Gamification and affective computing for the improvement of driving assessments

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Abstract. Urban transports and the act of driving in condensed urban areas can lead to effective changes in people's emotions. The time consumed to these tasks is also significant as most people spend a considerable amount of time just moving from one place to the other. Therefore, people are exposed to the risk of others and may pose a risk to other themselves. In order to target, and promote sustainable urban driving this articles proposes the use of gamification techniques and estimates of the users' emotions to influence not only good behavior but also sane emotional states for drivers. This work presents the integration of emotions into the gamification system for driving assessment.

Keywords: Affective Computing; Gamification; Smart Cities

1 Introduction

An ubiquitous society enables different solutions to classic problem such as urban transportation. It is in fact common knowledge that urban transports has problems that have fueled research and attention of governance bodies.

One such case is the driving analysis and hazardous behavior from drivers. It is fact the case that most of the fault for traffic accidents is in fact human error. This error is often avoidable is there are systems in place to detect the drivers state of mind, attention and driving patterns.

This field has recently caught the attention of insurance companies [3], which promote the use of ubiquitous applications to diagnose driver styles and promote safer driving by means of insurance bonuses. Though interesting, these applications are often simple in implementation and in some cases opaque to the user. This mean the user is not sufficiently aware of what is being recorded or if it is actually being rewarded of penalized by the use of these applications.

Another form of intervention is to promote users who follow traffic and driving recommendations such as alerts and rest pauses. In the field of pervasive and ubiquitous computing, it is possible to analyze driving behavior and categorize it in different categories such as aggressive or relaxed. These are not traditional assessment and possible by the fusion of data capture either directly by the vehicle or with the help of sensing devices [7].

The action upon users is a problem that needs to be solved. Not all users respond in the same manner to suggestions, recommendations or alerts and a tailor made, multi-purpose approach is needed for these structures to work.

In this article we present an architecture to link gamification to the emotional state of mind of users in order to influence driving behavior. Different strategies are devised to the management of points, levels and achievements. The objective is always to drive the user to become a safer piece in the urban transportation model and avoid potential hazardous consequences from prolong bad habits.

2 Applications of Gamification and Affective Computing

Gamification and affective computing do not generally appear linked as subjects of research. Despite their differences, these two themes can be combined in a strategic manner to steer human behavior as a positive influence.

2.1 Affective Computing and Urban Transport

The use of affective computing for urban transport implies the detection of emotional state or users. The emotional state can be interpreted in more ways than one. There is the personality of users which influences how users react to events, the current mood of the user which implies a mid term emotional states the current spirits of the user and emotion which is viewed how a user reacts to an event and may or may not alter his mood state. In terms of computational representation, the PAD space is a useful mathematical space where emotions can be represented [2]. Personality assessment can also derive a dominant emotion in this space. One way to obtain a personality is the use of questionnaires such as the Newcastle Personality Assessor (NPA) questionnaire was used [5].

Taking this in consideration, in urban transports there are different types of events which correlate in some aspect with the before-mentioned affective attributes. For starters, there is the driving style of an user. This is typically viewed as immutable manner in which a driver operates a vehicle. It can consist of a relation of average speed, break and acceleration times across multiple records of driving from an user in a simplified the approach. Then there are the current driving style for a particular period of recordings such as a trip. And finally, we have direct events which occur while driving which may or may not affect how we drive. Some driving events are known to affect profoundly how we drive, as an example we can think of episodes of road rage where some event from one driver such as lane cutting can trigger aggressive and dangerous behaviors from other drivers.

Directly comparing the previous two paragraphs, there is an obvious link between emotion and driving patterns that can be used to research the emotional link between the act of driving and positive or negative emotions. Taking cues from the driving style of the user we can infer some aspects of the users personality and the current driving style from a trip can be used to estimate users mood. Of course, this mood cannot be directly inferred, but it can be analyzed beforehand and validated by specialists from fields of psychology. For instance, a user with a tendency to drive at higher speeds may be inferred to be calm when he drives at lower speeds, but on the other hand a tendency to drive at lower

speeds, when driving more slowly it can be perceived as uncertain or undecided not necessary more calm.

The affective computing here depicted is not all related to the user frame of mind but with our interpretation of how a is emotionally responding to driving. Taking in consideration driving profiles inferences regarding driving personalities can be made.

2.2 Gamification and Urban Transport

The field of gamification is characterized by the use of game elements on non game applications. This can be translated as to use game components encountered in traditional games such as points and levels to real applications such as tracking fuel consumption [1]. Other potential fields of application include monitor driving distances or number of driving pauses.

Gamification is often used as a motivational and persuasive tool to influence behavior in a manner that promotes the objectives of the designer of the application system. When used to a community of users it fosters the competition of users towards a defined objective that is viewed as important.

In the field of urban transportation gamification can be used as reward tool to influence drivers to acquire safer driving styles [6]. Coupled with techniques from ubiquitous sensing, it can even target driving styles and emotional state of users, contributing to a safer environment in urban transports.

3 Design of prototype application

The design of this prototype uses the PHESS Driving application, previously developed for assessing user driving events. The idea of this prototype application is to have a system that reward points to user dynamically according to positive or negative emotion, translated by aggressive and non-aggressive behavior as categorized on the PHESS Driving application [7].

Taking into consideration this system, already implemented to categorize driving styles and a gamification platform, experiments with affective computing are made in this research. Taking cues from affective computing and related projects, means for the translation of driving events to emotional states are implemented. Based on the detected emotions dynamic point systems are used to reward or penalize driving activities in two stages: while driving and after driving. The first will act as a means to directly influence driving actions while the second aims to raise driver awareness.

In architecture, sensor data obtained through a mobile application of the PHESS Driving is used to obtain the users driving data, build user driving profiles and classify driving events.

The process flow is illustrated in figure 1. After the processing of user driving data, an approximation of usual driving emotion is made based on the driver profile which is then updated constantly by the data captured by sensors while driving. Alert signs are displayed in the mobile application depicting points

awarded, thus giving feedback to the driver. After the driving trip is over, the driver's profile is also updated and as a consequence the driver's initial emotion for next iteration might be different as well.

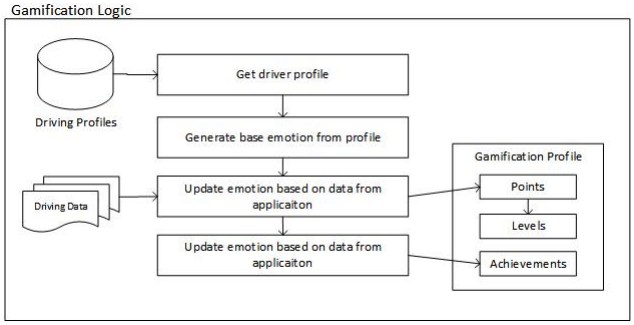

Fig. 1: Model describing the driving analysis in the system.

3.1 Emotion Classification

The computational representation of mood states is done according to the Pleasure, Arousal, Dominance framework described by Mehabian (PAD) [4] and the PAD space extended by Gehbard in [2], where the initial P, A, D variables are initiated according to an emotion list in this space.

Emotion classification is based on the analysis of the number of breaks and accelerations detected by mobile sensors: aggressive driving styles are connected with high frequency of breaking and accelerating actions; relaxed driving is correlated with stable velocity and low breaking and accelerating actions.

The update of emotions is a path between the PAD space where a current emotion is influenced by events and direct the state of the user towards a final emotion as a response to the event. The velocity of emotional change is regulated by a variable $emotionalWeight$ which will be higher if the emotion and the event have both either negative or positive classifications. When the classification differ then its value is lower simulation inertia in state change.

$$E_{actual} = E_{actual} + (E_{final} - E_{actual}) * emotionalWeight \tag{1}$$

Following this approach, two final states are defined representing angry and calm states so that a driver's emotion may be updated towards one of these states. The equation 1 represents the current driver's state moving in a vector space at a velocity defined by the $emotionalWeigth$.

For the purpose of this study, the final emotions considered are defined in table 1.

Table 1: Final Emotion States

Emotion	Coordinates	State
Pleased	(0.20, 0.10, 0.10)	Positive
Anger	(-0.51, 0.59, 0.25)	Negative

This study is limited to a classification of emotion states oscillating between pleased and angry emotions. The classification of additional emotions is being addressed in an extended research from this work.

3.2 Point, Level and Achievement Strategies

The use of emotions in gamification has the objective to become more natural and understandable to the user. Therefore points while driving are only attributed when the dominant emotion is classified as positive by the PAD space. Though there are currently only two final emotions being addressed, intermediate emotions can still exist by the paths the initial emotion makes in the PAD space.

After the trip, an assessment of the trip is made according to the classification of the average number of accelerations and decelerations per unit of time. Based on these inputs the PHESS Driving system can classify the driving session as aggressive or normal and additional points are generated to the user.

The achievements are automatically generated by rules defined in the gamification platform. Examples of current rules include the appearance of achievements related to positive trips after more than 10 negative driving sessions and reinforcement achievements as streaks achievements for positive driving sessions.

3.3 Study Case

In order to demonstrate the system, here a trace of the trip from a user in the platform is described. The user in question starts from a negative user profile and has a driving session of about 10 minutes generating about 226 driving events. From the results of this driving session, in figure 2, it demonstrates the emotional path derived and a partial sample of the driving trajectory.

From the emotional path we can derive that the user arrives at a positive stage early in the trip around the second minute, from when points are generated during its trip. At the end of the trip the analyzing the the driving session, more points are awarded due to the fact that this is in fact a positive driving session. Nevertheless, after the update of the user profile, its starting emotion is still negative and therefore, there is a penalization because the user driving session history is still affecting its user profile categorization.

Additional work is being done to add more dynamics to the gamification structure The idea is to pick up these experiments and add more point and achievement strategies to positively influence the user.

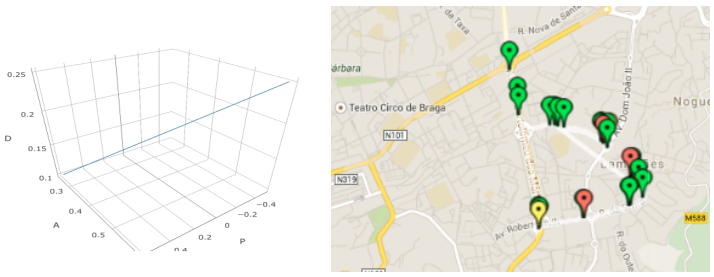

Fig. 2: Emotional path in the PAD space from driving session

4 Conclusion and Future Work

Gamification can be a useful tool for user persuasion, using reward methodologies or more advances methods such as information diffusion through user social networks. In the case of user driving habits it may influence how the driver reacts and influence them to positive attitudes. The use of affective computing, demonstrated in this article aims to make the gamification more social and understandable by the users. Linking the emotions to events and using predominant emotions to steer gamification rewards is an innovative idea for user persuasion.

The aim of this research is to continue the study of emotion perception by short questionnaires to the end of each trip and relate user feedback to intercepted notions from the affective system. Emotion linked to driving events is also being explored, in order to expand the current range and make the emotion space more dynamic. The study of affective persuasion will be monitored to be compared with traditional gamification to access differences or similarities in user persuasion.

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References

1. Corcoba Magaña, V., Muñoz-Organero, M.: GAFU: Using a gamification tool to save fuel. IEEE Intelligent Transportation Systems Magazine 7(2), 58–70 (2015)
2. Gebhard, P.: ALMA: a layered model of affect. Proceedings of the fourth international joint conference on Autonomous agents and multiagent systems pp. 29–36 (2005)
3. Handel, P., Skog, I., Wahlstrom, J., Bonawiede, F., Welch, R., Ohlsson, J., Ohlsson, M.: Insurance Telematics: Opportunities and Challenges with the Smartphone Solution. Intelligent Transportation Systems Magazine, IEEE 6(4), 57–70 (2014)

4. Mehrabian, A.: Pleasure-arousal-dominance: A general framework for describing and measuring individual differences in Temperament. Current Psychology 14(4), 261–292 (1996)
5. Nettle, D.: Personality : What makes you the way you are. OUP Oxford (2008), http://books.google.pt/books?id=PimuSGj1U_gC
6. Silva, F., Analide, C.: Gamification and the Improvement of Urban Sustainability. In: Ambient Intelligence and Smart Environments Series. pp. 446–455 (2016)
7. Silva, F., Analide, C.: Ubiquitous driving and community knowledge. Journal of Ambient Intelligence and Humanized Computing pp. 1–10 (aug 2016), http://link.springer.com/10.1007/s12652-016-0397-9 http://link.springer.com/article/10.1007/s12652-016-0397-9%5Cnhttp://link.springer.com/content/pdf/10.1007%2Fs12652-016-0397-9.pdf