Emotion and Personality in Driver Assistance Systems

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Abstract: Driver assistance systems are designed to support a human driver in the driving task. Since drivers are very different, the assistance system must adapt to the driver in order to provide the best support. The driver adaptive assistance systems which are currently designed provide adaptability which is generally done by the driver himself. Some already provide automatical adaptation. One of the key problems is intra-individual difference in behaviour. This is mostly considered as disturbance or covered by short-term models and quick adaptation. What causes intra-individual difference? Emotion is one of the factors in behaviour differences. This makes an emotional component in a driver model a considerable improvement potential for adaptive driver assistance systems. In our research, we investigate a driver model on the basis of the cognitive appraisal model by Orthony, Clore and Collins (OCC) combined with a personality model based on the "Big 5" personality factors. First results are produced in the curvature warning system scenario. The work is based on simulations in which the driver's emotional state is computed by the an emotional driver model. Current experiments provide plausible training data.

1 Introduction

Adaptive driver assistance systems monitor the driver's behaviour and determine the right time for information, a warning or even an intervention by the system. Often the driver's behaviour patterns are not clear and vary from day to day or even in shorter time spans. One of the factors which are responsible for this disturbance is the emotional state of the driver.

The aim of our work is to provide a simulation system, which produces training data for adaptive driver assistance systems. In this system, behaviour variations which are based on emotion are explicitly part of the simulation. The emotion can be fed into the system from an external source and it can be computed automatically as direct reaction to the current driving situation. In order to achieve this, we implemented a psychological model of emotion by Orthony, Clore and Collins (OCC) [1] and - as a further parameter for simulation - enhanced it by a personality component. This model is adapted and dedicated to the driving situation. In the following, driver assistance systems are briefly introduced. Furthermore, the basic information on the OCC model and personality is given before we outline the emotional driver model we work on.
1.1 Personalized Assistance Systems

The advantage and necessity of personalisation becomes obvious if the acceptance of assistance systems is regarded. It can be easily made plausible by looking at one of the scenarios we picked for the first tests of our model: the curve warning system.

The assistance systems warn a driver in case he or she may not have noticed an upcoming curve on a country road. As described in [2], the central parameter is the lateral acceleration in the curve. Given the average lateral acceleration in a curve and the average deceleration behaviour approaching curves, one can determine the time for a curve warning. Obviously this may be too late for the stereotype "grandmother" driver and much too early for a race driver like Michael Schumacher. Between those two extremes we find the drivers and customers of the vehicle manufacturer. If inter-personal differences in driving style and warning time preference are large, an adaptation of the parameters to the current driver is necessary for the acceptance of the product. How does the adaptation take place? Initially an average driver model is assumed and the current driver is watched to determine the key parameters identifying his driving preferences. Using these parameters, a better fitting assistance becomes possible. What is the benefit of an additional emotion component in the simulation model? As mentioned before, emotion is one of the factors that influence intra-personal behaviour variations. This makes it possible to generate training data which are "disturbed" in a controlled and plausible way.

1.2 The OCC model of emotion

There are a few models of emotion and we decided for the OCC model due to earlier experience in another application context [3]. The architecture of the emotion component is based upon the cognitive appraisal model by Orthony, Clore and Collins. The OCC model has become a very popular model for emotion synthesis. It comprises 22 emotion categories which are grouped in three dimensions: goal relevant events, actions of agents and aspects of objects.

The model provides intensity variables which quantify the influence of eliciting events on the subsequent emotion generation. These intensities are derived from the scenario. Each of them is associated with an emotion class. Emotion classes are ‘fortunes of others’, ‘prospect-based emotions’, ‘well-being emotions’, ‘attribution emotions’ and ‘attraction emotions’. The main task of an application that intends to use the OCC model is to adapt the events, actions and objects, as well as the associated intensity values to the application scenario.

The OCC model is specified in a qualitative way. Therefore, some further estimations needed to be made in order to automatically produce quantitative results in terms of emotions. For our first tests we decided to implement a simplified linear model.
1.3 Personality

How does personality come to play a role in the simulation? This is another attempt to control variations in the simulation. The personality of a driver can be seen as a bias for the emotion generation in traffic situations. When generating test runs, different personalities of drivers are generated which leads to different emotional reactions.

The term personality describes the factors that determine the character of an individual. The personality is considered stable over time whereas emotions have a rather short "life-span". In between we have the concept of moods. There are a lot of different theories about personality. The most important and currently dominant theories are the trait theories. Best known are traits like extraversion, introversion or neuroticism as discussed by Eysenck. The "big 5" model of personality, which is the most popular model nowadays, consists of the traits neuroticism, extraversion, openness, agreeableness and conscientiousness. We decided to use this model in our simulation.

2 An Emotional Driver Model

In the first approach we implemented a "co-pilot" which computes the emotional state while the vehicle is driven through the simulation in a defined way. The three main aspects of the emotional driver model are: the adaptation of the OCC model to the driving task, the combination of OCC and personality and the integration of mood.

2.1 Adaptation of OCC

The OCC model uses intensity variables which can be used to adapt the model to situations. There are global and local intensity variables which need to be filled with situation relevant information. As an example for a global intensity variable, we can consider 'proximity'. If a relevant event is far in the future its effect on the emotional state is lower than in case it's very close. In our case, we consider the event of leaving the road accidentally in a curve due to inadequate speed. If the potential event is far in the future (due to the distance of the curve) the emotion of fear is less intense. Local intensity variables refer to a specific emotion class. Considering events, examples are 'likelihood' and 'desirability'. If an event is very likely and not at all desirable, it causes distress. If this event is in the future, the so called prospect based emotions are concerned: in this case it's fear. In our example, the event of leaving the road is of course undesirable. The likelihood of this event depends on the speed and curvature as well as on the subjective judgement of the situation. Here we also have a cognitive component of the driver model which needs to be connected. After the critical situation is passed, the evaluation mentioned above may lead to the emotion of 'relief'. The intensity of relief depends again on likelihood and desirability of the event. In the first approach and in the modeled curve warning situation, we did not consider emotional reactions to the actions of other agents yet.
2.2 Integration of personality

How can personality be integrated with the OCC model? We augmented the basic model with a factor for each of the personality traits. The following examples shall show how we approached this task:

The influence of 'openness' can be seen as follows: a person with a high rating in this scale may show more intense emotions even though the global intensity variable 'sense of reality' has a low value.

The influence of 'conscientiousness' can be seen as follows: a person with a high rating in this scale may have a clearer concept of likelihood and therefore this aspect gets a higher weight as compared to the intensity variable 'arousal'.

The elicitation function of each emotion class contains the defined intensity variables. In our model, this function is enhanced by five further parameters: the personality traits. From these examples it becomes clear that the integration takes place on the general model level and does not rely on the traffic situation.

2.3 Integration of mood

We consider the mood of the driver as a filter for emotion elicitation. For example, the elicitation of joy is lower in case the person is in a 'bad' mood. In order to model a mood, we consider the pleasure-arousal-dominance space as described by [4]. The process is as follows: the elicitation values are computed for all emotion classes, these values are transformed in PAD-space (we use the transformation described in [5]) and then the mood is updated by a weighted combination of the current emotions and the current mood. In a first approach, the emotions finally shown are generated by considering the mood as a stabilizing factor. If an emotion is a point in the 3-dimensional PAD-space and so is mood, then the emotion coordinates are determined by pulling the initially computed position towards the mood position. The respective force is determined by the personality.

3 Conclusion and Further Work

In first simulation runs, the emotional reactions seem plausible. Nevertheless, a formal verification of the model can not be given. Future work will include the completion of the adaptation to the traffic scenario, the integration of further scenarios and the attempt to verify the emotional reactions which are observed. The final step is the closure of the loop: the emotional driver model shall be used to generate driving commands in the simulation.
References