Video-Based Overtaking Assistance Now A Reality

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***Abstract*—ITS solutions suffer from the slow pace of adoption by manufacturers despite the interest shown by both consumers and industry. Our goal is to develop ITS applications using already available technologies to make them affordable, quick to deploy, and easy to adopt. In this paper we introduce an ITS system for overtaking assistance that provides drivers with a real-time video feed from the vehicle located just in front. This provides a better view of the road ahead, and of any vehicles travelling in the opposite direction, being especially useful when the front view of the driver is blocked by large vehicles.**

***Index Terms*—Android application; real implementation; video transmission; live streaming; vehicular network; ITS.**

I. Introduction

Intelligent Transportation Systems (ITS) are advanced solutions that make use of vehicular and infrastructured networks to provide innovative services related to both traffic and mobility management, and that interface with other models of transport. ITS aims at using the already available transport networks in a smarter manner, resulting in significant coordination and safety improvements. Our goal here is to *integrate smartphones into vehicular networks* to develop ITS applications that can reach out to the masses in a short period of time. The choice of smartphones is not only justified by their wide availability and use, but also because they are evolving towards high performance terminals with multi-core microprocessors packed with sufficiently accurate onboard sensors.

The architecture and application has been developed for the Android platform, and has been named EYES [1]. The minimum requirement of EYES is having Android devices equipped with at least a GPS and a back camera. The application makes use of the camera to record video and transmit it over the vehicular network, thus providing an enhanced multimedia information aid for overtaking. The location information of the vehicles gathered from the GPS is useful since the transmission of the video feed only occurs between cars travelling in the same direction, and always occurs from the vehicle in front to the vehicle travelling behind. The Android devices are to be placed on the vehicle dashboard with the camera facing the windshield, so that a clear view of the road in front and cars coming from the opposite direction can be captured. Once started, the application requires no further user interaction to operate. EYES can be specially useful in scenarios where the view of the driver is blocked by a larger vehicle, or when a long queue of cars is located ahead and the driver wishes to overtake. In this case, it will automatically receive the video stream from the vehicle just ahead, and play the received feed on screen, thus aiding the driver in deciding the safest moment to overtake.

In the literature we can find many different applications to improve safety while driving that are targeted for smartphones, but only a handful aimed at providing visual aids to the drivers, namely SignalGuru [2], CarSafe [3], and iOnRoad [4]. However, none of these smartphone-based applications actually provides real-time visual overtaking aids provided by other cars taking advantage of vehicular networks, even though the idea of video-based overtaking assistance systems is not new. In fact, works like the See-Through System [5], which was later improved in [6], although not being targeted for smartphones, are focused on video-based overtaking assistance. Other related works worth mentioning are [7] and [8], which demonstrate the feasibility of such video-based assistance systems. In [7] authors proposed performance improvements to a video-based overtaking assistant by focusing on codec-channel adaptation issues, whereas [8] focuses on the reallocation of wireless channel resources to enhance the visual quality. Thus, in order to fulfill the need for a visual overtaking assistance application targeted at consumers, we decided to develop an application which, if combined with an existing vehicular network, would require no additional hardware besides a smartphone to operate. The proposed EYES application is targeted at smartphones since we aim at achieving rapid acceptance, and to promote the close integration of smartphones into vehicular networks.

II. EYES in action

We already know from the brief introduction of the application that the video streaming aways occurs from the car travelling just ahead to the car following it, and so no multi-hop relaying is required.

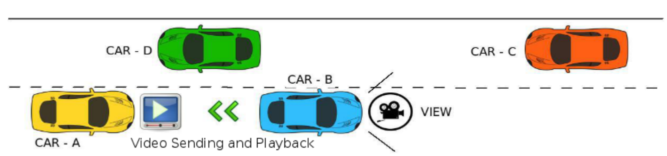

Fig. 1: Functional overview of EYES.

The Fig. 1 shows that CAR-B, upon receiving the video request from CAR-A, starts streaming the video. CAR-A starts

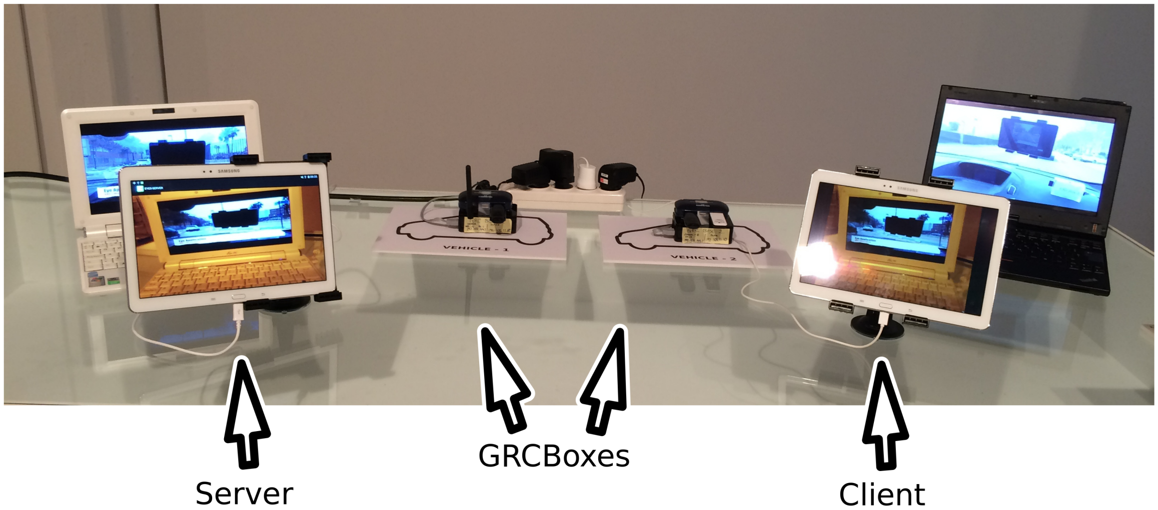

Fig. 2: Indoor demonstration of the EYES application.

receiving the video stream and plays it onscreen for its driver. Notice that there is no video transmission between CAR-C and CAR-D, even though they are travelling in the same direction and lane, and despite one vehicle being ahead of the other, because they are separated from each other by a large distance which prevents them from communicating with one another. It may be noted here that a device can act both as video source and destination. This is because, while a device is receiving video from another device, it may also be streaming its own video capture to a completely different device.

For proper operation, the developed application assumes the availability of a vehicular network, although the vehicles we use on a daily basis still lack the capability to communicate with one another. So, we equipped cars with GRCBoxes [9] inside them. GRCBox is a low cost connectivity device based on a *Raspberry Pi*[1] which enables the integration of smartphones into vehicular networks. It was developed mainly due to the difficulty in creating an adhoc network using smartphones. Another important feature provided by GRCBox is the support for V2X communications. The different networks supported by the GRCBox include adhoc, cellular and Wifi access points, among others. Thus, we use the adhoc network support of the GRCBoxes to create the required network for our application.

Fig. 3 shows how the application works when combined with GRCBox. Each car within the vehicular network has a GRCBox mounted. The smartphones of the passengers within the car are connected to the GRCBox, which is equipped with Wifi-enabled USB interfaces to communicate in adhoc mode, creating a vehicular network. Thus, all data exchanged between the vehicles takes place via the GRCBoxes. Even though the GRCBox is supposed to be equipped with 802.11p for vehicular communication, we used 802.11a devices instead as 802.11p-enabled hardware was not available while setting up the GRCBox to perform the tests. In future experiments we intend to use 802.11p compatible hardware to take advantage of the *WAVE standard* [10].

[1]More on Raspberry Pi: https://www.raspberrypi.org

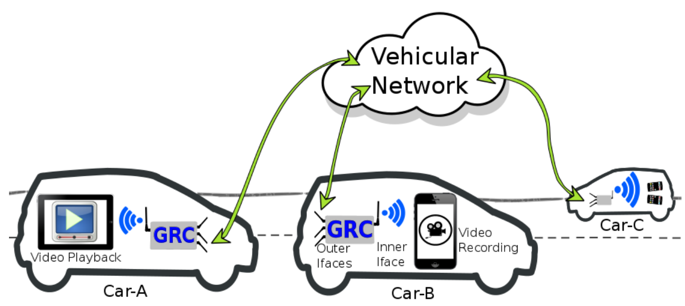

Fig. 3: EYES working together with GRCBox.

The EYES application was tested both in the laboratory and in a real environment using cars driven around our university campus. Each car was equipped with a GRCBox to create the required vehicular network, and the Android devices used were a Nexus 7 and a Samsung Galaxy Note 10.1 (2014 Edition). The Nexus 7 from Google was powered by a quad-core 1.2 GHz processor, ULP GeForce GPU, 1 GB RAM and 1.2 MP camera. The Samsung Galaxy Note 10.1, on the other hand, was equipped with a quad-core 1.9 GHz plus quad-core 1.3 GHz processors, 3 GB ram, 8 MP primary camera and 2 MP secondary camera.

Fig. 2 shows one of the tests with the application in the laboratory environment where the device acting as server is recording a video that is being played on the laptop placed in front of it. This recorded video is then streamed to the client device via two GRCBoxes emulating two cars, each mounted with a GRCBox. It is assumed that the vehicle ahead acts as the video source, and the other vehicle following it acts as the client. At the client end, the video stream is received and immediately displayed on-screen of the Android device. It evident from the figure that the delay between the capture

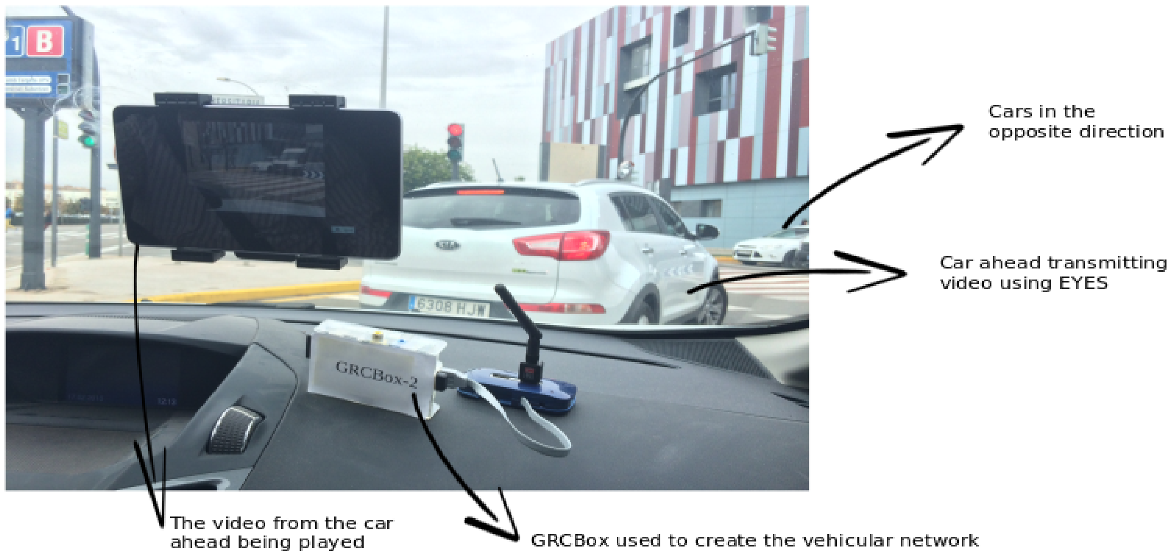

Fig. 4: Experiments with the EYES application in a real scenario.

and playback is minimal, thus proving its adequacy as a drive safety application.

Similarly, fig. 4 shows a photo taken during one of the *outdoor tests* [2]. The outdoor test is exactly the same as the scenario we had emulated in the laboratory environment. In this picture, we can see that the front car is trying to take a right turn, and the back car is receiving the video from the car ahead and playing it onscreen.

III. Conclusions

In this paper, we have presented a driving safety application that is able to help drivers in safe overtaking. The system provides a real-time video feed captured by the smartphone installed in the vehicle ahead, which is streamed to the smartphone of the driver seated in the car behind, which displays the video without user intervention. Thus, it provides drivers with important information and helps them decide whether it is safe to overtake. The developed application works correctly and was validated outdoors using real vehicles. From our observations, we acknowledge that combining smartphones with vehicular networks indeed opens a new horizon for ITS applications and, in the future, we will focus our attention on further improving our application before releasing it for public use.

Acknowledgments

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[2] Application in action: https://www.youtube.com/watch?v=jrIWbFjN3Hw

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