# Express Driver's Emotion with Emoticons in Driving Contexts

**Haechan Kim**
KAIST, Department of Industrial Design
335 Gwahangno Yusung-Gu
Daejeon Korea
kimhaechan@kaist.ac.kr

**Kun-pyo Lee**
KAIST, Department of Industrial Design
335 Gwahangno Yusung-Gu
Daejeon Korea
legump@kaist.ac.kr


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## Abstract
Drivers often feel various kinds of emotions in the context of driving. This research was conducted due to the difficulty of expressing the emotions in driving contexts. At first, throughout driver observation and survey it was found that existing interface in car is not enough to express drivers' emotion to other drivers. Also most representative emotions drivers want to express while driving were identified, which were made into emoticons. Interactive prototypes which display emoticons were installed in the front and back of vehicles so that drivers can express their emotions while driving. Experiments were conducted to verify whether drivers' stress was reduced when the prototype was installed in the vehicle, thereby enabling them to share their feelings with other drivers. The results showed that stress was indeed reduced in drivers compared to their original state.

## Author Keywords
Expressing emotion device; driving contexts; reducing stress

## ACM Classification Keywords
H.5.2 [Information interfaces and presentation]: User Interfaces

## Introduction

Drivers often scream in anger, apologize, or thank other drivers while driving. Unfortunately, these emotions cannot be properly expressed through the turn signal lamps or horn included in the vehicles' systems. As a result, drivers roll down the window and express anger, thus hindering communication. Various researches regarding drivers' emotion have been carried out including the common situations, including emotional situations while driving, the problems drivers face in expressing their feelings, how to solve the problem, and how much stress could be reduced if solutions were developed and implemented. Studies on emotional states while driving are easy to find. Various emotions are evoked according to different situations while driving. [1] One may be nervous or angry. For beginners, stress while driving can be extreme. A frightened driver has more difficulty driving. [2] According to these studies, attempts were made to solve problems by developing the vehicle's interface to provide a comfortable driving environment, or by communications between adjacent vehicles. [3], [4] However, these are not attempts to solve the problems caused by the emotions.

Other studies have tried to directly solve the problem through drivers' emotions. One, in particular, proved that the vehicle voice interface can provide a better driving environment when it regulates drivers' frustration by engaging them in conversation. [5] If emotions affect one's driving, what will happen when those are more effectively expressed to other drivers? Previous research implies that emotion is one of the important issues for designing car interface. However, those researches didn't find out the effectiveness of expressing emotions in driving contexts. Therefore, the aim of this research is to explore the benefits of expressing emotions to other drivers.

## Research Design

This research was conducted in two parts. The first part was to check the necessity for expressing in a driving context and the current problems with expressing emotion. Observing and survey were used to verify the ways of expressing drivers' emotions. The results made it possible to extract representative emotions and it also implied that current car interface cannot express driver's emotion well. A prototype was manufactured accordingly to solve the problem. The second part evaluated the prototype's effectiveness once it was installed and utilized by drivers. The result proves the hypothesis that expressing one's emotions easily and accurately to other drivers can release stress while driving, and the results and data will be helpful in designing future product.

## Part1. Understanding Driving Contexts and Emotions

*Observing driving contexts*

The first step of the research evaluates the current situations among drivers. The purpose of this step is to check how drivers express their feelings to other drivers. Following are the four sub-questions: what are the driving contexts that need expression? What is the media for expression of each context? Are the expressions happening frequently enough in each context? What are the contexts that are hard to express? To answer these questions, 7 participants were recruited (average age 24.5, 5 male and 2 female). 30-minute downtown driving was given as a task, and the drivers were observed during the ride-along. Situations in which the drivers expressed their

| | 13 most Frequent driving context |
|---|---|
| Situation required for communicating information | Abnormal behavior of the front vehicle |
| | Sudden parking on the side of the road |
| | Stagnated front car at green light signal |
| | Car to go straight on a left-turn lane |
| | Facing a car in a narrow street |
| Situation required for expressing emotions | Preventing cutting-in |
| | Yielding when cutting-in |
| | Sudden cut-in |
| | Front car driving too slow |
| | Abnormal behavior of the front vehicle |
| | Sudden parking on the side of the road |
| | Stagnated front car at green light signal |
| | Car to go straight on a left-turn lane |

**Table 1.** 13 most frequent contexts from observation and survey

feelings, as well as any other unusual situation, were all recorded and timed. At the same time, a smartphone was installed at the front of the vehicle to film the entire cabin area throughout the task and enable us to match the film, time, drivers' responses, and methods of expression after the task. After the ride-along, an interview was conducted to check the drivers' thoughts on expressing emotions while driving. The observation revealed what the contexts of the drivers' expressions are, what the media for the expressions are, and in which kinds of situations the drivers found it difficult to express their emotions.

*Survey*

For developing a valid conclusion with the results of observing, a survey was carried out. The survey was conducted online, and 75 experienced drivers responded. The questions were: (1) "Do you feel it necessary to express your emotions to other drivers while driving?" (2) "What kind of emotion do you express to other drivers the most?" (3) "What media do you use to express your feelings while driving?" (4) "What are the situations in which you can't express your feelings while driving?" Through both the field research and survey, driving contexts in which emotions were expressed were identified, and the data about media for each expression was found.

Result showed that drivers experience four main emotions. Appreciation, apology, anger, and fright were the most frequently observed emotions. Also, 84% of the survey participants responded that expressing emotions to other drivers while driving is more often necessary than not. Different kinds of contexts were gathered through observation and survey in which drivers felt it necessary to express their emotions and the major contexts could be narrowed down to 13 as shown in Table 1. These 13 contexts can be divided again into two categories: giving information and expressing emotions. Moreover, how the driver sends information or expresses emotions were linked with each context. The methods of expressing emotions were also divided into two types; using vehicle interface and expressing by drivers themselves. Horn, turn signal lights, and the movement of the car itself constituted using the vehicle to express emotions. The drivers' facial expressions, hand signs, voice, and gestures constituted emotional expression by the driver. By linking these results, it is clear that the vehicles are a means of sending information. Also, drivers tend to express their feelings using their facial expressions, body language, etc., and some attempts to use the vehicles' interface in order to express their feelings were found. For example, the high-beam headlight was originally installed for use on a dark or foggy road, but it is often used to express anger or warn other drivers by flashing it repeatedly.

Drivers express their emotions in various driving contexts with facial expression and gestures because a car's present features cannot fully transfer drivers' emotions. Although drivers communicate sufficient information to others through a car, but something that can more specifically convey a driver's emotion to other drivers is in fact needed. Through the studies of observation and survey, the biggest reason for emotion expression problems is that others cannot see the driver's facial expression or gestures; rather, they only see the car factors, such as its signals or lights. The driver's face, hands, and voice can directly express detailed emotions, but they cannot be effectively transferred in a driving context. Also it is difficult to express emotions only with current car features.

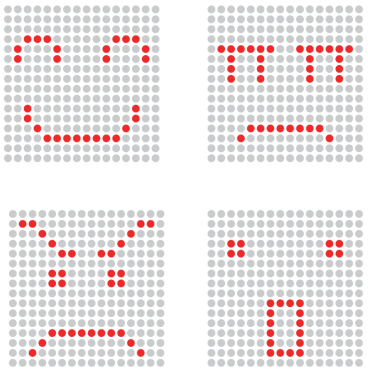

**Figure 1.** Emoticons in 16*16 dot matrix.

| Requirements | Features of prototype |
|---|---|
| It should express major emotions during driving | Make four different outputs |
| Other drivers should recognize expressions easily | Using red LED that has high visibility |
| Messages should be clear to be understood well | Using emoticons that are universal |
| It should not distract driving | Simple buttons for inputs |

**Table 2.** Requirements for new vehicle interface and the features of prototype according to those

Therefore, it was concluded that a new kinds of features are needed in cars. Results of this part could make requirements for features for new vehicle interface.

- It should express major emotions during driving
- Other drivers should recognize expressions easily
- Messages should be clear to be understood well
- It should not distract driving

The next step is to validate the effects of expressing emotions during driving with a prototype that reflects these requirements as Table 2. The comments and opinions of the participants were the core data of previous research, but the next experiment was planned to determine the effects of better emotional expression in driving contexts by gathering both quantitative and qualitative data. It was important to make the prototype quickly and conduct an experiment to evaluate its effectiveness.

## Prototype for expressing emotions during driving situations

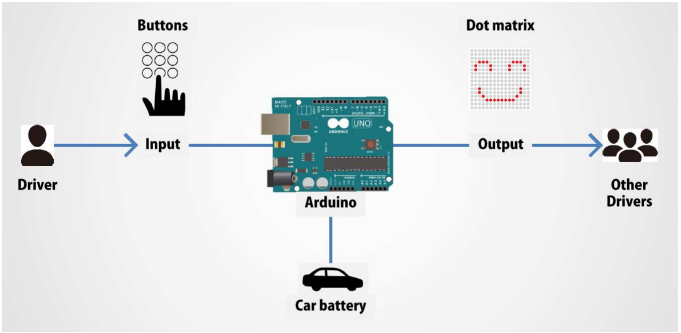


**Figure 2.** System diagram of the prototype

The prototype was designed with front and rear displays to enable the efficient expression of emotions and, thereby, solve the problem that was found in previous user research. This prototype consists of two components: the button and the display, both of which are installed in the car. The prototype functions in the same way as pressing a button to turn on the four-way flashers. This prototype expresses four different emotions in driving contexts that were extracted from the field research and survey. Anger, fright, appreciation, and apology were converted to emoticons and expressed through the display. The prototype is controlled by Arduino; the display is made with a dot matrix (16*16 red LEDs) and fully expresses the emoticons. Power is supplied directly from the car; the prototype needs no other batteries to work. It is a simple, but highly efficient prototype for discovering the effects of emotional expression. This prototype is made to be installed in car environment for the experiment. To determine the effects of this prototype, the participants were requested to use this prototype instead of gestures or voice in driving contexts in which they wanted to express their emotions.

## Part2. Validating prototype for reducing Stress

*Experiment with prototype*

In order to validate the effects of the prototype, the experiment was planned. Seven drivers (average age = 32.1, 5 males and 2 females) participated in this experiment; all of them were novice drivers who had received their driver's license within a year. Length of driving career was applied as criteria for recruiting because novice drivers are regarded to experience more stress during their daily drives. It was assumed that it was easier to see big effects of the prototype

| N=7 | **Expressing emotion (times)** | **Stress level (Likert)** |
|---|---|---|
| Set A | 3.43 | 4.23 |
| Set B | 8.29 | 2.77 |
| t-value | 8.78 | 5.05 |

**Table 3.** Result of t-test between Set A and Set B shows significant difference.

**Pre-interview for novice drivers: What are the problems in driving situations?**

*"I'm often worried about my faults and feel uncomfortable for fear of interrupting other drivers,"*

*"There are many cases that I feel sorry or angry but I can't express well to other drivers,"*

*"Sometimes my heart rate goes up and my face is red."*

**Table 4.** Pre-interview

with participants who have high stress. The experiment comprises pre-interview, two comparative field researches, and debriefing interview after the field tasks. The pre-interview consisted of questions that evaluated how much stress the participants had in their usual drives. Two field researches were carried out: once to evaluate the usual driving situation (Set A) and the second to observe the situation while using the prototype (Set B).

During field research, participants drove twice around a pre-determined 30-minute driving route, so they each had a total task time of 1 hour. Participants faced seven different driving contexts as they drove the route. These 7 contexts involved situations about expressing emotions but excluded information-only situations as identified among the 13 major contexts (Table 1) in the previous research. After completing the task, they checked the appropriate response on a 5-point Likert scale regarding the stress level in each of the 7 contexts (1=no stress, 5=most stressful). The purpose of checking the scale is to simply prove the difference in stress level between expressing emotions in the usual way and expressing emotions with the prototype. Debriefing interview was conducted after the driving session and contained questions about overall feedback of the prototype itself. Its purpose was to discover the possibilities of enhancing usability and the benefits to the participants when they used the prototype.

*Analysis and Discussion*

The result of the pre-interview was meaningful enough to understand the participants' stress problem in driving situations even though it is a subjective analysis of the participants' answers. They said "I'm often worried about my faults and feel uncomfortable for fear of interrupting other drivers," "There are many cases that I feel sorry or angry but I can't express well to other drivers," "Sometimes my heart rate goes up and my face is red." These responses showed that the participants experience stress during typical drives. The first finding of the field research is that the frequency of drivers' emotion expression exhibited a significant difference between usual driving (Set A) and driving with the prototype (Set B). When they drive the normal way for 30 minutes, they expressed emotion 3.43 times (SD=0.95) on average and the stress level for the 7 contexts was 4.23 points (1–5 point scale, SD=0.22), averaged across the 7 participants. In comparison, during drives that used the prototype, participants expressed emotion an average of 8.29 times (SD=1.24) and the stress level for the 7 contexts was 2.77 points (SD=0.10), averaged across the 7 participants. Paired sample t-test was conducted by SPSS. Frequencies of expressing their emotions of Set A and B were compared first. $t=8.78>2.45$ ($df=6$, $p=0.05$), therefore there was significant difference between Set A and B. Stress levels of Set A and B were also compared, and $t=5.05>2.45$ ($df=6$, $p=0.05$). It is also said that there is statistical difference of stress levels between Set A and B. The results prove that stress level definitely decreases with better ways of expressing emotions. The results also show that drivers need a better way of expressing their emotions in various driving contexts, according to how frequently the participants expressed their emotions with the prototype.

Ideas and improvement points to produce a better prototype can be found in the interview that was conducted after the participants completed the field tasks. Participants answered that they could express more precise feelings with the prototype than by using the ordinary features of a car. It shows the possibility of

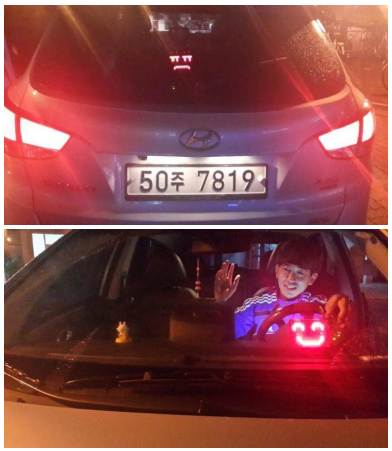


**Figure 3.** Installed prototype in participant's car

**Interview after field tasks: What are the feelings with the prototype?**

*"It's very interesting and I want a real product of this prototype. I can express my emotion and feelings a lot and it reduces burdens and fear when I do wrong things during driving"*

*"Location of buttons is a little bit uncomfortable. I need feedback that it is working well."*

**Table 5.** Debriefing interview

better usability for further work. Also, some participants felt it would be better for the prototype to enable them to communicate with each other rather than expressing only the driver's emotions.

## Further Work

This paper focuses on finding user needs and solving the problems. It also analyzes the effects of expressing emotions through the prototype to prove the relationship between expressing emotions and stress level. The research will further focus on stress while driving. Quantitative research for analyzing stress while driving will be conducted in future research. For example, after studying the relationship between heart rate and stress, next study will be measurement of heart rate for new prototype users that can prove the relationship more accurately. Not only user research, but also the prototype, should show improved features in future study. Making a prototype for better usability will make user testing easier. To keep the prototype from becoming a distraction during driving, its button will be attached to the car's steering wheel. Buttons will be individually modularized and attached so users can choose the emotions they want. If the prototype enables drivers to communicate with each other rather than just one way by showing emoticons, new effects will be discovered.

## Conclusion

This research suggests design elements that can be newly added to current car interface systems. The conclusion of the research is that new features that facilitate emotional expression while driving may release stress in driving contexts. The first step for this research is to discover the problems through user research in design process and figure out the solution to the problems. Through this process, a prototype was made as new features of car interface that satisfies user needs by enabling drivers to easily express their emotions to other drivers. This research will continue with prototypes with better usability and new concepts to figure out how to reduce more stress in driving situations. When all of the research is concluded, new features that help drivers express emotions will be installed on future cars, thus making driving less stressful.

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