ISLAMIC UNIVERSITY OF TECHNOLOGY

Gaming Insight: Conversion of Popular Sedentary Games into Motion-Based Form

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A thesis submitted in partial fulfilment of the requirements for the degree of Bachelor of Science in Computer Science and Engineering

Academic Year: 2017-2018

Department of Computer Science and Engineering

Islamic University of Technology.

A Subsidiary Organ of the Organization of Islamic Cooperation.

Dhaka, Bangladesh.

October 2018

Declaration of Authorship

We, Author list goes here, declare that this thesis titled, 'Gaming Insight: Conversion of Popular Sedentary Games into Motion-Based Form' and the work presented in it are our own. We confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.

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ISLAMIC UNIVERSITY OF TECHNOLOGY

Abstract

CSE

Department of Computer Science and Engineering

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Gaming Insight: Conversion of Popular Sedentary Games into Motion-Based Form

by Quazi Fahim Faisal Dhruba and Md. Mohsinul Kabir

Motion-based gaming can aptly substitute an individual's daily exercise requirements while being a great source of entertainment. Conversion of sedentary games into motion-based form can reach more gamers who are otherwise avoiding daily exercises. However, little research has been done on the factors to be considered to retain the same popularity as sedentary games. Hence, we developed the motion-based forms of two very popular sedentary games, Flappy Bird and Temple Run. We then conducted a study, which incorporated both of the games and involved a group of participants. By analyzing the user experience through feedback and observation, we determined the key factors involved in converting conventional games into motion-based form. Our study shows that if specific considerations are made, motion-based forms of sedentary games have the potential to be more or similarly appealing to users.

Acknowledgements

First and Foremost, We are grateful to Allah Subhanu Wata'ala for the good health and wellbeing that were necessary to complete this book.

We offer our sincerest gratitude to our supervisors, Hasan Mahumd and Prof. Dr. Md. Kamrul Hasan , who have supported us thoughout our thesis with their patience and knowledge whilst allowing us the room to work in our own way. We attribute the level of our Bachelors degree to their encouragement and effort and without them this thesis, too, would not have been completed or written. One simply could not wish for a better or friendlier supervisors.

In the various laboratories and workshops we have been aided for many days in conducting the experiments by all the stuff members of CSE lab. The smooth running of the experiments is much more a testament to their efforts than our own.

One vital part of our thesis was the experimental setup and collecting feedback of the participants. The participants of our experiments were students from first, second and third year students from the departments of Computer Science and Engineering, Software Engineering and Business and Technology Management. Their patience and helpfulness made our work easy. Every participants had to participate in the experiments for around forty minutes and they did it patiently. As there were about thirty participants attended our experiments, it is not possible to mention all the names. We appreciate all the participants' efforts that made our data collection procedure a successful one.

Ahsan Rezwan Sajid provided a friendly and helping hand during the development phase of the system. He used his knowledge of all the game mechanics and helped developing the games. Without his help, the system design and implementation phase would halt on many accounts. We appreciate his friendly nature, wit and look forward to working with him in the future.

The Department of Computer Science and Engineering has provided the support and equipment we have needed to produce and complete our thesis.

Finally, We thank our parents for supporting us throughout all our studies at University.

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Dedicated to our parents....

Chapter 1

Introduction and Background

1.1 Introduction

Regular physical exercise is very important for every individual. There is no debate regarding the numerous advantages of physical exercise for different age groups of people. Exercise is beneficial to psychological well-being, self-esteem, reduced risk of overweight and obesity [1]. Considering all these benefits, people should do at least 30 minutes of moderate-intensity physical exercise every day. However, most people do not perform the suggested amount of daily exercise despite the benefits. [4] In recent years, the number of playgrounds are also decreasing in a perilous manner [2]. Moreover, people being very busy in the status quo, do not get proper time to exercise on daily basis. A greater reason behind this is in fact people think 'exercise is uncomfortable and not entertaining' [5].

In the pursuit of entertainment, we observed that people from different age groups are extensively addicted to digital games. Currently almost 1.2 billion people play video games all over the globe [7]. However, most of the games they play are of sedentary form, meaning little or no physical activity is engaged in these games. Addiction towards these sedentary video games mostly results in elevated levels of anxiety and depression [9] and physical complications such as obesity [10]. Considering the popularity of conventional video games and lack of interest towards physical exercise, one solution in this regard can be to popularize motion-based gaming. Motion-based games are video games that facilitate to perform physical exercises with the help of technologies that tracks human body movements and reactions [11]. More precisely, motion-based games are a combination of physical exercise and video games [12]. If physical exercise can be incorporated with these video games to some extent, people would accept it for the sake of their attraction towards the video games. So in this paper we suggest to convert the popular games into their motion-based forms to engage more people in physical exercise.

Though there has been a revolution in motion-based gaming in the past decade, little research has been done on how to convert the popular sedentary games into their motion-based forms. There are many unexplored questions in this regard. Such as, reception of the motion-based form of conventional sedentary games among players, people's attitude towards the appropriateness of the translation of input mechanisms, key factors affecting the user experience in motion-based gaming, etc. Without knowing the answers of these questions, developers of motion-based games do not have the proper guidance on whether converting the popular games into their motion-based forms would be wise.

In our research, we try to shed light on this by converting two popular sedentary games into their motion-based form. We chose two very popular games for evaluating the game play experience: (1) Flappy Bird, (2) Temple Run. We used a depth camera (Microsoft Kinect v1.8) to capture the player's movements and gestures and used it in the game play. Players are not required to hold any kind of controller but can move around freely within a certain distance of the camera.

We developed both the sedentary form (played on android device) and motion-based form of the two games. To conduct the experiment, we chose our participants from a specific age group (18-30 years) who are mainly obsessed with video gaming, so that we can truly evaluate and compare between the game play experiences. Through the experiment session, we garnered participants' response by questionnaire and interview and tried to find the factors of motion-based games affecting the user experience.

The main contributions of our research are: 1) We show that converting motion-based form of popular sedentary games is necessary and widely accepted by the participants. 2) We present the prominent factors affecting the user experience while playing the motion-based games. 3) Based on our results and collected feedback, we provide design insights for motion-based games of popular game formats, and we discuss how our findings can help designers to design motion-based games in the future.

This thesis is structured as follows: first, we show the importance of this research by offering a background study and discussing the existing researches. Next, we describe our developed games and experimental setup. We follow the PENS [34] and IMI [35] methodologies and discuss the result with respect to the key factors involved in affecting the user experience we discovered. We conclude this paper by summarizing our plans for future work and by stating the contribution that this paper makes.

1.2 Background

Previous studies have shown that video games incorporated with physical exercise can increase motivation and lead to physiological well-being. They have potential to improve health and fitness and can also be used in rehabilitation for different kind of disabilities and disorders [3, 6]. However, the available selection of motion-based games is very constrained. Here, we review the existing motion-based games, general design guidelines for motion-based games and identify current limitations in existing researches that our research aims to address.

1.2.1 Benefits of motion-based gaming

Sedentary lifestyle often leads to obesity, overweight and a severe risk of diabetes [13]. In the United States of America alone, adult obesity rates have exceeded 35% in seven states according to the most recent Behavioral Risk Factor Surveillance System (BRFSS) data. According to World Health Organization, obesity and overweight has become a global epidemic with over 1.9 billion adults affected by it [14]. Sedentary lifestyle can also lead to depression and low self-esteem [15].

Though the suggested amount of daily physical exercise by the experts is only about 30 minutes, people are reluctant to perform this amount of exercise on a regular basis [4]. Motion-based gaming can help retaining people's attention towards physical exercise. Incorporating physical exercise in screen activities such as video gaming has helped preventing obesity [16]. Courtney et al. [17] showed in their research that motion-based games can provide physical activity levels similar to that of unstructured activity.

Motion-based gaming can also provide cognitive benefits. Yue et al. [18] addresses playing a motion-based game multiple times a day in short bursts improves the affective states of the player, which produces similar exertion levels as treadmill exercise, but is perceived as more fun.

1.2.2 Existing Sedentary and Motion-based games

According to statistics, there are over a billion people all over the world involved in playing video games [7]. Most of these games do not include body movements other than only finger movements like Teris (www.tetris.com), Minecraft (www.minecraft.net/en-us) etc. We selected two sedentary games to convert into their motion-based forms based on their wide popularity. Temple Run 2 was downloaded more than 20 million times in four days [19]. It also holds an aggregate score of 84% (www.gamerankings.com). Flappy Bird was the most downloaded free game in the App Store for iOS at the end of January, 2014. Though it was removed from both the appstores of iOS and android by its developer, it is still played by millions by pebble app versions [20].

Game technologies involving physical activity have been made commercially available, like Konami Dance-Dance Revolution (www.konami.com/games/ddr). This is a dancing pad with arrows, on which users step to control the game. Another product is Nintendo Wii (www.nintendo.com/wii) which uses an accelerometer-equipped input device, allowing users to control the game by their body movements. PCGamerBike (www.pcgamerbike.com) is a programmable controller using bicycle pedaling motion to control the game. Whitehead et al. did a survey of exergames with Nintendo Wii, Sony's EyeToy and traditional sedentary games in 2010 and addressed that motion-based games may help to minimize the threat of childhood obesity and sedentary related diseases [21]. Being commercial products, all of the above, generally provide bodily interfaces to interact with computer games rather than to motivate users to perform physical activity while playing.

1.2.3 Existing Design Guidelines for Motion-based Games

Sinclair et al. [22] proposed design implications to develop successful motion-based games such as the physical difficulty level of the exercise needs to be adjusted to maintain the required heart rate parameters (intensity) and the exergame must be playable for the required time period (duration). In addition, the activity must be captivating enough to have the player return to it on a regular basis (frequency). Rongkai et al. [23] developed two exercise-based interfaces for a car racing game and after evaluation, offered general guidelines for converting common classes of sedentary games to exergames such as mapping the movements in the game with the goals of an exercise. However, their study was limited in scope due to its focus on one single game. Several studies have been conducted for rehabilitation purposes targeting different age groups. Gerling et al. [24] presented a study evaluating sedentary and motion-based game controls comparing the game-play performance between younger and older adults. They developed a test bed game that supports four different devices that are commonly used for game input: Traditional mouse input, the Microsoft Xbox 360 GamePad, the Sony PlayStation Move controller, and the Microsoft Kinect sensor. They evaluated performance and experience among older adults when completing three different in game tasks- pointing, tracking and steering tasks with four game controllers. According to their study, the older adults demonstrated a more positive attitude towards motion-based game controls and statistical result of their experiment shows that motion-based game controls are suitable for older adults, offering an alternative to sedentary input devices. Mandryk et al. [25] proposed seven game design guidelines for full body motion controls for older adults such as age-inclusive game design, continuous player support, easy gesture recall etc. These studies considered a limited age group (older adults) which limited the applicability of their study. Alankus et al.'s[26] guidelines include: simple games should support multiple methods of user input, calibrate through example motions, ensure that users' motions cover their full range, detect compensatory motion, and let therapists determine difficulty. Floyd et al. [27] focuses on establishing a universal framework and outlining six rules that is advised to be maintained while designing exertion games such as providing an easy entry into play, implementing achievable short-term challenges to foster long-term motivation, offering adequate challenges that match individual skill levels etc.

All the previous works have shown that motion-based gaming can increase motivation which can be further enhanced by adhering to the proposed design guidelines presented in their works and this has been very successful. However, there are some inadequacy in those researches: (1) Most studies have been conducted targeting a small age group, which results in lack of universal guidelines for motion-based game designing (2) Severely limits game choice, which would have negative long term implications for maintaining motivation, (3) Proposed design guidelines mostly focuses on game mechanics rather than addressing interaction design which stalls to make the motion-based gaming more popular among people of all ages.

Chapter 2

Game Development for Study

Two separate versions, sedentary and motion-based, of two individual games, "Flappy Bird" and "Temple Run" were designed and developed to assess the user experience. The sedentary version of the games were developed for Android while the motion-based version of the games were developed for Windows.

2.1 Implementation and Controller mappings

Both versions of both games were developed using the Unity Engine (Unity 5.5.1f1) with scripts written in C#. The sedentary version was burned for Android while the motion-based version was developed for Windows. Motion-based version of both games utilizes the Kinect 1.8 for Windows sensor to detect gestures performed; this enabled us to use the 20 different gestures that can be detected by the Kinect SDK for unity engine, in order to trigger in game actions.

The two games differ in terms of their virtual game environment. "Flappy Bird" has a 2D environment with game assets being placed on the XY plane, while "Temple Run" has a 3D environment allowing movement and perception of all X, Y and Z axes.

2.2 Gesture and Game Mechanics

Flappy Bird and Temple Run both employ various gestures in the motion-based form to enable the player to achieve the same goals as in the sedentary forms.

2.2.1 Flappy Bird

A bird of predominantly green color is placed in front of a colorful background with mountains, trees and cloud. The bird continually moves in the Y axis to simulate motion while the player must interact to make the bird move upward. The bird has "weight" which causes it to fall downwards if not made to move upward. All elements are placed on a 2D plane. Figure 1 gives an overview of the game environment of Flappy Bird.

In game Task

Make the bird avoid obstacles: Rectangular obstacles are made to randomly appear which the player must make the bird avoid by making the bird jump over or letting it fall under them. In the sedentary version of the game, the player must tap the screen to make the bird move upward and avoid the obstacles. The bird colliding with an obstacle would result in termination of the game.

Ensure the bird does not fall to the ground: The game also terminates if the bird falls and collides with the ground. Therefore the player must periodically make the bird move upward to ensure it does not hit the ground.

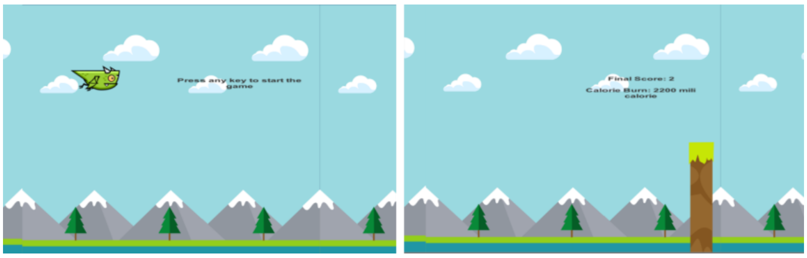

Figure 1 Game Screenshots of Flappy Bird, showing the game environment and performance statistics (score and calorie burned).

Gesture Selection

In the sedentary version, there is only one way for the player to interact which is by tapping the screen and making the bird move upward. Consequently, to keep the motion-based form consistent with the sedentary version, the Jump gesture was used to cause the same in game action to occur.

2.1.2 Temple Run

This is an endless running game. We felt the endless nature of the game would make the player feel more relaxed. In the game, an avatar with yellow costume runs on an ancient bridge filled with mosses in a dark background with obstacles appearing at random intervals. The avatar runs along the middle of the bridge without any effort of the player. This game is set in a 3D environment and has a more varied list of tasks to be performed. Figure 2 gives an overview of the game environment of Temple Run.

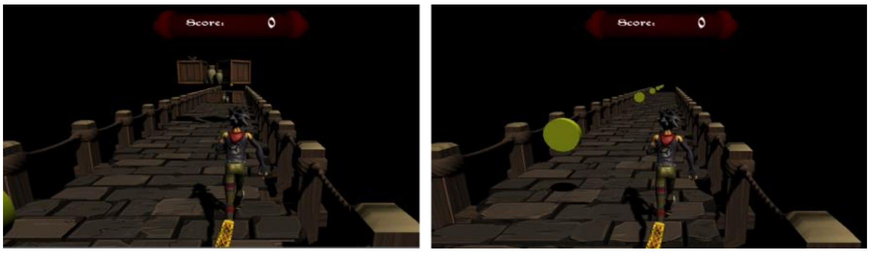

Figure 2 Game screenshots of Temple Run, showing the game environment, avatar and obstacles.

In-Game Tasks

Collect coins: Coins randomly appear on the bridge to the left and right, which may be collected by moving to the left and right that results in an increase in points.

Avoid the obstacles: The obstacles that appear require the avatar to either jump over or slide under them depending on the position of the obstacles (ground and floating). Collisions with obstacles result in a lowering of the score.

Gesture Selection

The four movement of the avatar described above have been mapped on to specific gestures in the motion-based game and are described below while figure 3 shows 3 of the 4 gestures being performed.

Raise Left Hand: In the android version a left swipe would move the avatar to the left. This action was triggered by raising the left hand in the motion-based form.

Raise Right Hand: In the android version a right swipe would move the avatar to the right. This action was triggered by raising the right hand in the motion-based form.

Jump: In the android version an upward swipe would cause the avatar to jump. This action was triggered by an actual jump by the user in the motion-based form.

Squat: In the android version a downward swipe would cause the avatar to slide. This action was triggered by a squat by the user in the motion-based form.

Chapter 3

Study

Using the games developed we studied the effect on user experience of playing the motion-based form of the sedentary games.

3.1 Participants and Procedure

Twenty-seven individuals participated in our study - 27 young adults (8 female; 22 male; mean age = 19.77, SD = 0.84, range = 18 to 30). None of the participants reported any motor problems that would have influenced participation in this study. 14 individuals were moderate gamers (around 1-2 hours per week), 13 were casual gamers (less than 1 hour per week) and 3 were avid gamers (more than 2 hours per week). When asked to respond to a Likert scale [28] which represented how frequently they engaged in physical activity/exercise per week (1 = Never, 5 = Very Often), the responses revealed a mean of 2.9 with SD = 0.66). None of the participants had experience using the Kinect. The participants participated in individual sessions where they had no contact with other participants in a within-subject experiment design. All sessions were audio and video recorded to be analyzed later.

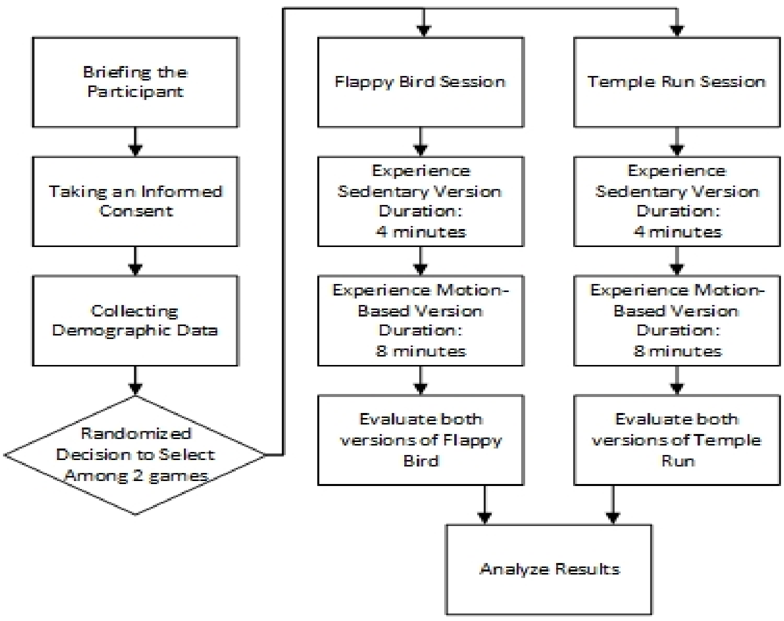

Figure 4 Overview of experiment structure

The participants were solicited through a public notice which instructed individuals interested in participating in the study to contact the researchers. The specific individuals were chosen to represent the demographic that is most involved in playing video games. Each participant was explained the overall structure of the experiments and presented with the list of gestures that they would be required to perform. Individuals that had reservations about performing any of the gestures were replaced.

After completing an informed consent, participants were asked to fill out a demographic questionnaire to assess prior gaming experience and how frequently they engaged in physical activity.

Figure 3 Images of three of the four gestures required in Temple Run. Raise left hand, Jump and Squat (L-R)

The experiment was divided into two parts; the first part asked the participants to evaluate their experience of the two versions of Flappy Bird and the second part asked the participant to do the same for the two versions of Temple Run. It was randomly decided which part the individual would participate in first. In each part the participants were asked to play the sedentary version of the game for 4 minutes (5 tries for Flappy Bird), during which the participants were allowed multiple tries if they had collided with obstacles. After the 4 minutes were over, the participants were asked to stop playing and allowed a 1 minute break. After the break, the participants were introduced to the motion-based form of the game, instructed on how to play, and allowed to play the game for 8 minutes. During the 8 minutes the participants were allowed multiple tries. The specific time mentioned was chosen as it was seen in initial sessions that participants took around 3-4 minutes to adapt and become familiar with the motion-based form of the game. A further 4 minutes was allowed to perform performance evaluation. Once the 8 minutes were over, he/she was asked to respond to a questionnaire which implemented Likert Scales to assess the participant's opinion of certain factors (which were analyzed based on factors illustrated in prior research [29, 30]) based on the experience. Two separate questionnaires were asked to be filled out for the two parts. An overview of the experimental structure is given in Figure 4.

3.2 Setting and Apparatus

The sedentary version of the games were asked to be played on an Android smartphone (Samsung Galaxy S8). This was done to ensure it was consistent with how the game is normally played. The motion-based version of the games were run on a Windows 10 PC connected to a projector which produced an image of 1.90 meters (diagonal). The participant was asked to stand at a distance of about 2 meters from the Kinect sensor, which was placed at around waist level of the participant, in proper lighting conditions.

3.3 Data Collection and Analysis

We collected user feedback in a number of ways. Two separate questionnaires were used; one to collect demographic data and another to collect feedback on user experience. The questionnaire used to collect feedback on user experience employed Likert Scales from 1 to 10 (1 = Strongly Disagree, 10 = Strongly Agree) where the participant was required to respond based on several statements provided. The statements given were kept consistent with factors discussed in PENS (Player Experience of Need Satisfaction) [29] and IMI (Intrinsic Motivation Inventory) [30]. Additionally, a few statements addressed factors and issues unique to motion-based games. Mean and Standard Deviation of all responses were calculated to help interpret the overall opinions expressed in the responses. Performance of the participants were recorded automatically through the game. The participants were also interviewed on their experience to gain a more elaborate insight.

During result analysis we compared the two games keeping the following factors discussed in PENS and IMI in mind:

- Immersion – We wanted to judge the participant's affinity towards being involved and engaged with the game environment.
- Intuitive Controls – We wanted to judge the suitability of the gestures and the participants' ability to perform said gestures.
- Interest-Enjoyment – We wanted to evaluate how motivated participants were in consistently engaging themselves in playing the motion-based form of the game.
- Ease of Play – We wanted to deduce how each game was accessible to the user.

Chapter 4

Result Analysis

4.1 Questionnaire Results

Participants were asked to rate their interaction experience on a 10-point Likert scale in response to statements in the questionnaire, few of which are given in Table 1. The questionnaire revealed that most individuals found the motion-based form of the game more enjoyable, upon further discussion it was revealed that the familiarity of the game played an important role. Consequently, most participants also expressed that existing sedentary games should be converted to their motion-based forms. In the Flappy Bird game, the players were shown the approximate amount of calories they had burned during their playing session; when asked to respond, if they found this motivating, an overwhelming percentage of participants responded positively (Mean: 9.30, SD = 0.99).

No.	Items	Flappy Bird		Temple Run	
		Mean	SD	Mean	SD
1	The motion-based form of the game was more enjoyable as I was familiar with the sedentary version.	8.33	1.82	8.52	1.50
2	I want more sedentary games to be converted to motion-based forms	8.22	1.58	8.63	1.67
3	I played the game for fun more than physical exercise	7.30	2.07	7.26	1.95
4	Defeating my peer’s score was more satisfying in the motion-based form of the game	7.66	2.08	8.30	1.79
5	I should be able to remap the gestures required from a list of gestures at the start of the game	8.89	1.60	8.48	2.00

6	The movements required for the game should be more intense	6.66	2.63	6.85	2.27

Table 1 Table of specific questionnaire questions regarding key issues and their responses' Mean and SD. Responses were based on a Likert Scale, where 1 = Strongly Disagree, 10 = Strongly Agree.

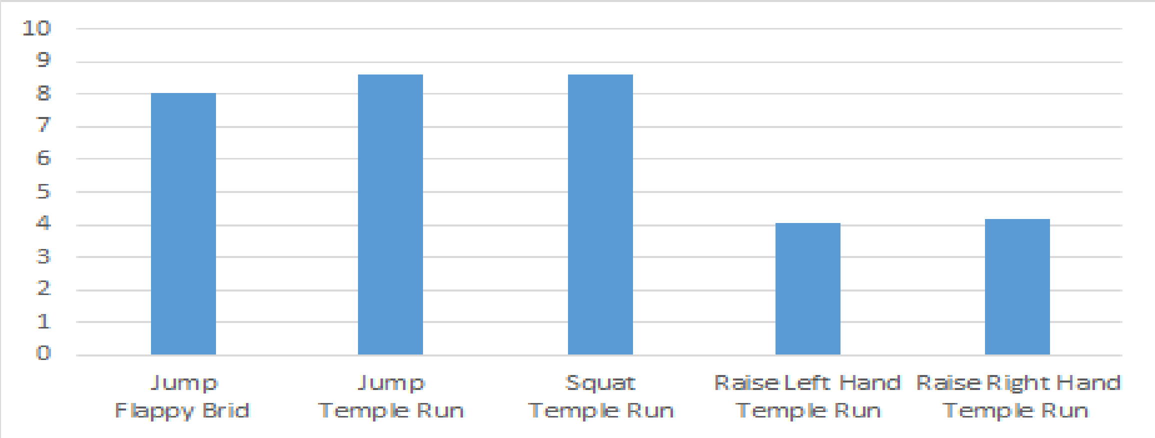

Figure 5 Graph comparing the suitability of each gestures in the games according to participant responses.

When asked to judge the input gestures, it was revealed that gestures that resembled the movement of the character/avatar on screen were well received whereas the gestures that triggered movements/actions that were not similar were seen as not suitable. This is illustrated in the participants' responses, to being interviewed, that were similar to the following: "Raising my left hand to move the character to the left was weird, it would have been better if I was required to move my entire body to the left instead". Figure 5 also illustrates the difference in suitability between the gestures as represented by the data collected through the questionnaires.

4.2 Performance Metrics

Performance of the participants were recorded by the system in terms of number of tries (in Flappy Bird), required time for participants to consistently perform detectable gestures and in-game score. In the Flappy Bird game, 19 out of the 27 participants needed three tries to properly have the system detect their jumps continuously. While in Temple Run, on average 34 seconds of play were required before the players could continuously have their gestures be detected. It was also noticed that relatively tall participants (above 1.73 meters) were having difficulty performing detectable gestures.

4.3 Observations

Quite a few observations were made when interviewing the participants. A persistent comment from the participants was regarding the distance the bird, in Flappy Bird, moved when the participant jumped. They suggested that the distance the bird moved upward be representative of the intensity of the participants' jumps instead of a fixed distance as illustrated by the following response: "If I jump higher the bird should move higher." Overweight participants (categorized through calculation of BMI, by utilizing height and weight data) showed significant enthusiasm in playing the motion-based games. A participant had excitedly pointed out: "It was so entertaining. I would like to play this on regular basis. If I could score even 5 every day, I would worry less about my diet plan to lose weight." This demonstrated possible long term appeal of the games especially for individuals looking for an entertaining alternative to traditional exercise.

When asked if the frequency of obstacles were appropriate, the participants pointed out that, initially the obstacles should be sparse as a certain amount of time is required to adapt to the gestures; but as the game progresses, the obstacles should be more frequent but not to an extent that makes the player exhausted. There was also great enthusiasm shown by the participants in beating their peers' score. There were several instances where participants requested additional session for playing the game so that they may be able to beat the score and we noticed participants being visibly disappointed if they were unable to do so, while being elated if they were able.

4.4 Summary

The responses from the participants to the questionnaire and the interview were analyzed. Figures summarize the responses. Upon further discussion with the participants during the interviews several conclusions were drawn with regards to the factors given below:

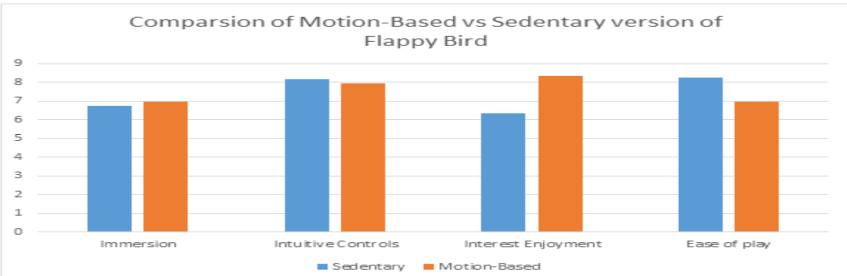

Figure 6 Graph comparing the sedentary and motion-based version of Flappy Bird with respect to key factors.

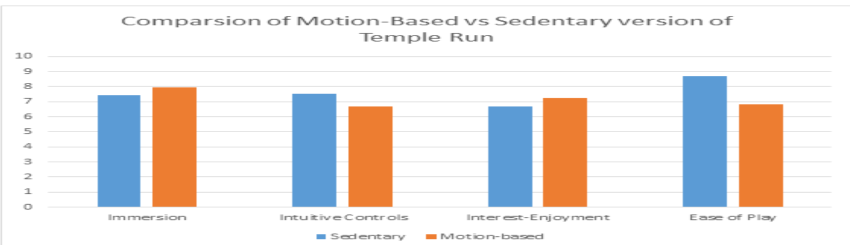

Figure 7 Graph comparing the sedentary and motion-based version of Temple Run with respect to key factors.

4.4.1 Immersion

Participants felt immersion was better in Temple Run as there was a 3D environment, which especially helped perceive motion. While in Flappy Bird, the 2D environment caused a less immersive experience. The lack of immersion in Flappy Bird was also attributed to static nature of the in-game elements. The motion-based version of both the games were perceived as being more immersive in comparison to the sedentary version. (Data Visualized in Figure 6 and 7).

4.4.2 Intuitive Control

When comparing the motion-based version of the games, it was noticed that the participants felt the motion-based version of Flappy Bird had more intuitive controls; this was attributed to the perceived inappropriate translation of two input actions discussed previously. Both the sedentary versions had more intuitive controls compared to the respective motion-based forms due to participants' familiarity with the input methods. (Data Visualized in Figure 6 and 7).

4.4.3 Interest-Enjoyment

While the familiarity of the sedentary versions resulted in prolonged interest from the participants in the sedentary versions, a greater amount of enjoyment was derived from the motion-based forms. Interviewing the participants also resulted in the conclusion that showing the amount of calories burned in Flappy Bird resulted in motivating the participants and keeping them engaged. (Data Visualized in Figure 6 and 7).

4.4.4 Ease of Play

Both sedentary versions of the game were seen as easy to play, due to the familiarity associated with not only the games themselves but also the input methods. Consequently, motion-based versions were perceived as requiring greater effort due to additional steps required to set up the game and the lack of familiarity to the gesture based input mechanism. (Data Visualized in Figure 6 and 7).

Chapter 5

Findings

Our study yielded several significant findings. Each finding was derived from the data collected in our experiments, participant responses during post experiment interviews and observations made. The findings given below, are categorized as factors and design considerations that should be kept in mind to enhance the user experience of motion-based forms of sedentary games.

5.1 Factors affecting user experience

The factors listed here have been deduced from our results to have the greatest effect on user experience:

5.1.1 Role of familiarity

In our study, it was clearly revealed through the data collected that the participants found the motion-based form of the games more enjoyable due to the participant being familiar to the sedentary version (Table 1, Item 1). This can be extrapolated to deduce that the positive experience gained by players of popular sedentary games have the potential to positively affect the acceptance of the motion-based form of those specific games. Results further show that players want motion-based forms of more popular sedentary games (Table 1, Item 2). Players show greater comfort once they realize that the motion-based form is set in a familiar environment but at the same time are intrigued by the possibility of rediscovering the game through a new way of interaction.

5.1.2 Appropriate game environment and mechanics

The need for an appropriate game mechanics cannot be stressed enough regardless of the kind of game being developed. But our data specifically shows how it is crucial in motion-based games. In Figure 5, it is illustrated how participants found certain gestures to be not suitable. This underscores the need for the in game action triggered by a specific gesture be consistent to how the gesture itself is performed. Otherwise, there is a considerable disconnect between the user's perceived in game action and the actual in game action that is triggered.

5.1.3 Variable game difficulty

We noticed how there was always an initial period of time required for the participants to acquaint themselves with the mechanism of the game. Therefore, the difficulty of the game should be low in the initial stages. As the game progresses, while it should get increasingly difficulty, the rate at which this occurs should not be the same as in the sedentary form. This is due to the player experiencing physical fatigue as the game progresses which also contributes to the player finding it harder to keep playing the game. Therefore, mimicking the progression of the sedentary form in the motion-based form is not advised.

5.2 Design Considerations

We believe if the specific design considerations given below are kept in mind when developing motion based versions of sedentary games, they will lead to a better user experience, as our research has shown:

5.2.1 Freedom in gesture selection

It was overwhelmingly observed in our study that players prefer to be given the freedom to modify the specific gestures that trigger specific in game action (Table 1, Item 5). This is due to several factors. Often difficulty is faced by players in performing specific detectable gestures. Had this difficulty been consistently faced by individuals for a specific gesture, it would have been justified to specify a gesture that has a better rate of detection. But, it has been observed that errors in detection may happen for any gesture and it varies from one individual to another. This can be attributed to the player's inability to perform the gesture or other factors such as, height of the player, clothing worn by the player, etc. Therefore, to enable an experience where the player is able to smoothly interact with the system, it is important for developers to give players the freedom to choose the gesture they are comfortable in consistently performing.

5.2.2 Gesture implementation incorporating intensity

In our study, it was consistently pointed out by the participants that human gestures are not binary, they do not have only a complete and an incomplete state. Rather they vary in terms of both completion and intensity. This needs to be reflected in the way the in game elements respond to the player's gestures. For example, if a jump performed by the player causes an in game element to move upwards, the distance of that movement should properly represent the intensity of the player's jump. This would enable the player to feel more in control of the game environment and contribute towards a better user experience.

5.2.3 Inclusion the display of quantitative measure of physical exertion

While physical exercise is not the primary focus of players when playing the motion-based form of sedentary games (Table 1, Item 3); our results show that if a quantitative measure (e.g. calorie burned) of physical exertion is shown to the players, during or after the gameplay session, it has the potential to greatly motivate the players to regularly engage themselves in playing the motion-based form.

5.2.4 Incorporation of multiplayer gameplay

As illustrated by the data from our experiments (Table 1, Item 4), players find interactions between them and other players more rewarding in the motion-based form. We noticed quite an intense emotional response from players depending on how they performed in relation to their peers, this points towards the need for a competitive environment in motion-based forms in order to keep players engaged and motivated. Therefore, incorporation of multiplayer gameplay has significant potential to enhance the user experience.

Chapter 6

Conclusion

There is scope for greater extensive work to better understand the dynamics involved when making motion-based forms of sedentary games. Specifically, several suggestions put forth in this paper have scope for further exploration through proper implementation, for example, a remappable gesture implementation and variable in game response to variable gesture intensity. These suggestions, once implemented can yield further insight, upon more study and experimentation.

In our study, we have developed the motion-based form of two very popular sedentary games and have collected user feedback through multiple channels from a group of participants who were allowed to play and experience the games in a controlled environment. Analysis of our results have led to formulation and realization of several design considerations that have been shown to have great importance in enhancing the user experience. Our research helps us conclude that when motion-based forms of existing sedentary games are developed, they have potential to be better received and more enjoyed by players. The research presented in this paper lays the foundation for further exploration into the dynamics and nuances involved in designing and developing motion-based forms of sedentary games. In light of the benefits and untapped scope of motion-based games, it is increasingly important to allocate research efforts in this area.

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