Gamification of Car Driver Performance

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Abstract. The potential of serious games can be used to captivate the road users in exhibiting green driving behavior. Serious games can be an engaging medium in conveying information effectively. We exploited the pervasiveness of smartphone and serious games concept to develop a gamified environment for the road users. Our approach comprises two games that would gamify the driver performance based on the driver performance assessment results. The driver performance will be evaluated using a smartphone-based evaluator and the assessment results will be transmitted through a Bluetooth module to the gamified environment (this happens on real-time basis). The game environment comprises various levels and indicators with the provision of audio feedback on the game status.

1   Introduction

The task of educating or training through a gamified environment unleashes the complexity of a concept. Gamifying mechanism provides an interaction and engagement of users with the gameplay and this could motivate the users in achieving optimal outcomes. The process of gamifying a non-game context, provides a better learning possibilities for the users [1]. Usually the traditional games focus on the engagement of the users with the gameplay by delivering a good amount of interactivity and various properties on the game scene for entertainment. The serious games focus on providing information and training on some context or to instill certain concepts through a gameplay [2, 3]. Designing a serious game is highly challenging as it should seal the information and entertainment in the same box. The core of serious game should be equally balanced between the information and entertainment, if there is an imbalance in this, then the informative content becomes trivial.

Usage of an instructional design (application of technology and multimedia) in crafting a serious game framework can be a significant aspect of a serious game design [4]. The incorporation of instructional design and serious games can enable higher level of learning outcomes, as the design will involve necessary game characteristics (competitions, goals, challenges and etc.) and learning objectives [5]. With all these assets, serious games can be exploited in automotive domain to foster green driving (maintaining optimal driving behavior constantly, without rapid harsh events). The driver behavior has a major contribution in road safety and green mobility aspects. When analyzing the driver behavior, it's important to understand the difference between the

driver behavior and the driver performance, where - the driver performance is referred as the abilities (such as skills, knowledge, and cognitive abilities) of the driver and the driver behavior is the preference of driver from the experiences gained [6]. It's also a mandatory fact to concern about the safety, while developing applications that would captivate driving behavior. These applications should also consider the aspects like driver distraction, immersion on secondary tasks and etc., which could grab driver's attention. Because, the involvement of drivers in secondary tasks while driving can cause on-road hazards [7]. We target to improvise the knowledge of the driver by an infotainment system, which manages to gamify the driver performance. We propose a gamified environment for drivers to promote a green and collaborative driving. The performance of the driver is evaluated using a smartphone-based evaluator and the assessment results are sent to the gamified environment. The game environment allows the player to visualize the performance on the game screen without direct user inter-action to the game. This provides immediate feedback of the performance on game environment and the process of immediate feedback would cultivate a procedural learning [8] and enables user engagement [9, 10]. The immediate feedback also provides an understanding to the user about the driving performance. Especially, when driving behavior is bad with more harsh driving events (such as: harsh brake, high acceleration and etc.), the user can visualize a downfall in the game. Thus the impacts of driving pattern on gameplay helps the users to understand driving performance and improvise the driving behavior. The driver game allows user to advance levels, gain bonuses and win the game, if the performance is good. Incentivizing the user performance provides a motivation for the users to progress and improvise the driving traits from the gameplay [11]. The game provides an audio feedback of the state changes and also for avoiding distraction while driving. The performance gamification enables a broader gaming aspect for the drivers, where the driver can just mount the smartphone on dashboard and game without even interacting or looking on to the game screen.

2 Gamified Approaches for Green Drive

The serious games and community building (SG-CB) application provides scope for gamifying the driver performance and this gamification will spotlight the impact of driving pattern [12]. The driver behavior gets reflected on the game environment and the fluctuations on the game play happens based on the driver performance.

We propose two gamified approaches to encourage the green drive and they are:

- The Driver game
- Snake and ladders.

2.1 The Driver Game

The driver game provides a gamified environment for drivers on a smartphone-based gaming setup. The game involves no interaction with user (driver) and is connected through a Bluetooth module with signal evaluator (Fig. 1).
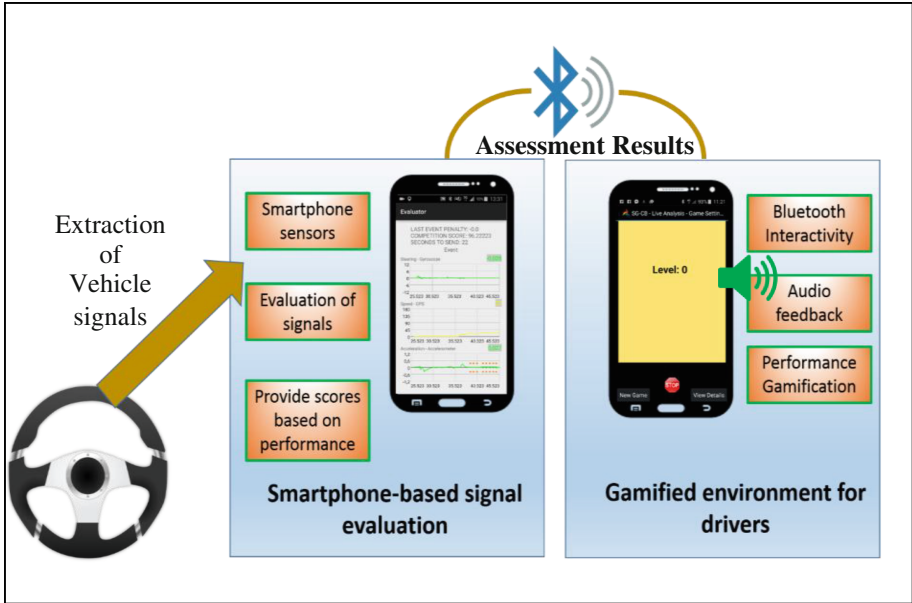
Fig. 1. Driver game architecture and setup

The driver game is housed inside the SG-CB application and the game comprise two phases. The first phase involves the extraction of vehicle signals and this is done using the car evaluator module (A smartphone-based application for assessment of vehicle signals). The second phase involves the representation of driver performance on a gamified environment. The driver game establishes a Bluetooth connection to extract the user performance scores from the signal evaluator module. The user performance results (normally a score ranging from 0–100) are transmitted to the game scene and it's represented on the game environment (Fig. 2).

Fig. 2. Driver game sample scenario

The driver game has a game screen with less number of properties and representations (see Fig. 3(a)). The game screen in driver view comprises a big window with gradient of colors displayed from yellow to green depending on the driver performance. The game starts with the yellow gradient and based on the performance, the yellow gradient will shade towards green. The driver can look for the change in gradient pattern to understand the performance. Additionally, the user gets an audio feedback of the game status and this would allow the user to focus on driving without having need to look upon the game screen for updates. When the user halts the vehicle in a traffic or at any place, there is an option to visualize the game on a detailed view comprising of more visual elements representing levels, lives, score and bonus/malus gauge (see Fig. 3(b)).

(a)   (b)
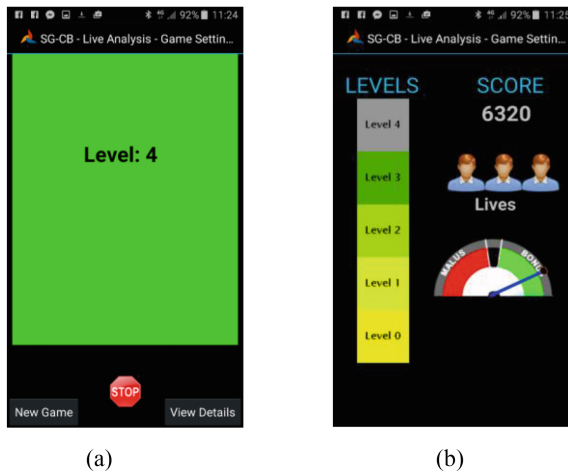
Fig. 3. (a) Driver view display with gradient window, (b) Detailed gaming view with representation of various properties of game (lives, levels, score and bonus/malus gauge)

The driver game comprises five levels and each level has a certain threshold value that has to be acquired within the allocated time. If the user completes a level within the allocated time, then the user gets a bonus and will be advanced to another level and if user is unable to complete a level, then a malus is provided and the user gets retained in the same level. The bonus and malus gauge acts as a performance estimator and will predict, whether the user is likely to get bonus or malus based on the current performance. Driver can switch between the views to visualize the performance on a game environment. Thus, the driver game provides a real-time performance display on a gamified environment based on driving events such as brake, acceleration and Steering wheel angle.

2.2 Snake and Ladders

The snake and ladders is a live gaming approach and it's linked to driver performance. The game scene comprises of certain slots, where user's position will be placed and

based on the performance the user climbs the ladder and gets advanced to other levels. On the possession of good events, the user gains some points and a dice is rolled virtually and based on the result, the user advances on the slots. The snake and ladders concept in our gaming framework, provides a gamified environment for the users to view the evolution of their performance. In this approach, the users can compete with their peers associated with competition. The game has two levels and the complexity increases as user progresses and winner of the game secures a championship (Fig. 4).
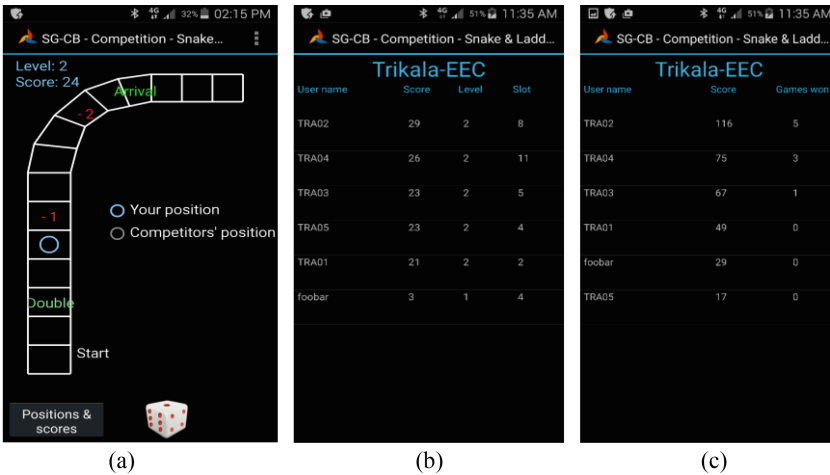
Fig. 4. (a) Snake and ladders game environment, (b) List of user scores and position details, arranged based on performance, (c) Championship screen-list of users, arranged based on scores.

3   Impact on Driver Performance

The two game approaches intend to impact the driver performance through HMI and the user can analyze the performance outcomes during the drive (performance gami-fication, bonus and malus gauge and evolution of performance on snake and ladders game). Every drive of the user will definitely have something to convey as a part of betterment and eventually, contributes for eradicating the harsh driving behavior. Under the hood, these game approaches convey a mode of feedback to the drivers in the form of incentives, scores and visualization of performance. The feedbacks from the game approaches take a combinational effect on the user performance by inducing the knowledge and comprehensive understanding about the driving behavior in engaging way. The snake and ladders game offers an interactive gaming platform to compete with the peers and progress by acquiring virtual coins. The goal of the user becomes to gather virtual coins and on the pursuit of it, there will be a competitive platform for enhancing the driving performance. The major impact of these game approaches on driver performance would be an emphasis on two attributes, which are the rewards and downfall (Fig. 5).
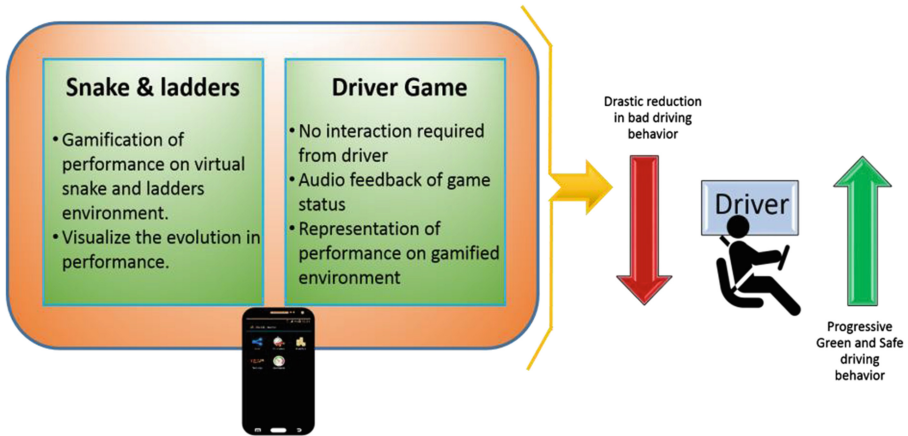
Fig. 5. Driver performance impact based on gamified approaches

The rewards will act as a factor of motivation to improvise the driving behavior and to maintain the optimal performance to earn incentives. Whereas, the downfall in scores and performance would provide an extensive analysis of performance, which enables the users to understand and react towards eradicating the bad driving behavior. The constant exposure to our defined game approaches would progressively increase the driver performance and adheres the driver to stay optimal and also brings down the harsh driving behavior by spotlighting the flaws.

4   Conclusion and Future Work

The game approaches provide a performance gamification that would enable the users to visualize the impact of driving behavior on the game screen. This mechanism would also induce a game based learning traits, as we focus to reflect the driving performance directly on to the game screen. There are certain aspects, which we would like to highlight from our gamified approaches. We aimed to improvise the driver performance and cultivate the green driving traits, but it's more important to make the users to persevere in the state of betterment and keep improvising tenaciously. The gameplay incentivizes the user for good performance and this provides an encouragement. These incentives create motivation and enable the users to maintain an optimal driving behavior at most of the instances. Also, the competitive strategy uplifts the performance of users and peers associated in a game. The strategy is the core of gaming applications and inducing a concept through a gameplay works well in reaching the audience, as it's transmitted through an engaging medium.

As a part of future work, we are planning to reduce the configurational settings for establishing the Bluetooth connection between the smartphone-based evaluator and the game environment. It's also necessary to provide a customizable gaming options for the users to adjust the game parameters on the smartphone UI as per the needs. These concerns are currently on progress for making the gamified environment more

user-friendly. Henceforth, the process of performance gamification will provide the users with a competitive self-gaming experience and also promotes the collaborative green mobility.

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