# Floating Car Data: Comparison of Smartphone and On-Board Diagnostics (OBD)

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**Abstract.** On-board diagnostic (OBD) devices are able to extract information in vehicles to determine traffic flow patterns through localization data, speed, and direction of travel and time. An alternative, low-cost, ubiquitous custom-built mobile application, "SmartDriving" (SD) is presented in this paper. The resulting data from the mobile application was compared with data collected through OBD. Results showed that the collected data was satisfactory regardless of the device used and therefore the mobile application was validated as data collection tool.

**Keywords:** OBD, Smartphones, Sensors, Driving Behavior

## 1 Introduction

Applications that provide information regarding the monitoring of mobility patterns are of particular interest for the transportation sector, as they can be used to study driving behavior that affect traffic flow and road safety [1]. For example data related to travel time can be used to measure congestion [2] and data-based applications that adhere to sensor technology are able to advance transportation through real time transport services that promote a of low environmental impact. In line with this, the driving style known as eco-driving was defined in the mid '90$_s$ and in the last decade it has been the subject of some initiatives and projects at European level. The growth of the eco-driving awareness is also testified by the many websites promoting this driving style in the U.S. and worldwide [3].

Due to the large number of electronic systems, modern vehicles are becoming an invaluable source of information that can be used for different purposes. With the help of these data a variety of applications can be developed to assist the driver. For example, to monitor the vehicle health, analyze driving behavior, for vehicle fault detection, and driving style evaluation criteria's. As a result of the analysis of the gathered information driving patterns can be improved and fuel consumption decreased contributing thus to reduce the environmental impact of traffic.

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Accurate and timely information regarding traffic is decisive to minimize congestion and reduce travel times, being thus road and vehicle monitoring crucial for road safety and efficiency of transport. To this end the European Commission has introduced a unit known as European On-board diagnosis (EOBD) that is in charge of monitoring the emissions of vehicles [4].

Several systems have been developed to acquire data related to driving patterns using smart phones. Their embedded sensors (i.e. accelerometer, digital compass, gyroscope, GPS, microphone, camera) make them cost efficient devices to gain information related to traffic or road conditions. For example, tri-axis acceleration signals can be analyzed to extract road surface anomaly information by using similar techniques to those applied in the classification of driver styles [5].

The tracking and localization of data related to vehicles can also be facilitated by OBD data loggers. Several solutions from different vendors for fleet management and tracking already exist that include telematics platforms for vehicle health monitoring or to track stolen vehicles [6] [7] [8] [9].

## 2 Implementation

In this paper, we present a method to collect and integrate data from OBD II and smart devices. We aim at determining which device provides a more efficient and cost effective solution with regards to a real-time assistance for drivers based on their driving behavior. Data is collected from two different sources via the telecommunication system 3G or LTE, and stored in a MySQL database for later retrieval via multiple queries and a subsequent analysis and visualization.

The system architecture was designed for open source software. We used the LAMP stack which consists of the four components Linux (operating system), Apache (web server), MySQL (database system) and PHP (server-side script interpreter).

A Web interface was also developed to monitor and display all the collected data in a user-friendly manner. Fig. 1 represents the data acquisition and integration method. Data analysis takes place based on input from sensors. Relevant notifications regarding unsafe or inefficient driving behavior are then sent to the driver via Application Programming Interfaces (API).

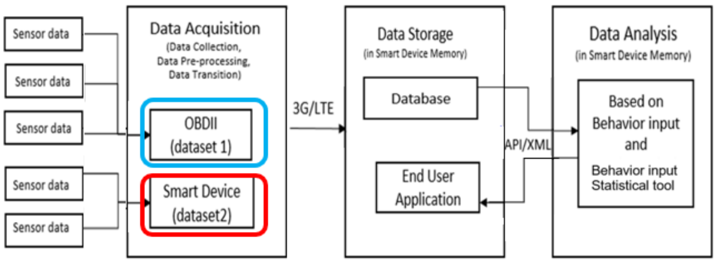


**Fig. 1.** Conceptual diagram to acquire and analyze the collected data.

### 2.1 OBD Data Collection

Data was acquired through an OBD device by using the advanced plug and track real-time tracking terminal with GNSS, GSM and Bluetooth connectivity, TELTONIKA FMB001. The device is able to collect device coordinates and other useful data including vehicle onboard computer data to transfer them via GSM network to the server.

In case of a loss of connection to GNSS satellites, it continues to acquire data that is logged under the last known coordinates. Data are stored in a SD memory card for later transmission to the server via GPRS.

This device is suitable for applications where location of remote objects is needed: fleet management, car rental or taxi companies, personal vehicles, etc. The TELTONIKA FMB001 connects directly to the car OBD-II and is able to read up to 32 vehicle onboard parameters. Data monitoring and visualization can be performed through a desktop and web-based application. Fig. 2 and Fig. 3 illustrate the data collection process and the web interface respectively.

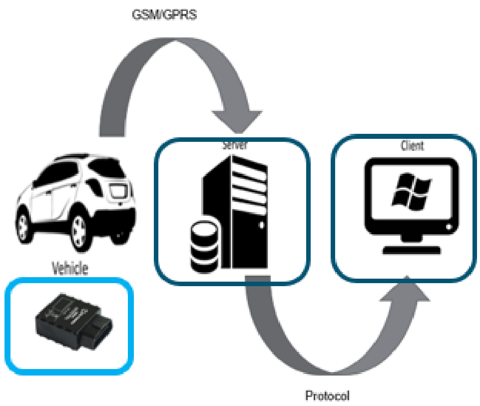


**Fig. 2.** Data collection via OBD.

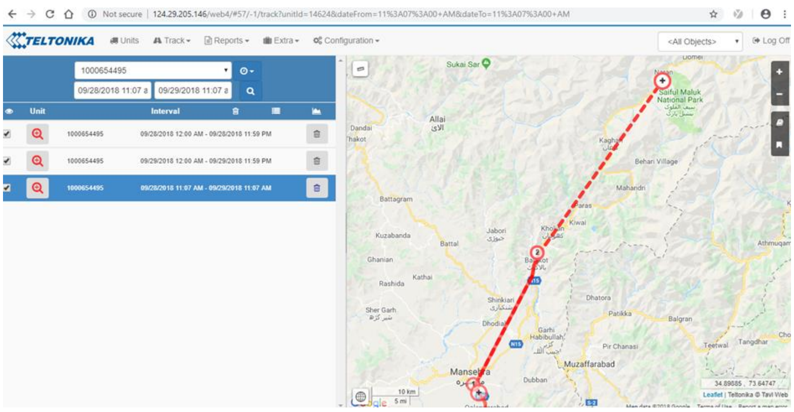


**Fig. 3.** ODB Web interface from Teltonika.

## 2.2 Smart Phone Data Collection and Analysis

To collect mobile phone-related data we developed an Android application that we called *SmartDriving (SD)*. The application is capable of monitoring driving behavior by using mobile sensors such as GPS, Bluetooth and accelerometer.

The application provides an interface to create an administrator account. After successful registration, the administrator can manage different users (i.e. drivers) and add vehicles. The location of the driver's vehicle is shown on a map. When the driver activates the "start trip" button, the parameters below are captured and stored in a MYSQL database:

- Vehicle's coordinates
- Altitude
- Current Time
- Speed of vehicle (m/s)
- Acceleration of vehicle (m/s2)
- Deceleration of vehicle (m/s2)
- Bluetooth
  - Number of Bluetooth devices found near or in the range of the driver's smart phone with time stamp
  - Signal strength (low, medium, high)
  - Bluetooth MAC address
- Angular velocity
- Temperature (Celsius)

The "End Trip" button stops the recording process. All the travels performed are plotted on Google Maps (for a real time driving monitoring the respective API were used) as polylines via latitude/ longitude coordinates. The administrator can see the list of drivers, registered vehicles and all the trips that are incomplete (in process) or have been already completed. Users can also update their information and change their passwords. The *SmartDriving* application works with sensors of the Android device, which is why it requires certain permissions. Fig. 4 shows its user interface. Fig. 5 shows the flow diagram that illustrates the major components of the developed smart phone application.

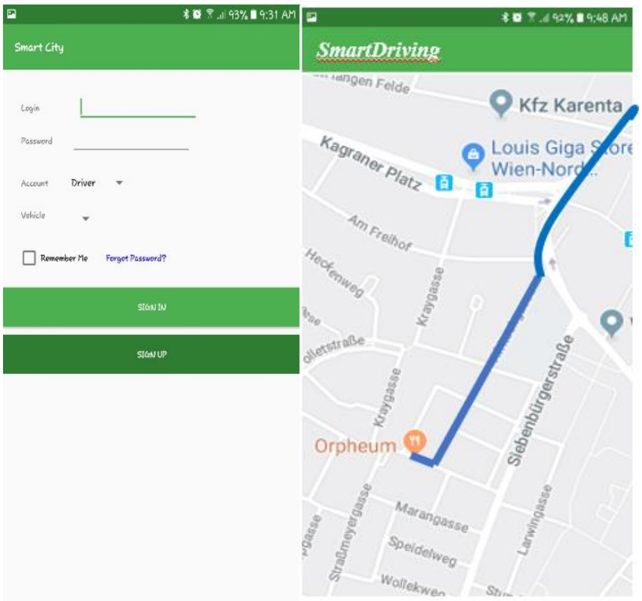


**Fig. 4.** *SmartDriving* application. The image on the left shows the login interface. The image on the right shows one of the trips that were taken.

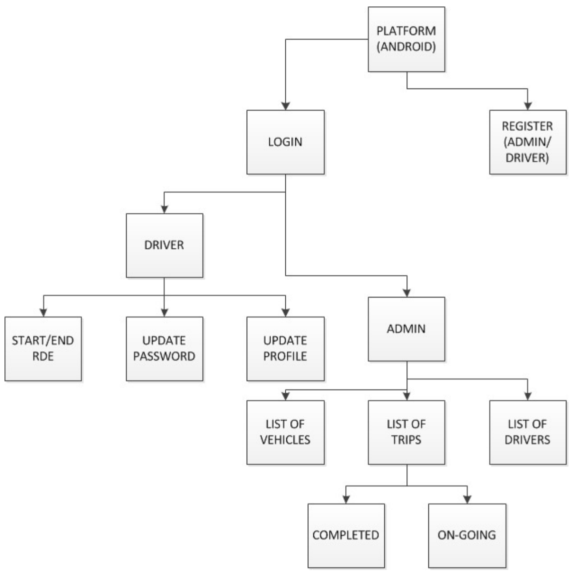


**Fig. 5.** Flow diagram illustrating the major components of the developed *SmartDriving* application

The logical database design was implemented in MySQL. Fig. 6 shows the entity relationship diagram. The data collection steps of both the *SmartDriving* and the OBD are illustrated in the flow diagram in Fig 7. Travel data such as origin and destination were visualized on Google Maps.

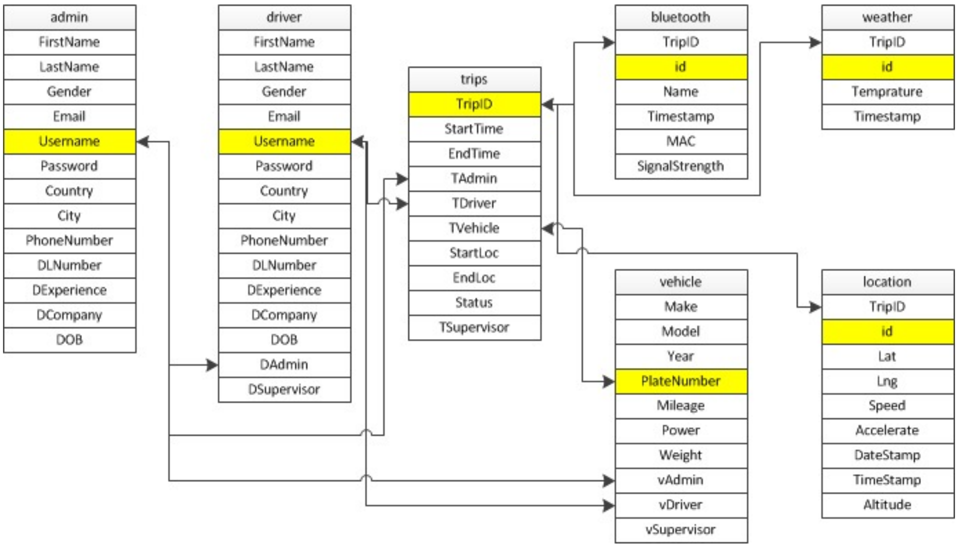


**Fig. 6.** Entity relationship diagram.

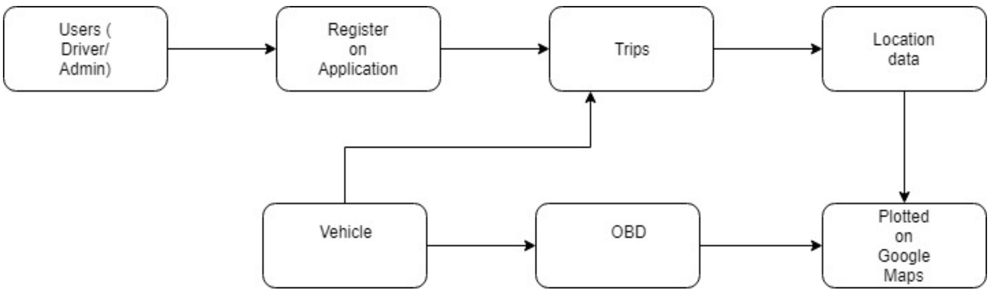


**Fig. 7.** Flow diagram illustrating the developed *SmartDriving* smart phone application and the data collected by using an OBD device

Data from 5 trips of 15 minutes each was collected for 5 consecutive days using a OBD device and the smart phone application both in the same trip. 18,000 records were analyzed and their differences regarding both collection methods evaluated by plotting the trips on maps and calculating the difference between the two data sets.

## 3 Results

Location data comparison occurred based on differences between distances at a particular location. Results showed a good performance of the developed application as illustrated in Fig. 8 by an example of the data collected using the *SmartDriving* application and the data collected from OBD.

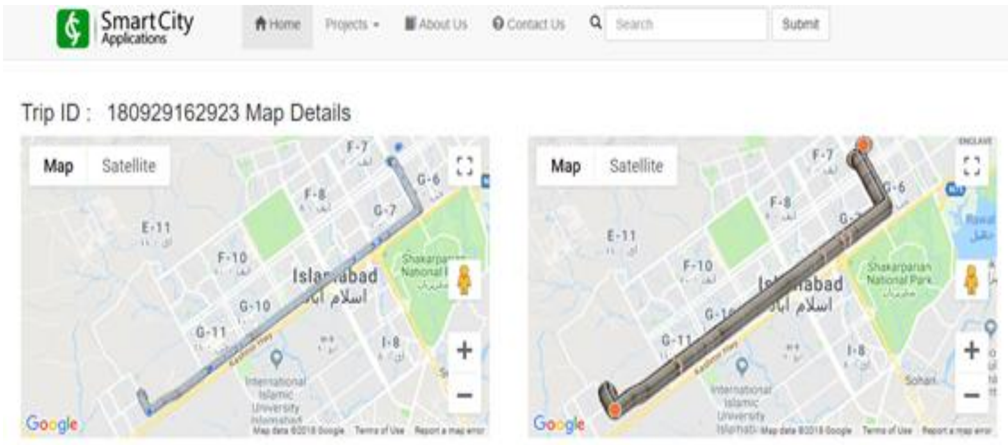


**Fig. 8.** Implemented web portal showing *SmartDriving* (left) and OBD data (right) from a trip.

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