Eye tracking in mobile games as a tool to improve the Game User Experience: a case study

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Abstract

This paper's objective is to describe the usage of eye tracking technique in mobile games as a way to improve the usability and enhance the game user experience.

Keywords: Eye tracking, mobile game, game user experience, user interface.

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1. Introduction

The paper presents a case study and aims to explore the usage of Eye tracking technique in mobile games as a tool to improve the game user experience. To do so, a First Time Usage (FTU) tutorial developed for the mobile game Wake Woody (an infinity run game) was evaluated through the Eye tracking technique. The FTU is a non-intrusive tutorial in wich the player received hints through dialog boxes that were shown during the first use of the game. This information was about how to perform the commands (jump, double jump and dive) and the game's mechanic (run against the time and collect checkpoints to increase it) during a game session.

The test consisted in a unique task performed by users: they should play the game 3 times, without interruptions, and the Eye-tracker was used to track their eye's path. The Eye-tracker's heat maps and think aloud protocol were used to identify problems about the proposed tutorial.

2. Related Work

Eye tracking has enabled researchers to have and use new data about many different aspects of the visual dimension of the game experience [Bergstrom and Schall 2014].

An Eye-tracker follows the user's eye movements by reflecting infrared light onto the eye and then, using a geometrical model, determines the exact gaze point of the user [Tobii Technology 2009].

The basic idea behind Eye tracking is that our eye movements can be used to make inferences about our cognitive processes [Peyrichoux and Robillard-Bastien 2006]. According to the "strong eye-mind" hypothesis, there is no perceptible delay between what is fixed and what is processed [Just and Carpenter 1976].

In particular, Eye tracking has assisted researchers and designers in better understanding when and for how long different elements of the display attract users' visual attention and what elements are overlooked [Bergstrom and Schall 2014].

Eye movements are typically analyzed in terms of fixations – a pause of the eye movement on a specific area of the visual field, and saccades – rapid movements between fixations [Jacob and Karn 2003]. This data is usually illustrated using gaze plots (or scan paths) which show saccades and fixations or aggregated heat maps which show the amount of or length of fixations [Rayner 1998].

Below, there is a brief explanation about how each Heat Map styles are calculated, according to Toobi Eye Tracker Research [2010]:

Count: the plot shows the accumulated number of fixations from all the selected test persons. This means that this plot only shows where people have looked and not for how long. That means that a 2000 ms fixation will look the same as a 100 ms fixation. It also means that a person that has spent a long time looking at a stimulus will have a greater impact on the heat map than someone who only glanced at it shortly.

Absolute Duration: this plot shows how long the selected test persons have looked at the different areas in the screen. This means a 2000 ms fixation will be 20 times higher (in color value) than a 100 ms fixation.

There are also many metrics related to visual behavior, as the following ones:

Number of fixations on an Area of Interest (AOI): indicates greater importance to the user. A number of fixations on a particular screen element should reflect the

importance of this element, ie, the most important elements are often fixed.

Duration of gaze on AOI: a longer duration (long fixation) is generally inferred as indicators of the difficulty of a participant to interpret the content of an area.

Although the Eye-tracker identifies where the users are seeing, the eye tracking technics cannot tell what they are thinking (longer fixations may mean that a participant found a particular area interesting, but it can also indicate that he or she found that area is difficult to understand).

When evaluating usability, the data gathered from Eye tracking should be combined with other data acquired from other methods since eye movements cannot always be interpreted correctly without the participant explain their actions [Tobii Technology 2009].

Verbal protocols are often used for this; these techniques allow measuring the cognitive process of users during the eye tracking test. [Barreto 2012]

2.1 Post Experience Eye Tracker Protocol (PEEP)

The ultimate goal of games is to entertain, which involves getting into a state of flow and immersion. The experience that must be measure is in flux constantly and is driven by the user. Interactivity impacts the research design and analysis, and supporting this state while running an eye tracking session is necessary for obtaining meaningful data. [Bergstrom and Schall 2014].

PEEP is a cued retrospective think aloud (RTA) based on eye gaze video where is shown a video recording of the participant's interaction with the interface on which the eye movements and fixations are also shown. This technique has the following steps according to Maughan et al. [2011]:

1. User is asked to complete a task on their own, without intervention and without being asked to voice their thoughts.

2. Moderator watches user eye traces in real time and notes any interesting gaze patterns. Monitoring can be conducted from a separate room.

3. On completion of the task the moderator asks the user to comment on the dynamic replay of their eye-movements. The user is shown both video highlights and static representations of their eye traces.

4. Moderator can show any distinct eye gaze patterns to probe further the underlying motivation of the user.

This technic has proven more effective as verbal support, giving participants an accurate reminder of his thoughts, than using a traditional video [Maughan et al. 2011].

3. Case study

A qualitative approach was adopted in this research. According to Nielsen [2000], 5 users are necessary to perform a qualitative research, because after the fifth user, the findings tend to repeat.

Therefore, 6 users (both genders) were selected through a field research survey. All of them were casual mobile gamers and play as a way of passing time (lunch interval, waiting in the bank line, waiting for someone, before sleep, etc). Only 1 user had played the first version of the game analyzed and 5 users had already played Infinity run games, since 3 noticed that this game style is their favorite one.

The experiment was conducted in a controlled environment and each session lasted about 30 minutes. Due to the degree of immersion that games in general require, no questions or interruptions were made while users were playing. The participants performed 3 runs and were asked to complete the task on their own, without intervention and without being asked to think aloud their thoughts. The goal was to preserve the lived experience and collect the post-experiment data through retrospective comments, the users were encouraged to verbalize their actions and decisions made during the test. According to Guan et al. [2006], this method provides extra information about the task and therefore can be useful to facilitate interpretation of the results of Eye tracking.

It was used an X2 Tobii Eye Tracker to perform the test. The data collected by Eye Tracker were analyzed to evaluate the effectiveness of the proposed tutorial (understanding of controls). Meanwhile, the moderator watched, in real time, the eye-traces (movement of the user's eyes) and made notes about the fixation points detected.

After the task, the moderator used the PEEP technique. This technique provided valuable and complementary inputs to analyze the Eye-tracker data.

The data analysis is based on a qualitative research made with the same users an then compared with the Eye tracker data collected in the tests. Absolute Duration Heat maps were used to show the data from user's eyes movements.

3.1 Findings

Jump - Users spent more time looking at the character, obstacles and coins (red area in the center of the figure 1). It was observed that users did not need to seek for additional information about the single jump. Since it is a simple command, they performed it intuitively.

Figure 1: Absolute Duration heat map for jump tutorial.

Double jump – To perform this command, users began to pay more attention to the tutorial instructions, as is shown in the figure 2. Although there was an increase of fixation durations in instructions dialog boxes, the users' attention (warmer areas) is still focused on the game elements (obstacles, coins and character), which demonstrates the immersion of users in this point of the game.

The map shows a small cold area (marked in green) on the term "in the air", which means that users spent more time looking at that point. One user said that he did not understand this message very well.
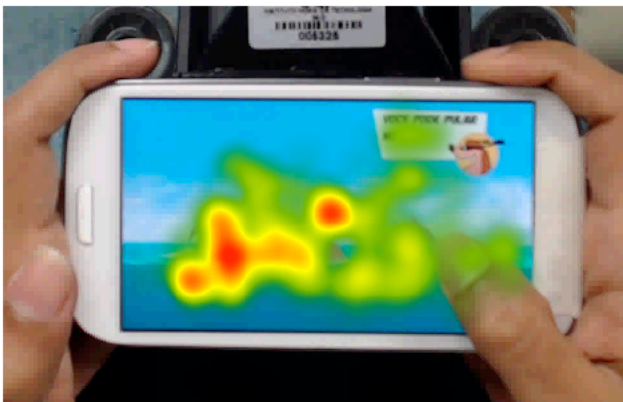

Figure 2: Absolute Duration heat map for double jump tutorial.

Dive - At this point, there was an increase of looking duration in the instructions dialog boxes (figure 3). This happened because, to perform this command, users had to

seek out information from the tutorial and took longer to interpretate and assimilate the instruction. Two users said that they felt confused with this instruction, which led them to look longer to the dialog box.
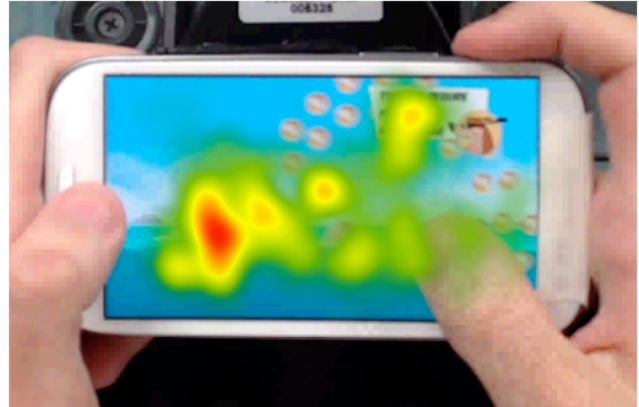

Figure 3: Absolute Duration heat map for dive tutorial.

Time - Users were able to quickly assimilate this instruction. The lighter green area on the word "time" shows that this instruction had the least amount of duration (prolonged fixations).

As is shown in the figure 4, the users attention turned to the time counter when they realized that the game clock counting was near to zero and then they should worry about this element (time) throughout the game. There are fixations on the word "time" and the clock icon that suggests it. All the users said they understood that the game works like a race against the clock.

Figure 4: Absolute Duration heat map for time tutorial.

Checkpoint - In the figure 5, there is a concentration of fixations along the checkpoint milestone and time. All users quickly read the instructions and understood this message and this game element behavior.
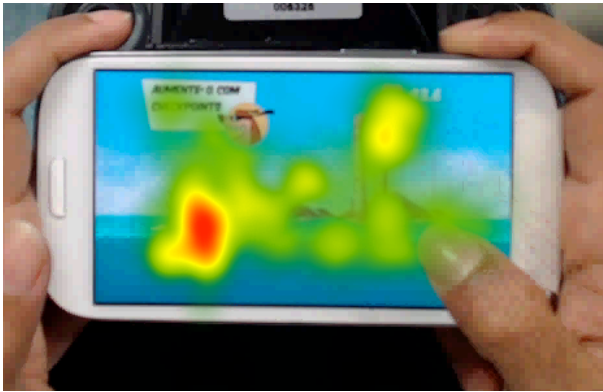
Figure 5: Absolute Duration heat map for checkpoint tutorial.

4. Conclusion

This case study demonstrated the great potential of Eye tracking as a way to improve the game user experience in mobile games. Through this technique it was possible to observe the users' behavior during the game session and verify if their attention is where it was planned to be.

However, due to the specificity of mobile games, deeper studies and research are necessary to improve the Eye tracking technique applied to this niche. Some specific metrics as attention capitation and visual involvement are more relevant to games and should be more explored in further researches.

Acknowledgements

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