# Dangerous Driving Remote Sensing based on Mobile Society

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***Abstract:* I am disappointed driving a car in Szekesfehervar. It is good to see, that there are a lot of cars, more than 500 cars pro 1000 citizens, which shows, that people have got money, so the economy in Szekesfehervar is really prospering. But most people do not care of traffic rules, actual traffic situations and optimal traffic. Some of them are only impolite and aggressive, but lot of them cannot really drive. Can we help on this situation? Can we detect dangerous drivers not harming the GDPR? Could we warn the conscious drivers for dangerous drivers in the close traffic environment? Seeing an alarming ambulance car, my daughter said once, that we cannot know, when an accident will happen. I reflected as alighting, that of course, we can! The article presents an initiative mobile application based on android society.**

***Keywords*: Smart cities, Smart traffic, Driving society, Driver responsibility, Connected cars**

## I. Introduction

My experience is, that the driving moral is terrible in Hungary and in Eurasia east from Hungary. There are terrible drivers driving too fast and/or ignoring the driving rules and/or too slow and/or dummy. Furthermore, there are impolite and dummy drivers who do not or do not want to recognize the optimization opportunity in a congested concurrent traffic situation, e.g. traffic situation in Figure 1.

As Google drives the traffic indication on Google Maps based on Android Mobile Device anonym position data submission, there could be setup a social dangerous driving detection appliance named to CDDDA or RDDDA. Other major example for anonym driver tracking works in Waze Mobile Navigation Application.

A sensing and warning system, as a part of an Intelligent Transportation Systems (ITS) could support not only the conscious drivers and pedestrians by warning them for reckless drivers in the certain traffic zone, but it could help to broadcast the appearance of alarmed ambulance, firefighter, police or disaster management vehicles to avoid the collision with personal vehicles and with other alarmed vehicles (Fig. 1.). In Hungary, approximately 500 ambulance car accidents happen annually. The internet is full of articles and videos about careless drivers ignoring the siren on the public roads.

Moreover, these applications can support the Usage Based Insurance (UBI) [1], or can "*gauge subjectively gauging recklessness from a passenger's perspective"* [2].

An appliance like this can use the following data collecting technologies for rating the driver's behavior and broadcast real-time warning information:

- connected mobile devices,
- dedicated IoT devices,
- connected cars.

Figure 1. Accident of two official ambulance car in a rural major city in Hungary

## II. Methods for Detecting Dangerous Driving Behaviour

A comprehensive literature review shows that sensing the dangerous driving is a general topic in many countries and in many fields.

The major device for dangerous driving behavior detection method is the smartphone. Typical solution is the yaw angle detection, which can be based on low accuracy accelerometers and gyroscopes. The benefit of this application is, that there are no requirements about the orientation of the device, but it should be developed different algorithm for each of behavior, moreover there could be interferences with normal motion features. [1]

The difference in developed systems are the applied sensor-fusions and the driver behavior and risk analysis methods and algorithms. The gyroscopes are not able to detect the reckless driving directly, there are a lot of circumstances to correct the measurement in real time.

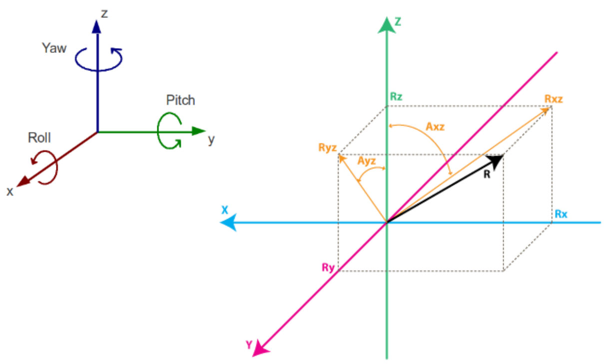


Figure 2. Yaw, pitch and rolling detection with gyroscopes [3]

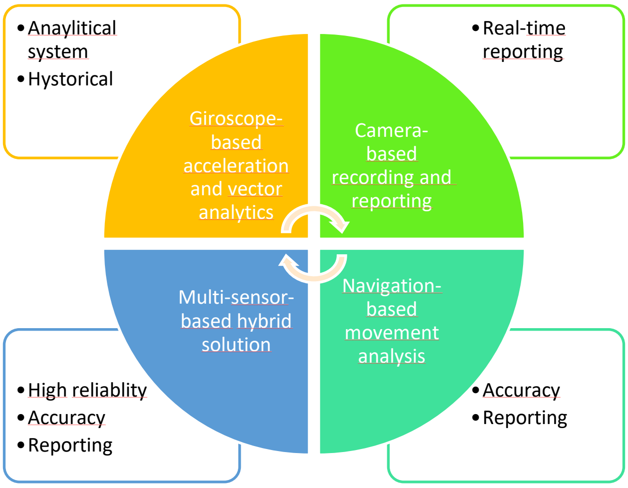


Figure 3. Short analysis of detection possibilities of Reckless and dangerous drivers

On the other hand, the capability of mobile devices hosting these embedded sensors is limited in energy consumption and computing.

Most of the application targets only the device onboarded in the car. The available devices are motion detection camera, gyroscopes, and GNSS-based navigation devices. These devices can detect the reckless driving or sense it by several analytical process, but there are accuracy limitations. [4] There are camera-based solutions aiming the detection of drivers influenced by the alcohol or drugs [5] or recording speeding and ignoring red-light. And there are wearable equipments development for detection sleepy drivers. [6]

## III. CONNECTED APPLICATIONS

Ref. 5. examined the recent results and applications not only the sensor-based, but network-like applications mobile device for supporting intelligent traffic management systems.

The key of these intelligent traffic management applications is the connectivity, which can provide the warning information to the transport society integrated into widely used applications running during driving or transportation.

There are several navigation applications, which provides traffic information on the map used for navigation. In next subchapters, there is a short comparison about these applications used primarily and widely in Hungary.


Figure 4. Navigation Screen and Event-reporting UI in Waze Mobile Navigation Application

### a) Waze application

Waze application is a generally used mobile navigation application extended by "Wazer" society coming from event reporting and registration opportunity.

Benefits are its popularity, and the anonym and identified end-point tracking, which can be used for traffic flow tracking and tracing. Based on the traffic flow information, enhanced route rating is provided, which helps to optimize the route based on estimated travelling time. Moreover, it can warn the drivers for approaching at a traffic jam.

Re-routing is also available function, but the system does not sense the growing or changing traffic load, (or only does not take it into the calculation), therefore, mostly at the start of traffic jams and at the end, it may propose longer, but stuck bypasses. This gives a worse route than the original stuck route. And typical periodical traffic load cannot be analyzed.

Moreover, based on user-friendly event reporting with minimized interaction requirement, it can warn the drivers for accidents, broken down cars and reported road controls, or building sites, road constructions and closures, as well. Some of these events can be managed centrally by Waze moderator.

### b) Traffi Hunter Mobile Application

The Traffi Hunter is a road control forecasting application to prevent drivers from penalty about especially speeding, road-toll and truck weight control. It is officially not forbidden but helps the drivers to get away with penalty of highway code fouls. It is equipped with user-friendly reporting user interface for real-time submission of speed control and road controls. Moreover, there is a database about fixed speed traps and published monthly road control schedules.

### c) Google-Maps Navigation Application

Google-Maps is the general map application of Google therefore, it is basic application for Android-based mobile devices. But it is available on desktop application. It collects end-point devices, as well, so traffic flow tracking and route rating is also available. Based on this, the typical traffic load can be checked for a certain period of week, but only on desktop. (Fig.5.)

The other benefit of Google-Maps is its worldwide usage, which give the application developers and service providers to insert into the maps their locations as a Point-of-Interest (PoI).


Figure 5. Traffi Hunter Mobile Applcation

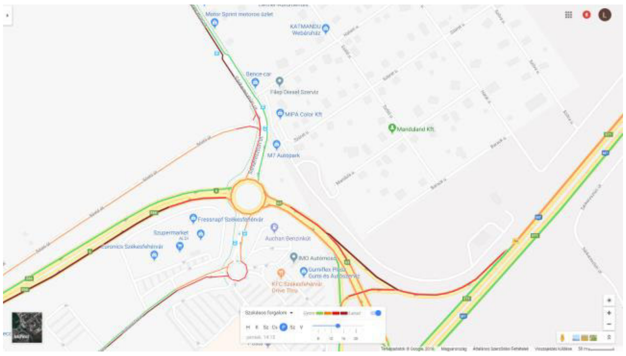

Figure 6. Periodical Average Traffic Load in Google-Maps Web Application

Moreover, other applications like site and facility structural maps, mobile parking place discovery and location- and time-based payment solutions can be mapped on Google-Maps.

## IV. Structure and Functionality of Complex Warning System

As a summary, Waze and Google-Maps applications can collect and provide driver behavior information in real-time, but there are a lot of missing components:

- Driver rating based on international highway code:
  - collection driving behavior-related data,
  - conversion collected data to smart data,
  - submit smart to the central system,
  - collection of pedestrian density data.
- Warning system using driver rating data:
  - central system warns drivers/pedestrians in certain traffic environment for occasional dangerous drivers,
  - warn drivers to high density of pedestrians/traffic jams.
- Collecting additional traffic safety intensive data:
  - tracking the position of alarmed ambulance, firefighter, police and military cars,
  - mash-up of real-time weather station reports.
  - (Tracking the weather conditions from car onboard systems, which requires connected cars.)

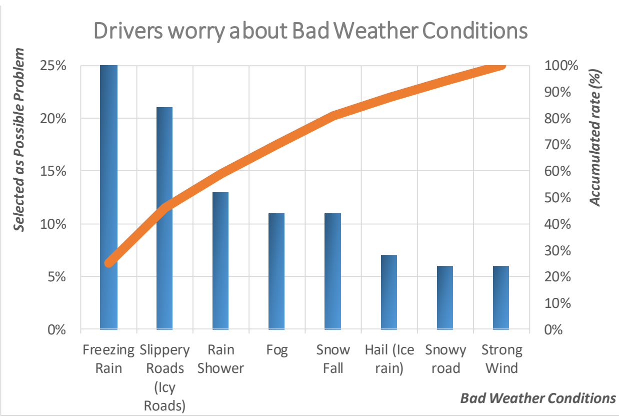


Figure 7. Most Frequent Bad Weather Conditions Driver's Worrying about

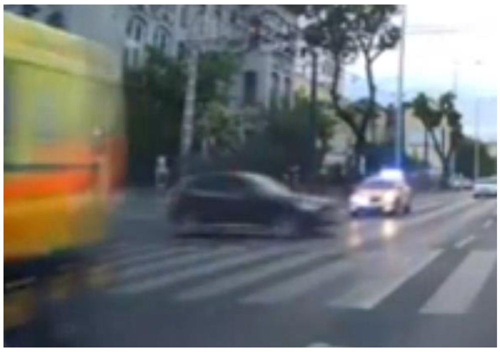

Figure 8. Inattentive driver crossing on Ambulance Convoy hitting nearly both ambulance vehicle

- Warning system using additional data:
  - approaching of alarmed ambulance, firefighter, police or military vehicles,
  - approaching to bad weather conditions, especially freezing rain, slippery roads, hail, fog, rain shower as a short survey shows .

The tracking of alarmed vehicles has got high importance, because not only the firefighters and sometimes police vehicles move in convoy, but there are more and more cases, when an ambulance vehicle is followed by a medical car in much more cases, and the transporting society is not prepared for this in many cases. Most of the drivers seeing an ambulance car crossing a road, think that the way is free, and causing serious dangerous traffic situation. (Fig.8.)

## V. Most Frequent Traffic Incidents in Székesfehérvár and in Hungarian Public Roads and Detection Possibilities

Analyzing personal traffic data, the following traffic incidents are most frequent in daily city and intercity traffic:

### *a) Ignoring right hand rule*

At known locations of crossroads with same priority, ignoring the right-hand rule, namely passing the cross section without braking or no stop for a car approaching in from right, can be detected. This event can be weighted if there is a car approaching from right, the weight of ignoring is bigger. If there is detectable braking by the vehicle on priority road, the weight of ignoring it is the biggest.

An additional weighting factor should be added to rate the behavior at crossings with objects in eclipse or hard to see. This feature should be applied at any situation where eclipsed objects are involved into the crossing situation.

### *b) Ignoring STOP sign protecting priority road*

At known locations of Stop signs, stopping the car can be detected. Ignoring the Stop sign can be weighted by the certain traffic flow, namely if there is a car approaching to the road crossing on the priority road, the weight of ignoring is bigger.

If there is detectable braking by the vehicle on priority road, the weight of ignoring it is the biggest.

*c) Ignoring priority against a car approaching on primary road*

Similar to ignoring stop plate, at known locations of Priority is mandatory signs, approaching vehicle on priority road can be detected. In this case the score is smaller, than at ignoring Stop sign.

*d) Ignoring priority in roundabout type street crossings*

It is similar to the previous cases, but score can be weighted by approaching speed and the presence of other road users.

*e) Ignoring Pedestrian Crossing*

Basically, pedestrian crossing zones must be approached by car with 30 km/h in Hungary. In this case, the score is depending on the approaching speed and the presence of pedestrians and its number.

In this case, weighting factor should be added to rate the behavior at crossings with objects in eclipse or hard to see or near to nursery, elementary and high schools and playgrounds and parks.

*f) Ignoring the right direction in one-way road*

The detection can be based on movement direction and triggered by turning or leaving the one-way road on the entrance side, but the weighting should be based on distance and on stuck cars moving into the right direction.

*g) Ignoring alarmed Ambulance, Firefighter and Police cars*

Detection is based on motion vector, and scoring based on speed, interference and crossing the route of alarmed vehicle.

*h) Dangerous take-over at frontal oncoming car*

Detection is based on motion vector, and scoring based on speed, and interference with frontal oncoming car (distance measurement). GPS accuracy could be enough depending on absolute speed.

*i) Crossing closing line*

If closing line data is available on the road section, the closing line crossing detection is available. It is hard to detect because of average GPS accuracy, can be corrected based on comparison positions of previous and following vehicles proceeding into the same direction on the road.

*j) Ignoring speed limit especially at bad weather conditions (Absolute speeding)*

This behavior can be detected by GPS signals and can be weighted by the certain bad weather condition and based on the presence of other road users who can be endangered.

*k) Ignoring bad weather conditions especially freezing rain, slippery roads, hail, fog, rain shower (Relative speeding).*

This behavior can be detected primarily relative to the other vehicles on the same road. Rating can be based on speed, following distance and takeover attemptions.


Figure 9. Slow down! My dad works here, too!

*l) Road construction and building sites*

Continuously refreshed database can determine the locations of these sites, and the prescribed traffic limitations such as speed limits, lane closures, lane shifts and other restrictions, which can be updated and revised by car onboard camera-based traffic plate recognition.

Driver's behavior scoring can be weighted by the endangering level of the road users and site workers.

As it previously mentioned, additional weighting factor should be applied at rating the driver's behavior at crossings signed with objects in eclipse or hard to see or near to nursery, elementary and high schools and playgrounds and parks. This information can be added, managed and revised centrally and by road users.

## VI. Issues about Driver's Privacy and Reliability and Research and Development Tasks

In case of a driver's behavior scoring system, drivers do not want to be identified themselves, and get a negative ranking. Therefore, the system should identify the driver's anonym, without name, if we want the system to make popular in road user society. At this point, we lose the opportunity to use the system to support the work of judicial experts and insurance companies in case of evidentiary issues.

So, one of the development tasks is to develop the system to even-handed, socially-trusted, consciously usable and useful warning system. In this case, the drivers want to participate in the communal usage of the system and position in the ranking in best position meeting with its conscious thinking about driving safety.

Technological requirements are above the accuracy and real-time information providing are the minimal battery consumption, CPU usage and mobile network traffic load by the application, and the integration with popular navigation systems.

## VII. Summary

The paper summarizes the foundations of driver behavior analysis and traffic warning system. The analysis of possible traffic incidents, its detection possibilities and issues about driver's privacy shows that there are two major tasks to develop:

- reliable, energy- and communication-efficient, real-time detection of inattentive, reckless behavior of drivers,

- even-handed driver's behavior rating system weighted by the presence of affected road users, the danger level of the situation and the complexity of road crossing site.

The success of such a system is dependent on trust of road users especially running seamless and at low power and network consumption in background on mobile devices of non-driving road users, pedestrians, bicycle, roller, Segway and motor riders, and participants in public transport. In case of bicycle, roller, Segway and motor riders, a useful extension of the warning system can be the headset- or smart-watch-based warning signals.

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