

User Modelling and Emotion Recognition of Drivers through a Multi-modal GPS Interface

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Abstract. Drivers play an important role on road traffic. Traffic frequently has a big impact on drivers' emotions and drivers' emotions have a big impact on traffic. Traffic congestions may be the cause of human drivers' frustration, loss of their patience and control, leading to aggressiveness and so on. On the other hand, drivers' aggressiveness may cause dangerous driving, car accidents and drivers' fighting. This results in an endless loop of traffic problems that is propagating along many drivers. However, even excessive enjoyment may also lead to dangerous driving, since people may underestimate the road dangers and drive carelessly. Thus, it is very important to aim at keeping drivers calm, happy and alert when they drive. In view of this, it would be extremely useful to extend the functionalities of existing GPSs to include user modelling and emotion recognition abilities so that they may provide spontaneous assistance that would be dynamically generated based on the results of the user modelling and emotion recognition module. The action of GPSs would be to provide automatic recommendation to drivers that would be compatible with their own preferences concerning alternative routes and make them feel happier and calmer.

Keywords. User modelling, Traffic, Emotion recognition, Affective computing, Multi-modal GPS.

1 Introduction

With more and more people in the world and in the workforce, roads are becoming increasingly crowded; when we're all frustrated with traffic, sometimes people make mistakes or pull impolite driving maneuvers, which can lead to anger from other frustrated drivers; this often results in road rage, which can pose a significant threat to health and safety for everyone on the road [1].

Counseling psychologist Jerry Deffenbacher and his colleagues [2] point out that: "Those high-anger drivers are a source of alarm. Even typically calm, reasonable people can sometimes turn into warriors behind the wheel; when provoked, they yell obscenities, wildly gesture, honk and swerve in and out of traffic, and may endanger their lives and others."

In the official site of the city of Santa Rosa at the Section of Traffic [3] there is a question: Which is an example of aggressive driving?

According to the same site, among other things the above question includes the following examples:

Speeding up to make it through a yellow light.

Switching a lane without signaling first.

Going over the speed limit in a school zone or neighborhood.

Approaching so fast that the driver of another car that is stopped, feels threatened.

Tailgating a car to pressure the driver to go faster or move over.

Tailgating a car to punish the driver for something.

Driving with an alcohol level above the legal limit.

Drive while drowsy enough to have droopy eyes.

Making an obscene gesture at another road user.

Moreover, the Official U.S. Government site for distracted driving [4] warns people, that: "Distracted driving is unsafe, irresponsible and in a split second, its consequences can be devastating." On the other hand, research and experience demonstrate that happy drivers are better drivers [5].

In view of the above, it seems that human emotions play a very important role to traffic management and it is to the benefit of traffic to put research energy on recognizing automatically human emotions of drivers and building systems that would react accordingly. In view of this, it would be extremely useful to extend the functionalities of existing GPSs to include user modelling and emotion recognition abilities so that they may provide spontaneous assistance that would be dynamically generated based on the results of the user modelling and emotion recognition module. The action of GPSs would be to provide automatic personalized recommendation to drivers that would be compatible with their own preferences concerning alternative routes and make them feel happier and calmer.

The main body of this paper is organized as follows: In Section 2, related work on research of ourselves and others is surveyed and discussed. In Section 3, the aims of the proposed research is presented. In Section 4, the proposed solution is presented. Finally in Section 5 the conclusions of this paper are drawn and also connections to proposals of other participants are highlighted.

2 Related Work

Affective Computing is a recent area of Computer Science that studies human emotions:

- Emotion Recognition by the computer
- Emotion Generation from the computer

Until recently, human emotions were not considered at all by the designers of user interfaces. However, research that flourished during the past decade has been based on the important argument that human feelings play an important role on human decision making and affect all areas of human computer interaction. There has been a lot of research on automatically recognizing human feelings and generating emotions from the computing. This kind of research is labeled affective computing. So far,

there has been significant progress in this field. Nevertheless, there is still a lot of basic research needed and thus affective computing remains a hot research topic.

Another area that has been investigated by many researchers during the past decade is that of user modeling and generation of personalized recommendations to computer users. Recommender systems constitute an area of research that attracts researchers from a wide area of computer science and applications varying from e-commerce to electronic libraries.

2.1 Previous Work on Affective Computing and GPS Recommender Systems in our Lab

In our own research lab we have made extensive research in the areas of affective computing and recommender systems [e.g. 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16].

This research has resulted in four Ph.D.s that were completed successfully, two monographs and many papers in the area.

One recent relevant basic research project that we had was entitled:

“Technologies of affective human-computer interaction and application in mobile learning” and it was developed in the Software Engineering Lab of the Department of Informatics at the University of Piraeus. Our Industrial Partner was Sony Ericsson. The main research problem that was investigated was recognition and generation of emotions through multi-modal hand-held devices. In the context of this project, two Ph.D.s were supervised and completed:

1. Ph.D. student: Efthimios Alepis (Supervisor M. Virvou)
2. Ph.D. student: : Ioanna-Ourania Stathopoulo (Supervisor G. Tsihrintzis).

The research topics that we dealt with were:

- Emotion recognition through microphone and keyboard
- Emotion generation in animated agents
- Incorporation of animated agents in mobile learning
- Visual Analysis of facial expressions
- Construction of our own database of facial expressions

2.2 Previous Work of Affective Computing and Traffic

Two powerful partners — a well-funded consumer-facing company and a top research university, such as MIT — joined forces to produce inventive solutions to real-world problems. Audi of America wanted to be involved in conversations about America’s urban future and provide cars that fit into tomorrow’s tech-dominated cities. The carmaker wanted to encourage people to admire and buy Audi cars by giving them an online tool with information about their roadways. The MIT lab Research Laboratory of Electronics studied exactly the kind of data that the Audi idea needed. The result is the Audi Road Frustration Index (Fig. 2), an entertaining web-

Analysis of facial expressions....

We have built our own database

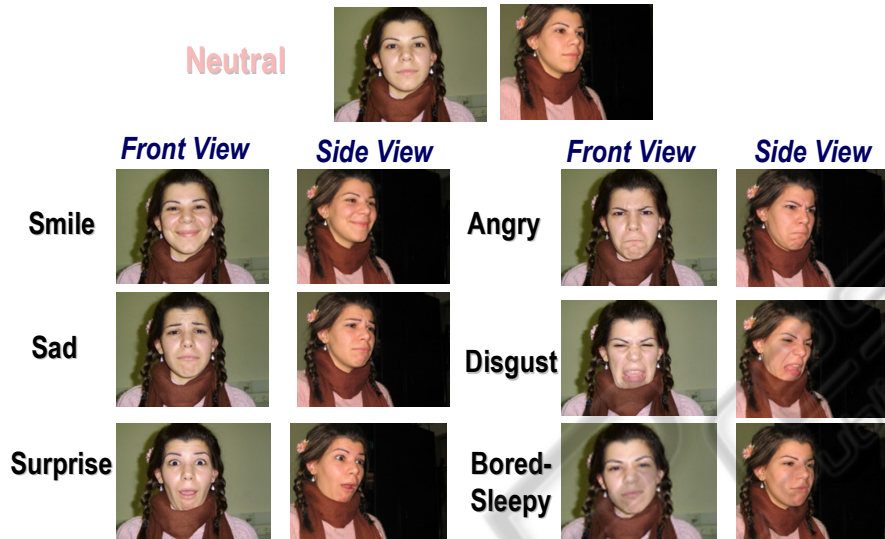


Fig. 1. Facial expressions denoting human emotions.



Fig.2. Audi's Frustration Index.

site that launched in beta in mid-September. It tells users at any given hour how the roadways and drivers' moods in their city rank compared to others nationwide. For instance, Sacramento, Calif., is often as miserable as New York City [17].

Thus, Audi's latest ad campaign for the new 2012 A6 claims to want to make the road "a more intelligent place," starting with asking drivers to pledge to be on their best behavior while behind the wheel. At the top of the German automaker's list of sins is driving while drinking a latte, leading us to perceive the effort as only half serious [18].

Another joint effort on researching the influence of emotions on drivers arose from a leading University, Stanford, and a leading car company, Toyota [19]. This effort resulted in a study that examines whether characteristics of a car voice can influence driver performance and affect.

- In a 2 (driver emotion: happy or upset) x 2 (car voice emotion: energetic vs. subdued) experimental study, participants (N=40) had emotion induced through watching one of two sets of 5-minute video clips. Participants then spent 20 minutes in a driving simulator where a voice in the car spoke 36 questions (e.g., "How do you think that the car is performing?") and comments ("My favorite part of this drive is the lighthouse.") in either an energetic or subdued voice.
- Participants were invited to interact with the car voice. When user emotion matched car voice emotion (happy/energetic and upset/subdued), drivers had fewer accidents, attended more to the road (actual and perceived), and spoke more to the car.
- To assess drivers' engagement with the voice, participants were invited to speak to the Virtual Passenger.

Other recent research efforts include Using Paralinguistic Cues in Speech to Recognise Emotions in Older Car Drivers by Christian Jones and Ing-Marie Jonsson [20]. Finally, there has been research on "Analysis of Real-World Driver's Frustration" [21], to name some very recent research projects in the area.

2.3 Conclusions from the Related Work

It seems that there is interest from World Leading Universities, such as MIT and Stanford and leading car manufacturers such as AUDI and TOYOTA respectively, to produce new affective systems for the drivers.

However, there are not yet many such research attempts. This means that there is a lot of scope in this particular research topic that seems to be gaining research interest. In this respect, our proposed approach is very innovative to the field.

3 Aims of the Research Proposed

The aims of this work package are the following:

1. Recognition of basic emotions of drivers based on visual-facial and audio-lingual recognition and contextual information.
 - a. Visual facial recognition through a camera
 - b. Audio lingual recognition through a microphone
 - c. Recording of contextual information that contributes to change of drivers' feelings.
2. Monitoring and recording drivers' preferences with respect to traffic and making inferences leading to recommendations.

Technically, the above aims are going to be pursued using the following:

- Neural network-based and support vector machine-based classifiers for the visual facial recognition,
- User stereotypes and multi-criteria decision making theories for the audio-lingual recognition and the contributing contextual information,
- User stereotypes, machine learning algorithms and user monitoring for the acquisition of user models of drivers with respect to their needs, preferences and knowledge level of routes.
- Multi-criteria decision making for the selection of appropriate recommendations.
- Advanced multi-level recommender systems, which produce recommendations by combining a specific driver's preferences with preferences of 'similar' drivers.

4 Proposed Solution

We propose to build a user modeling module that will take into account

- Individual features of drivers such as route preferences, age, car type.
- Emotions of drivers in particular situations
- Traffic information

The driver would be monitored by a camera into the car so that image analysis of his/her face may take place. The driver will also have a microphone to interact with the system. The habits and behaviour of drivers will be analysed and recorded in a long term user model over the web.

In return, the driver will receive

1. Personalised recommendations about routes
2. Personalised advice on handling emotions of drivers in particular situations

The proposed solution will include the following:

- A navigation system which will provide location-based services with a personalized way, taking into account the preferences and the interests of each user.
- Location-Based Services are provided via Web Services
- A personalization mechanism

The term “location-based services” (LBS) is a rather recent concept that integrates geographic location with the general notion of services.

The five categories in Fig. 3 characterize what may be thought of as standard location-based services.



Fig.3. Standard location-based services.

One of the most basic characteristics of the LBS, is their potential of personalization as they know which user they are serving, under what circumstances and for what reason.

A system architecture that can be used is illustrated in Fig. 4. This architecture illustrates how user modeling can be incorporated in order to record drivers’ preferences and the use an inference engine to produce hypotheses on future preferences of users on other similar situations. Moreover, it shows how information from LBS can also be used. This information can be processed and passed to a user interface device, such as a GPS in a car. Moreover, Figure 5 illustrates three input devices, such as camera, microphone and keyboard that can be used to process information about a driver in terms of his/her emotional state. This kind of processing will be incorporated in the user modeling component as illustrated in Fig. 4.

5 Conclusions and Connection with other Research

We propose to extend the functionalities of existing GPSs to include user modelling and emotion recognition abilities so that they may provide spontaneous assistance that would be dynamically generated based on the results of the user modelling and emotion recognition module. In return, the action of GPSs would be to provide automatic recommendation to drivers that would be compatible with their own preferences concerning alternative routes and make them feel happier and calmer.

Our contribution could use information on traffic and routes that could be developed by other partners of the project such as Thomas Jackson and Tom Thomas. Relevant goals to Tom Thomas individual preferences of drivers concerning favourite routes. Also we see ourselves in the user interface (human computer interaction) as mentioned by Brahmananda Sapkota in his talk about functionalities to drivers. Finally, we can provide individualised information to the “informed driver” of Apostolos Kotsialos.

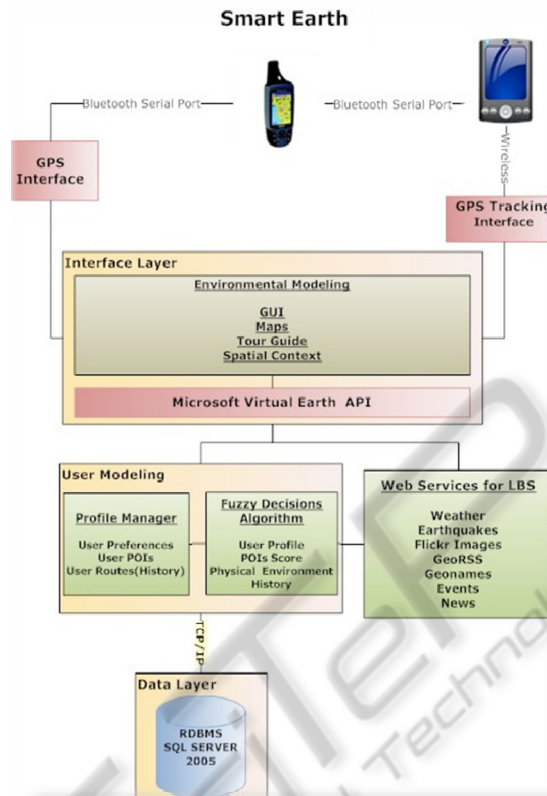


Fig. 4. A system architecture.

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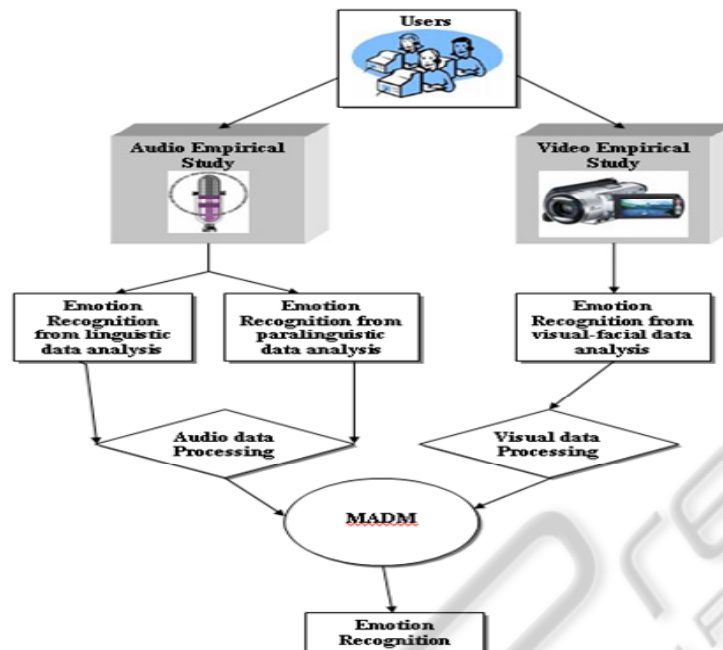


Fig. 5. Affective recognition through 2 modalities of interaction.

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