of Transilvania University of Brasov.

2. The paper bring some experimental contributions to driver behavior in order to correct

several theoretical model limitation limitations. Most models assume that drivers make instantaneous decisions based on current or past traffic conditions. These decisions are purely reactive responses to the situation. In reality, human drivers may conceive an action plan and perform it over length of time based on anticipated future conditions [1].

3. The accuracy of a Smartphone, MEMS, accelerometer is comparable to that of a normal-sized accelerometer. However, the sampling rate between the two is considerably different. A cell phone accelerometer can reasonably take up to 10Hz, while the higher grade accelerometer is able to collect data at a much higher 160Hz sampling rate. This is due to the fact that phone accelerometers are included primarily for the purpose of determining phone orientation, and is not intended to record accurate and rapid acceleration data. Between the two sources of recording, it is safe to assume that the acceleration data from Samsung Galxy S2 accelerometer, is more likely to serve as the "correct" acceleration that accelerationn data obtained by Samsung sGyo and HTC smartphones.

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