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Paul Green
Bastian Pfleging
Andrew L. Kun
Yulan Liang
Alexander Meschtscherjakov
Peter Fröhlich



**The Association for Computing Machinery
2 Penn Plaza, Suite 701
New York New York 10121-0701**

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Improving Connectedness between Drivers by Digital Augmentation

Chao Wang

Eindhoven University of
Technology
Eindhoven, the Netherlands
ch.wang@tue.nl

Jacques Terken

Eindhoven University of
Technology
Eindhoven, the Netherlands
j.m.b.terken@tue.nl

Jun Hu

Eindhoven University of
Technology
Eindhoven, the Netherlands
j.hu@tue.nl

Matthias Rauterberg

Eindhoven University of
Technology
Eindhoven, the Netherlands
G.W.M.Rauterberg@tue.nl

Abstract

The road environment can be seen as a social situation and road user safety can be viewed as not just skills-based and rule-governed. Driver need to coordinate with each other to share the infrastructure. Lights, horn and speed information are the most frequently used tools to exchange information, limiting both the range and the bandwidth of the connectivity, which may lead to misunderstanding, irresponsibility and social isolation. With everywhere available connectivity and the broad penetration of social network services, the relationship between drivers on the road may gain more transparency, enabling social information to pass through the steel shell of the cars and giving opportunities to reduce anonymity and strengthen empathy. In this study, we utilized the "Four Side" communication model to describe different dimensions of information exchanging between drivers, which would be enhanced by the latest Vehicle to Vehicle communication technology. Under this model, three prototypes on a driving simulator were developed for further exploration to get the insights of social interaction between drivers by digital augmentation.

Author Keywords

Connected cars; C2C communication; Social computing

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H.4.m [Information Systems Applications]:

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Applications]: User Interfaces – *user-centered design***Introduction**

Usually driving occurs in a situation where there are other road users. Like using other communal facilities, drivers need to coordinate with each other to share the infrastructure. But when we sit in our “iron cages”, there are only a few channels to deliver information on the road. Lights, horn and speed information are the most frequently used tools to exchange information, limiting both the range and the bandwidth of the connectivity [6]. The advent of everywhere available connectivity and the broad penetration of social network services provide opportunities for changing this situation [1]. Under the “Four sides” communication model, we proposed three novel concepts of exchanging “Self-revelation” and “Relationship” information between drivers, in the purpose of validating whether the digital augmentation of communication will enhance driving experience.

Limitation of information exchanging leads to misunderstanding, irresponsibility and social isolation

When a driver takes a trip to somewhere, usually, there are frequent encounters between him and others drivers. From this aspect, drivers may “meet” thousands of others on one trip. However, Juhlin et al [2] argued that communication between drivers is an odd form of social interaction compared to face-to-face interaction because of two constraints: speed of the vehicles and enclosed position of drivers. First, the encounters between drivers are often rather short,

ranging from a couple of seconds if the cars meet in opposite lanes to minutes if they travel in the same direction. Second, the interaction is influenced by the drivers being inside vehicles made of steel and glass. Bandwidth of interaction are restricted to signals of cars such as horn, indicator or using the clunky movement of the vehicles as a form of body-language. On one hand, limitation of information exchanging between drivers is positive as too much information distracts normal driving tasks and disturb the peace and private environment of cabins. On the other hand, this kind of limitation causes three major problems: 1) Irresponsibility: The distance between drivers and the vehicle design (metal frames, tinted windows) provide a feeling of anonymity. It is easier to project blame or attribute intentionality for their driving offense onto an unknown person who cannot be seen than it is when the person is known, or their facial expression can be seen [8]. A field study by Ellison et al. showed that anonymous drivers engage in more aggression than do identifiable, nonanonymous drivers [3]. 2) Misunderstanding: Current signal system with little humanity and courtesy of vehicle seems insufficient for expressing driver’s intention and providing social context. As a result, driver tried to invent means of exchanging social cues, using headlights, hazard lamps, blinkers, and even, hand gestures, in what Renge has dubbed “roadway interpersonal communication” [4], for the purpose of transferring more social information to reduce misunderstanding on the road. 3) Social isolation: While driving, people are encapsulated in a domestic, cocooned, moving capsule, an iron bubble [5]. Being constrained in front of their steering wheels and “interacting” monotonously with non-human-like machines on the road for a long time that provide a feeling of disconnection, which may result in

tediousness, loneliness and fatigue. Therefore, while our body are physically constrained in vehicle, our minds are trying to escape from the "iron cages" and regain connection with the outside world by, for example, listening to the radio, making a phone call or texting, even through they know this activity may lead to distraction and dangerous situation.

ITS technology provides new way for drivers' social interaction

Traditional tools based on physical signal system are too blunt to to address the three problems because of the two constraints mentioned above: speed of the vehicles and the enclosed vehicle design. Recently, new Intelligent Transport Systems (ITS) technology is thought to offer significantly better opportunities to enlarge the channel of information exchanging. Intelligent Transport Systems (ITS) concern the use of information and communication technologies applied to transport infrastructure and vehicles, which could improve the safety by increasing drivers' awareness and efficiency of traffic by providing real time information. Currently, ITS mainly focus on communication of system level which could be called V2V and V2I communication, often summarized as V2X, does not aim for direct "Driver to Driver" communication. However, ITS technology has the potential to break physical limitation of communication between drivers, by transfer social information which ranges from concrete facial expression, gestures and speech to even more broad digital information such as virtual avatar, status or "emoji".

Actually, this trend has been already emerged for a period. During the CES 2012 in Las Vegas, Mercedes Benz with its 2013 SL-Class model, showed an in-car

platform able to connect and interact with Facebook [6]. Drivers were able to insert messages by selecting pre-set messages with touch screen interfaces. In 2013, Volkswagen and Google launched an Android app called SmileDrive (smiledrive.vw.com), which enabled drivers to share their travelogue, filled with the captured photos, maps of the trip, status updates, as well as other memories that are collected on a single URL. Waze (www.waze.com), is a highly engaged community of users willing to provide real-time traffic information. In this application, drivers could choose avatar, post mood and even "beep beep" other users.

Communication model

For further analysis of the communication between drivers, we utilized the "four sides" model (Fig.1), which was proposed by Schulz von Thun [7] based on the work on human communication by Karl Buehler and Paul Watzlawick. According to this model, any message principally contains information on four facets: 1)content layer, information about facts; 2)self-revelation layer, information about the sender as person; 3)relationship layer, information about the relationship between sender and 4)receiver and appeal layer, information about an appeal to act. Those four aspects of a message are equally relevant for the person talking and the person listening. It could be said that we talk with four mouths and listen with four ears. Which of the four sides the sender wants to emphasize is determined by his or her thoughts, intentions and communication abilities. The receiver in turn has the possibility to react to each aspect of the message. In the driving scenarios, However, as the limitation of the communication bandwidth, some facets of information are hard to be conveyed or misinterpreted. Conflict often happened when one driver misunderstanding



Figure 4: The visual effect of synchronizing music with other drivers on the road.



Figure 5: Wave hand to "get" the music of others cars.

another drivers' intention. For example, when a driver is overtaken by a sports car with high speed, he may think that it is a rude people in a fancy car speeding on the road. But actually they are from the same university. Furthermore, the sport car driver is just in a hurry of sending his sister to the hospital and wants to apologize for the aggressive overtaking behavior. With the help of V2V technology, drivers would be able to send more explicit information and emphasis on one sides of communication square in the future. For instance, people could broadcast to surrounding drivers that he is in a hurry to the airport, show others that he is a "Star Wars" fan or give others an apology for their mistakes. These messages provide more contextual information for communication between drivers, which may alleviate the problems mentioned above: misunderstanding, irresponsibility and social isolation.

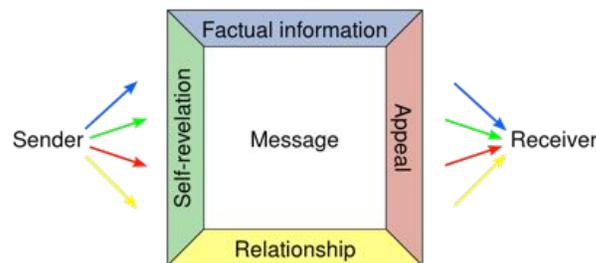


Figure 1: Four sides model.

Concepts

Under the four sides model, three concepts, which emphasizes on self-revelation and relationship sides, were proposed for further evaluation. These concepts were described by three scenario stories as follow:

In a hurry to the airport (Self-revelation)

Mr. Lee wants to go to the airport, unfortunately he encounters a traffic jam in the city. When he enters the highway there is only 1 hour left before the airplane takes off. Then he put a virtual sign "In a hurry to the Airport" on the top of his car to show his situation. This sign could only be used for 2 hours per month. When other drivers around knows his situation they have more tolerance to his fast driving behavior.

Badge on the road (Relationship)

Peter lives in Eindhoven, he is a Marvel hero fan and likes the soccer team PSV as well. Yesterday He chose 3 free virtual icons in the "CarBadges" online service for his car: "Marvel hero", "PSV" and "Eindhoven". Now he is on the highway to Berlin for watching the UEFA European Championship, PSV vs FC Bayern Munich. On the road he sees several drivers who also have "Marvel hero" badges when they approach. He knows that they could see his as well because they chose the icons in same category. But which excites him more is that he finds several cars passing by that are also put on "PSV" and "Eindhoven" badges, indicating they are PSV fans and might go to Berlin for the match as well.

Synchronizing Music (Self-revelation & Relationship)

Donald has been driving alone for 2 hours on the highway. There are not many cars on the road at this moment, the long tedious journey makes him a little bored and lonely. He decides to opens the "Music-Around-Me" application of his car. Several minutes later, by approaching a car in front of him, a slight rhythm of "Only Love" is rising in his cabin. The text indicates that the music is played by the front car. "It's a nice song", he thinks. So he waves his hand to get the song playing in his own car. Several second later, a "bling" sound

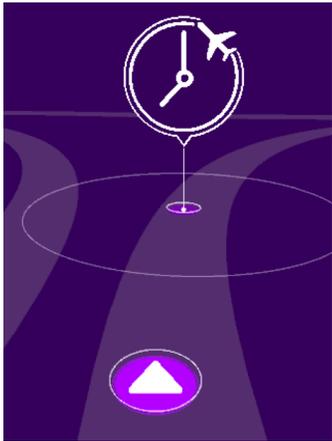


Figure 6: The interface of the concept "In a hurry to the airport".

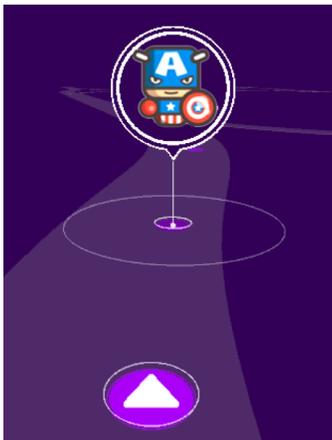


Figure 7: The interface of the concept "Badges on the road".

comes from his speaker, he smiles, as that indicated the car behind him get this song from his as well.

Design, prototype and apparatus

Apparatus

Three prototypes based on corresponding concepts, is designed, developed and integrated in a driving simulator. The driving simulator includes a steering wheel, seat, pedals, gears, three 32" screens, speakers, a 10" screen and a LeapMotion sensor (Fig. 2).



Figure 2: A 10" screen and a LeapMotion sensor was integrated in the driving simulator.

Visual interface

In this system, an enhanced navigation interface is displayed on a 10" screen attached in a driving simulator. The interface is design to show three layers (Fig. 3) of information: 1) Geography layer. This layer shows the 3D model of the driving scenario, including roads, lanes and important buildings etc. 2) Vehicle layer. Participant's vehicle is shown as an arrow and six surrounding vehicles (front, front-left, front-right, back, back-left, back-right) are shown as dots. 3) Notification layer. This Layer contains surrounding drivers' self-revelation and relationship information including that

the driver is in a hurry, the driver is a "stars war" and the driver is sharing music (Fig.6, 7 ,8).

Auditory feedback

Furthermore, two speakers is implemented in the front of the simulator to delivery auditory feedback of 2 kinds of information: 1) Vehicles Approaching. When a driver who share music is approaching (in 200 meters), the volume of music is increasing according to the distance between the participants and relevant cars. 2) Auditory icon. A sound clip will be played as an auditory feedback of confirmation of synchronizing music with others.



Figure 3: User interface design: 1. Geography layer; 2. Vehicle layer; 3. Notification layer

Gestural input

Gestural interaction is adopted for the prototype "Sharing Music" as the operation of synchronizing the music from other cars (Fig. 5).

Planned Study Design

With our study we try to answer the following questions: 1) Are these applications accepted by people? 2)Are



Figure 8: The interface concept "synchronizing music" with other drivers on the road.

these applications which disclose drivers' self-revelation and relationship able to increase belongingness and empathy between drivers? 3) Do these applications increase people's mental workload while driving? To address these questions, both the quantitative and qualitative research method would be applied. For measuring the drivers' empathy and belongingness, the Toronto Empathy Questionnaire [9], the Heartland Forgiveness Scale [10] and the social connectedness questionnaires [11] will be used. For the measuring the perceived workload, NASA Task Load Index (NASA-TLX) will be applied. After the driving session, in-depth interview will be conducted to find the factors influence driver's tolerance, belongingness and mental workload.

Conclusion

Generally, we expect that the three novel concepts and corresponding prototypes would be used as a probe to explore the possibility of adding social features into the connected vehicles in the future. Moreover, the insight generated after experiment will contribute to establishing a model of communication which combined face-to-face interaction with digital augmentation.

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