A Game for Studying Maintenance Alerts’ Effectiveness
(Extended Abstract)

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ABSTRACT

In this paper we present a space-ship game which allows us to evaluate human behavior with respect to maintenance and repairing malfunctions. We ran an experiment in which subjects played the space-ship game twice. In one of the games, they were simply told that they should perform maintenance every 20 seconds, and in the other game they received alerts from an agent for performing maintenance every 20 seconds. We show that when receiving alerts, people tended to perform more maintenance, and performed slightly better (not statistically significant). We suggest that in order to further improve the performance of the players in the space-ship game, one should also consider when to provide these alerts.

Categories and Subject Descriptors

1.2.m [Computing Methodologies]: ARTIFICIAL INTELLIGENCE—Miscellaneous

Keywords

Maintenance Optimization; Alert System; Computer Games

1. INTRODUCTION

In this paper, we present the spaceship game, which allows us to model and evaluate people’s tendency to perform maintenance and repairs. In this game, a player controls a spaceship, which shoots asteroids (see Figure 1 for a screen-shot). The player must also retain enough fuel for the spaceship to function. The player is required to perform maintenance actions on his or her spaceship. Occasionally and depending on the frequency the player performs maintenance, the spaceship may suffer malfunctions with one of several levels of severity which require repair and may limit the spaceship’s performance. We ran an experiment in which subjects played the space-ship game twice. In one of the games, they were simply told that they should perform maintenance every 20 seconds, and in the other game they actually received alerts for performing maintenance every 20 seconds. We show that when receiving alerts, people tended to perform more maintenance, and performed slightly better (not statistically significant).

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2. RELATED WORK

It is not always easy to modify the behavior of humans, since people often follow suboptimal decision strategies because of lack of knowledge of own preferences, the effects of the task complexity, framing effects, etc. There have been various attempts in the field of human-agent interaction to change or modify the behavior of humans in a way which would be favorable for the agent [3, 4, 10, 7, 2, 6, 5]. Although there exist many applications to help equipment owners maintain equipment, however, we are not aware of any study of such an alert system in this field. Studies do exist, however, in the field of medicine, in which patients are reminded to take their medicine [12].

Several studies have considered interruption management, asking about the best time to interrupt the user [1, 8]. Shrot et al. [11] clustered the users into groups and then used collaborative filtering in order to determine which interaction method would work best with each type of user. This approach yields different policies for different users. However, in contrast to this paper, they did not try to change the user’s behavior, but convey information at the best timing. Huang et al. [9] suggest a maintenance model, which uses a form of personalization. The model utilizes collected data to inform a user about recommended tasks that needed to be performed.
3. THE SPACESHIP GAME

The characteristics of the spaceship game were motivated by the following real world maintenance characteristics:

1. Maintenance tasks that must be performed distract the user from performing his or her regular tasks.
2. Maintenance activities decrease the probability of faults, but equipment may still sometimes malfunction, even if it is well maintained.
3. The severity of faults increases if they are not repaired.
4. Maintenance tasks cost less than repair tasks.

In the spaceship game the player controls a spaceship (see Figure 1). Throughout the flight the spaceship should shoot down meteors which fly in space. Every time a meteor is shot down, the player gains money (points). The player must also avoid getting hit by the meteors and loses money when hit occurs. The spaceship has a fuel tank that diminishes over time, and the player needs to occasionally refill (with some monetary cost proportionate to the amount of fuel missing). The spaceship is refilled by contacting a gas station. If the spaceship runs out of fuel, it is automatically refilled by a refilling ship, however, such a refill is very expensive.

In order to reduce the probability of malfunctions, the spaceship needs to occasionally carry out maintenance actions. Each of these actions is both time consuming and incurs a monetary cost. While performing a maintenance action (which lasts several seconds), the spaceship 'freezes' and the player cannot shoot down any asteroids and thus is unable to gain any points (but at the same time it cannot lose points either). There are three levels of malfunctions: minor, moderate and severe. Each malfunction is associated with repair costs with respect to the score and time (i.e. the spaceship freezes during the repair time). The more severe the malfunction, the higher its repair costs. If a malfunction occurs, it starts off as a minor malfunction, the,n if not repaired, it may escalate to a moderate malfunction and eventually a severe malfunction. The moderate malfunction limits the movement and shooting rate of the spaceship, and a severe malfunction does not allow the ship to move or shoot until repaired. More details on how malfunctions are sampled and how maintenance actions may be used to avoid them appear in the next section. In this paper we study how an agent providing maintenance alerts may improve a player’s performance in the spaceship game.

4. EVALUATION

In order to evaluate our agent and the maintenance alert method, we recruited a total of 66 subjects through Amazon’s Mechanical Turk to play the spaceship game. These subjects played two games, one with alerts and the other without. The subjects performed significantly (t(130) = 4.43 : p < 0.0001 using the student t-test) more maintenance actions when they received alerts than when they did not receive them, with an average increase of 58.7% in maintenance actions (5.46 vs. 3.44). However, subjects’ score did not differ significantly when they received alerts and when they did not receive any alert. The alert system accounts for a non-statistical significant improvement of only 3.4% (2745.2 vs 2654.6). Figure 2 illustrates these results (error bars represent 95% confidence interval).

REFERENCES


Figure 2: Average performance of subjects when receiving alerts and when not receiving alerts.


