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Multi-screen and Multi-device Game Development

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Abstract. Users are interacting with an increasing number of devices and screens. However, these screens are usually used independently without collaboration between them. Although there have been several advances in multi-screen applications the game community does not seem to have fully explored this opportunity as yet. This paper presents an approach for the development of mobile multi-screen and multi-device games. The approach aims to enable and foster the creation of multi-device games sharing information via a centralized screen and is demonstrated by means of an example, the well-known Casino Roulette game. The results of a preliminary evaluation of the game are also presented.

Keywords: Multi-screen, Multi-device, Game development

1   Introduction

Nowadays users have become accustomed to carrying several devices (e.g. smartphone, tablet) in addition to being able to use devices available in the environment (e.g. screens). This might be beneficial as users have several screens available to interact with at any one time, but it might also pose some drawbacks such as how the user divides their attention between devices. The multitude of devices that can be interacted with simultaneously has triggered opportunities such as multi-screen and multi-device applications development and has enabled the emergence of improvements both in terms of user experience and methods of interaction offered. In fact, new applications are being developed, from apps with distributed interfaces through to games using several devices simultaneously (e.g. a smartphone and a smart TV).

Despite all advancements that have been made in this field and surprisingly, for us, there is no game available in the IOS and Android app stores which explores this concept. Indeed, several applications use inter-device communication technologies but most of them focus on chat and data transfer. These facts together with the desire to provide a different user experience has motivated the development of this work.

This work presents the development of an approach for the creation of games based on several screens and devices.

The paper presents an analysis of the state of the art in Section 2. Based on this analysis, the added value of the proposed approach and its architecture are presented in Section 3. In Sections 4 and 5 a case study to illustrate the approach and the results of a preliminary user study are respectively presented. Finally, conclusions and future work are outlined in Section 6.

2   State of the Art

Nowadays, some users frequently use several devices "simultaneously". For instance, watching TV while interacting with their laptop or checking text messages on their smartphone. In several situations, sharing information between devices is valuable. Motivated by this situation multi-screen and multi-device solutions have been developed.

Some solutions like Allshare[1] or Chromecast[2] enable sharing of content across connected devices. Other solutions focus on facilitating the creation of multi-screen applications. Chmielewski et al. [3] present a uniform way of building smart multi-device applications. Bassboss et al. [4] present an approach for developing multi-screen applications and enabling traditional web applications to use multi-screen capabilities with minimal effort. Along the same lines, Sarkis et al. [5] present a refactoring system that splits a web application into parts ready for distribution across devices. This means that existing web applications based on a single-screen can be transformed into multi-screen applications. Other works focused on the development of second screen approaches (e.g. [6]).

In the game community, some approaches have explored this aspect. For instance, Nintendo 3DS [7] possesses two screens and the associated games use both but without any centralized device. Wu et al. [8] developed a multi-screen cyber-physical video game. The developed game uses inertial sensors and 4 screens without using any centralized device. Some physical casinos have a Casino Roulette video game instead of a physical version. This video game is like the one illustrated in this paper but was developed with the sole purpose of being based in a casino and it is not mobile like ours. This means that players are not able to play it with their own devices.

Instant Places [9] enables users to interact with public displays using their own devices. This approach is similar to ours but is not a game. Improvements are being made in the game community in several areas, developments [10, 11], applications [12, 13], interaction among others however, we are unaware of any mobile multi-screen and multi-device game that makes use of a centralized screen working as a game board shared by all players.

3   Approach

This section describes the proposed approach both at architectural and implementation levels.

3.1 Architecture

In Figure 1, the architecture of the system is presented. The element A represents the host (e.g. the iPad) and elements B and C the clients (e.g. the iPhones). The communication between the elements was made thanks to the Multipeer Connectivity framework [14] that supports both Wi-Fi and Bluetooth technologies.
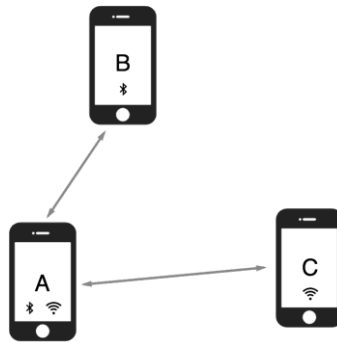

Fig. 1. Architecture using the Multipeer Connectivity framework

3.2 Implementation

The approach was developed using the Apple Xcode IDE (version 7.3) and using the Swift language. The Operating System used was the iOS9 but compatibility with more recent version is supported.

The implementation is supported by the stated communication channel (Multipeer Connectivity framework) that supports peer-to-peer connectivity and the discovery of nearby devices. In addition, the channel is used to synchronize the devices and share information between them. It is also customizable for different purposes. This initial implementation was made only for IOS devices but implementations for Android devices and inter Operating Systems are planned as future work.

The implementation was divided into 2 parts: i) Server - usually running on iPads (to improve the User Experience due to the presence of larger screens) ii) Clients - usually running on iPhones and, follows the typical client-server architecture. The server waits for clients to establish an individual connection with it. Each client possesses the same Graphical User Interface (GUI) which is different from the GUI of the server. All interfaces developed are responsive and were tested with devices of different screen sizes.

Once all clients are connected the game can start. On one hand, each time the server reaches a different state all clients are automatically notified. On the other hand, clients must explicitly send information to the server. In addition, a synchronization mechanism was used to guarantee that all devices are synchronized.

During development, the guarantee that new multi-screen and multi-device mobile games can be easily developed based on this approach was given particular attention.

4   The Example

The example used corresponds to the development of a casino gambling game, i.e., the Roulette game. The game was developed for IOS devices and typically works with a tablet (i.e. an iPad) in the center of the space, working as the board of the game. In addition, several smartphones (i.e. iPhones), one for each player, are used to interact with the game and to complement the information provided by the tablet. The game can be played simultaneously with up to 7 players.
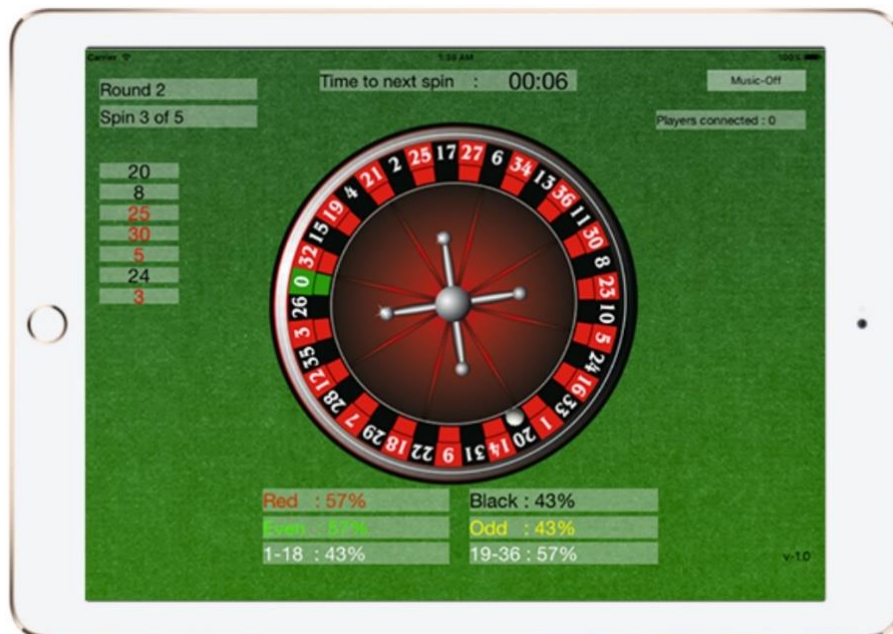

Fig. 2. Client Play Menu

Fig. 3. Server Play Menu

Some modifications to the original version of the game were made to increase interest in the game as it is played without real money transactions. Furthermore, particular attention was given to the user experience and usability of the game, for instance, interactions such as drag and drop and ambient music are supported. Interfaces running on clients and server are presented in Figure 2 and Figure 3 respectively.

4.1 Rules of the game

The rules of the game typically consist of choosing to place bets on either a single number or a range of numbers, colors – red or black, whether the number is even or odd, or in different groups. To determine the winning number and color, both wheel and ball spin and then the ball falls into one of the 37 colored and numbered pockets of the wheel. In the case of success the player wins a percentage of the bet otherwise the bet is lost. Several players can play simultaneously and can bet at any time before the wheel starts spinning.

Aimed at enhancing the user experience provided and since no real money is used, modifications to the original Roulette game were introduced. The goal of the game is to end the game with the most winnings. The game consists of 5 rounds with 5 spins each. The player ending the game with the highest number of winnings has won. Players do not have to bet on every spin. In addition, the option to use winnings to buy enhanced elements of the game (e.g. different board styles) was introduced.

4.2 Running the game

Figure 4 presents the initial client GUI presented to the user. It provides three options:

- Play – to start playing the game;
- Shop – to buy enhanced elements (e.g. backgrounds);
- Help – to obtain help.
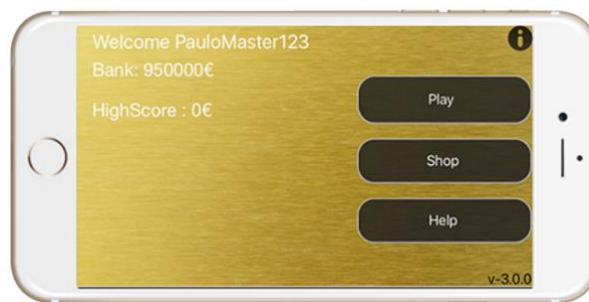

Fig. 4. Initial menu of the Client GUI – Roulette game

In case the user selects the play option a GUI like the one presented in Figure 2 is presented. The user should first connect to the iPad (clicking on the top right button).

Once a successful connection is made, bets can start, varying between the value of 1 and 20 per betting chip. Drag and drop, long press and click are examples of different types of interactions supported by the game.

The shop option enables the user to access a virtual shop. Since no real money transactions are made, this shop is intended to make use of the money won.

Figure 3 presents the GUI of the iPad. It indicates the players connected, time left to the next spin, the history of winning numbers, statistics and the ability to control the ambient music.

5 Evaluation

A user study was performed with end users who played the game. At the end they were asked to complete a questionnaire that addressed four aspects (as defined in the standard USE questionnaire [15]): participant characterization; usefulness; ease of use; and user satisfaction. Subjects were asked to answer on a 7 point Likert scale with values from -3 (strongly disagree) to +3 (strongly agree). The questionnaire included open questions on the strengths and weaknesses of the game, and enabled the participants to make any further comments if they wished.

5.1 Participants

Ten people voluntarily participated in the experiment. They were not compensated for their participation. Participants were aged between 18-24 (9 males, 1 female), where 2 had completed high-school, and 8 had bachelor's degrees. With regard to current videogame playing frequency, 7 participants stated they frequently play games, 2 play irregularly and 1 occasionally. Only eight participants had already played the original Roulette game. Eight participants had never played any videogame using more than one screen prior to the experiment.

5.2 Apparatus

The developed solution was deployed with the following devices:

- iPad 2 with 9,7 inches – working as the board of the game;
- iPhone 5 with 4 inches – working as client;
- iPhone 6 with 4,7 inches – working as client;
- iPhone 6S Plus with 5,5 inches – working as client;

5.3 Procedure

Groups of participants (varying between 2 and 4 members) met the experimenter and were escorted to the experiment room. The experimental procedures were discussed orally with each group and participants were encouraged to ask questions. Each participant of the group was then given an iPhone (different models were used) with the

game previously installed. Participants were then asked to launch the game and connect to the board of the game (i.e. to the iPad). Afterwards the group of participants played the game until the end. Each game lasted 500 seconds and is composed of 5 rounds with 5 spins each. The game was played with 3 groups, 2 of them with 3 participants and one with 4. During the evaluation, the experimenter took notes of the reactions and comments made by the users. After ending the game participants were asked to answer the post-experiment questionnaire (see Appendix I) handed to them and to indicate basic demographics (gender, age, academic background) as well as relevant previous experience.

5.4   Measures

The measures used in this study were the post-experiment questionnaire and reaction while playing the game. The post-experiment questionnaire was composed of 32 questions and was divided into six sections: Subject characterization, Usefulness, Ease of Use, Ease of Learning, Satisfaction, and Open questions.

5.5   Results

Overall, the participants' reactions to the game were quite positive. According to the data collected through the 10 questionnaires all criteria but one obtained a mode of 3. The usefulness criteria which was the weakest aspect received a mode of 2.

Participants found it easy to learn and to use and were satisfied with it. None answered any questions negatively in Usefulness and Ease of Learning criteria and very few in Ease of Use and Satisfaction criteria (see Figure 5).

In the open questions participants made several comments such as a re-bet option should be provided as well as an option to undo the last bet. The remaining comments were positive. Participants enjoyed playing and liked the concept of the game. Some examples of comments made are: "The game is fun to play with friends", "I liked a lot the experience", "Amazing game".

Overall the results of this preliminary user study indicated a positive reaction to the concept of the game and to the game itself. These results should be interpreted carefully due to the lower number of participants but they provide us with some insight.
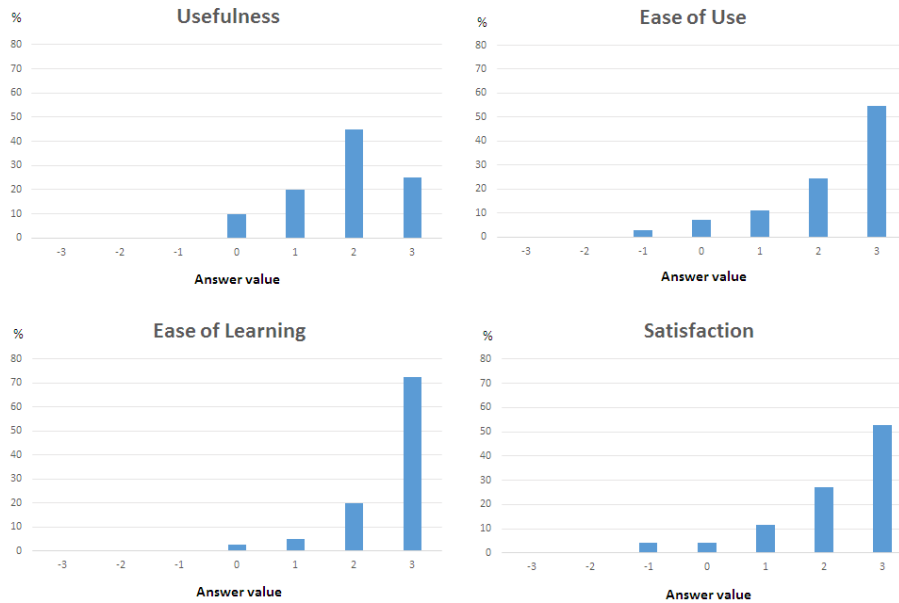
Fig. 5. Questionnaire results

6 Conclusions and Future Work

This paper presents an approach for the development of mobile games based on several screen and devices. The creation of multi-device games sharing information via a centralized screen is the type of game the approach aims to foster. We believe this approach constitutes a step towards the development of mobile multi-device and multi-screen games and an improvement for the entertainment community.

The approach was demonstrated by means of an example, the well-known Casino Roulette game. An evaluation of the game developed was accomplished with ten participants. The results of this preliminary user study has provided us with insights that have led us to believe that games following this approach might be well accepted.

As future work, further evaluations are needed both with end users and developers. The latter is important to demonstrate that the approach can be reused in the development of new games using this concept. Furthermore, the expansion of the approach to support devices using different operating systems (e.g. Android OS) and, its exploration in different contexts (e.g. in a car) is also intended. The possibility of making these multi-screen/device games available in on-line App Stores is being considered.

Acknowledgments

Appendix

I - Post-experiment questionnaire

	Strongly disagree		...		Strongly agree		
Subject characterization	-3	-2	-1	0	1	2	3
1. Age:							
2. Gender:							
3. Academic background:							
4. Do you often play computer games?							
5. Have you ever played the Original Roulette game?							
6. Have you ever played a game using more than one screen?							
Usefulness							
7. It meets my needs							
8. It does everything I would expect it to do							
Ease of Use							
9. It is easy to use.							
10. It is simple to use.							
11. It is user friendly.							
12. It requires the fewest steps possible to accomplish what I want to do with it.							
13. It is flexible.							
14. Using it is effortless.							
15. I can use it without written instructions.							
16. I don't notice any inconsistencies as I use it.							
17. Both occasional and regular users would like it.							
18. I can recover from mistakes quickly and easily.							
19. I can use it successfully every time.							
Ease of Learning							
20. I learned to use it quickly.							
21. I easily remember how to use it.							
22. It is easy to learn to use it.							
23. I quickly became skillful with it.							
Satisfaction							
24. I am satisfied with it.							
25. I would recommend it to a friend.							
26. It is fun to use.							
27. It works the way I want it to work.							
28. It is wonderful.							
29. I feel I need to have it.							
30. It is pleasant to use.							
Open Questions:							
31. Indicate what you consider the strong and weak points of the game.							
32. Other comments.							

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