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DRIVER ASSISTANCE SYSTEM – VEHICLE TO X COMMUNICATION SERVICES

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ABSTRACT

we introduce the Android based driver system "DriveAssistance". This application visualizes the traffic information that originates from Vehicle-to-X communication services as well as from central traffic services (CTSs) on the user's smartphone. This give an overview to the driver of the traffic around her/him on a map view, this application can also run in the background and notify warning messages for certain traffic incidents.

I. INTRODUCTION

"Vehicle-to-X" communication is a promising technology that has the potential to improve the safety of everyday road travel. A study performed by the U.S. NHTSA concluded that Vehicle-to-X systems could potentially address 81% of all-vehicle target crashes. By this it is clear that an efficient visualization for such Vehicle-to-X systems' data is crucial for the drivers, still research is focusing on system and technology aspects, such as radio communication, GeoNetworking. With this system DriveAss, in which we contribute design and implementation concepts concerning the presentation of traffic information.

As growing market of smartphones and tablet personal computers and other PPDs considerable alternatives to in- vehicle integrated systems. Especially in mid-sized cars, which often have no head unit at all, the user's PPD can be used for adding functionality in the automotive domain. Also today's premium cars offer the possibility of coupling a PPD.

This paper will give an overview on such type of approaches. Then present the setup of our system and introduce our Android-based DriverAss, ending with a summary of our findings and implications on future purpose.

I. RELATED TYPE OF TECHNOLOGY

In the present time smartphones and tablet PCs are equipped with a range of modern and highly accurate sensors, they can also be used for analyzing driving related scenarios. "Mednis et al" developed a system that allows the detection of potholes using a mobile device's built-in accelerometer. Mednis's Android application achieved a true positive rate of 90% in real world usage. The driving context can also be derived directly from the vehicle's on-board diagnostics system. Zaldivar et al. used the OBD-II interface for accessing safety relevant data, such as G-forces and airbag states. By combining this data with measurements from the mobile device's sensors, a high detection rate of serious accidents could be reached.

Grimm provides a high level discussion of a mobile device communicating with a Vehicle-to-X. In his approach, a smartphone was used as platform for developing new services without the need of changing the

vehicle's architecture. They further state that the combination of a Vehicle-to-X on-board unit with a mobile device "seems to provide a viable solution for market introduction of Vehicle-to-X systems."

II. DRIVER ASSIT SYSTEM

Driver Assit Systemconsists of two components:

A. A vehicle-integrated Vehicle-to-X communication unit (on-board unit, OBU),supporting ITS G5 or 802.11p.

B. One or multiple PPD's.

The standardized Vehicle-to-X communication unit can be directly integrated in the vehicle's system. This unit can also be retrofitted in any existing vehicle with only little efforts.

Since Vehicle-to-X communication is based on slowly changing standards, it is not very likely that the Vehicle-to-X unit is outdated within a typical car lifespan of 9 years1. The usage of a personal portable device as data processing unit and HMI has multiple benefits like:-

- In safety-critical situations it is very beneficial when the driver is accustomed to the HMI. This is especially of interest for car sharing scenarios.
- Whenever a user buys a new PPD with more sensors, higher processing power and better display, it is like a car hardware upgrade that enables new applications.

In this, the on-board unit acts as Vehicle-to-X gateway that handles the radio communication, the GeoNetworking as well as the encoding and decoding of the Vehicle-to-X messages. Connectivity between the components is based on the (IP) and can be established via WLAN, Bluetooth. The OBU is further connected directly to GPS receiver and automatically creates the default Vehicle-to-X messages for the vehicle. The mobile device also gets copies of the messages from the ego vehicle and can use the GPS position from the Vehicle-to-X unit for its calculations.

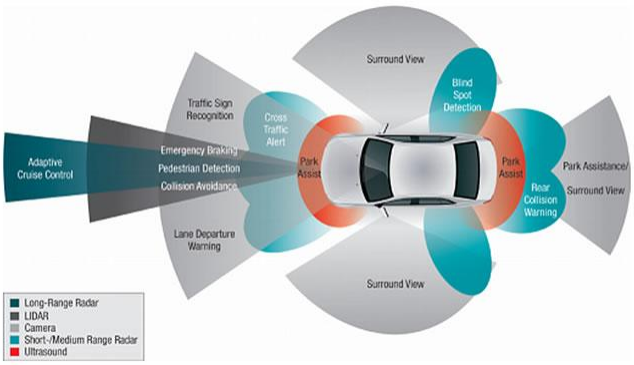

Figure.1

4 Features

- The combination of data from multiple sources, including Vehicle-to-X communication.
- Since the application is designed for the usage in vehicles, it has a very clear structure and large control elements.
- The information from Vehicle-to-X communication is currently derived from Cooperative Awareness Messages (CAMs, ETSI TS 102 637-2, 2011) and Decentralized Environmental Notification Messages (DENMs, ETSI TS 102 637-3, 2011). So far, the following Day-1 use-cases are supported:

- Approaching Emergency Vehicle Warning (AEVW, CAM)
- Electronic Emergency Brake Lights (EEBL, DENM)
- Stationary Vehicle Warning / Post-Crash Warning (PCW, DENM)
- Traffic Jam Ahead Warning (TJAW, DENM)
- Working Area Warning (WAW, DENM)
- Hazardous Location Notification (HLN, DENM)
- DriveAssist can also query central traffic services (CTSs) using the PPD's mobile data connection.
- These free or paid services are normally provided by service providers that collect and aggregate data from different sources.
- Common sources are the police, road maintainers, private persons, or automobile clubs.
- For measuring the traffic flow, automated sources such as sensors (light barriers, induction loops), floating phone data (FPD), or floating car data (FCD) are the state-of-the art.

III. HOW TO PRESENT TRAFFIC

It's important that the driver can instantly recognize what type of traffic incident is reported. For this, common standardized traffic signs have been used for indicating the traffic incidents' types. In case there was no appropriate official sign, meaningful pictograms following the design principles of the official signs have been created. All warnings are presented in a red triangle. Besides the visual warning, text-to-speech (TTS) can be enabled in the preferences. The TTS informs about new events and can repeatedly warn the user when she/he approaches an incident. The distances and repetition interval can be defined in the preferences.

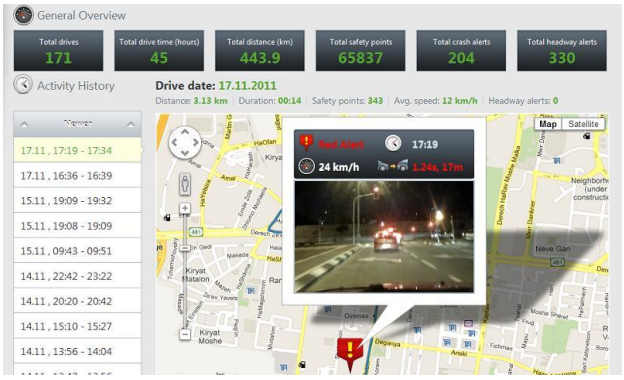

Figure2

To provide an overview to the driver and the other vehicle passengers, a map view can be started.

IV. WARNING DISPLAY

DriveAssist gives a service which allows starting and displaying a warning, for example, after a car accident. Further down the cross street, a working area warning (WAW) is displayed. By zooming out, all received traffic events can be seen. For CTSs this can cover an area of several 100 square kilometers. By tapping on an icon, additional information is displayed. This information contains, among other things, the source of the information, a more precise description of the event, and, when available, also the length and the time-loss due to the event. For acoustic notifications about new nearby incidents, a circle of interest around the car can be

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defined. New events are also indicated by a larger version of the warning symbol in the lower left corner of the screen. Besides the map view, it is also possible to get a list of all nearby incidents.

Although another application, such as navigation application or the phone interface, is currently shown. Similar to the map view, the user can also specify a circle of interest in the preferences, when she/he wants to be informed about nearby incidents.

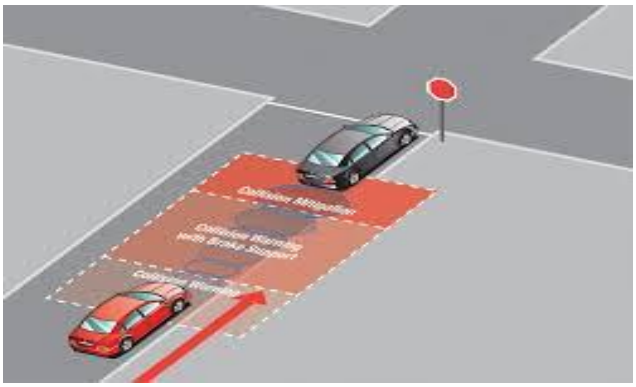

Figure 3

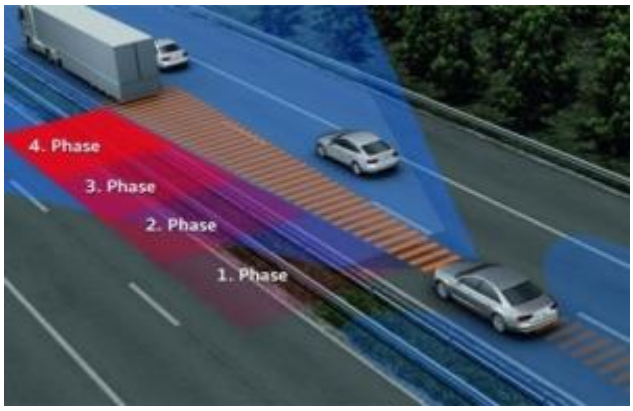

Figure 4

The warning screen shows the type of the detected traffic incident through well-known standardized traffic symbols. The direction of the event relative to the car is indicated by the red dot (here: above the ego vehicle). The visual output is accompanied by a text-to-speech generated audio warning.

Fig. 6 shows a working area warning (WAW). The construction site is 250 meters ahead of the vehicle. Besides the symbolic presentation. The red dot indicates the direction of the incident relative to the car's long axis. The eight sectors scale allows the driver a fast estimation where the incident is. The distance to the event is rounded down to multiple of 50 meters (configurable in the preferences) and updated regularly. Whenever the distance to the incident falls below a definable distance that does not anymore allow a correct estimation of the direction in which the incident is located, the dot is replaced by a red rectangle around the vehicle. Together with a TTS output, this shall inform the user that the incident is nearby and can be anywhere around the car.

Figure 5

Figure 6

When the traffic event is nearby (e.g. less than 15 meters away), the GPS accuracy does not allow indicating the precise position of the event. For that reason, the red border around the car shall symbolize the user that the event can be anywhere around the car.

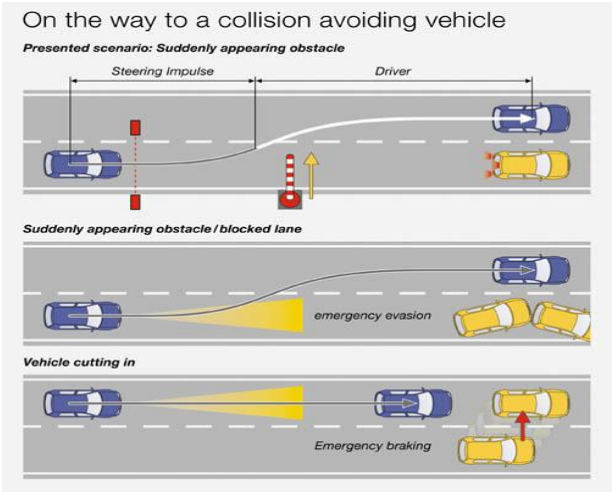

Figure 7

The warning message is always displayed full-screen and does not need any kind of interaction. Depending on the PPD's Android version, DriveAssist can also run when the screen is turned off and can turn the screen back on when a warning should be displayed.

V. CONCLUSION

We have shown our Android-based driver assistance system. Our system is able to combine traffic information from different sources and offers several modes for informing and assisting the driver and vehicle passengers. Since the system is based on a Vehicle-to-X unit that can be retrofitted in any vehicle.

This system could be an affordable solution for the broad market introduction of Vehicle-to-X. The combination of data from Vehicle-to-X and CTSs further allows for a good operability from the beginning on.

Not only improving the safety of everyday road travel, but the gathered information could also be used for improving the driving efficiency and comfort. Likethe system could suggest changing to public transportation by evaluating the timetables ofnearby stations via central traffic services. For that reason, we will integrate navigation functionality in the next version of DriveAss.

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