B.Sc. (Hons) in Software Development

Ollscoil Teicneolaíochta an Atlantaigh

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Biometric Data Analysis in Digital Game Scenario

By
OTITO MBELU

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Minor Dissertation

Department of Computer Science & Applied Physics,
School of Science & Computing,
Atlantic Technological University (ATU), Galway.

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Chapter 1

Abstract

Background and Objective The aim of this project is to analyze the relationship between the fitness status of a gamer and their performance in a digital gaming scenario. And if such relationship could be established, to determine which features affects their performance and to what degree do they contribute to their performance. Various biometric and fitness data were considered and used fo the analysis based on their suitability for capturing relevant fitness features that correlate to on's physiological state. Heart rate variability (HRV), Average Heart Rat, maximum Heart Rate, Active Steps and quality of sleep are the features under consideration.

A test game designed to measure and capture user's performance in a first-person shooter gaming scenario was used. Three basic metrics where chosen to measure user performance. They are Fine Motor Test, Visual Test and Audio Test. The Fine motor test captures the average tracking time and accuracy for engaging targets, the Visual Test captures the average response time, average tracking time and accuracy while the Audio Test captures user's response time.

Chapter 2

Introduction

First person shooter games represents the class of games where the player views the environment through a viewport and can perform such actions as looking around, moving around, aiming and firing of weapons. these actions are accomplished using various button or combination of button.

During a typical gameplay, players are confronted with other opposing players and are required to eliminate their opponents using various weapons available while evading enemy fire. To successfully compete in such a scenario, players are expected to react fast, effectively track targets, accurately hit targets, perceive sound and accurately map them to a location within their environ.

The primary objective of this research work is to formulate a metrics that can accurately measure users performance in the such scenario and compare their performance with their fitness data with the aim of finding a correlation between performance and physiological state.

2.1 Background

PUBG: Battlegrounds (previously known as PlayerUnknownś Backgrounds) is a battle royale style player versus player (PvP) shooter game developed by PUBG Studio. Players face-off with each other using various types of battlefield weapons in a last man standing deathmatch and the last person to remain alive wins. The game is available in all major platforms and as of March 2021, the mobile version of the game has accumulated more than a billion download outside of China with revenue of over $9billion while the PC and console versions have accumulated a total revenue of $4billion [?].

Since its first release in 2017, the game has since become one the fans favorite and has over '350,000' peak concurrent monthly users [1]. As a multiple award-

[1] statista

winning game with proven longevity records and a large community. Interest in the game cut across diferent demography and is equally far-reaching across the globe. The game playing scenario requires players to face-off with other players and there is where some skills like 'eye-hand-coordination', 'ear-hand-coordination', 'fine-motor' skills, etc: are required to compete favorably against other players. Players have access to a varieties of weapons with different capabilities and can make in-game adjustments to their control to suite their various preferences.

This project is a continuation of research work previously done by Fourth Year Software Design Students titled 'Biometric Data Collection for Performance Optimization in a Digital Game Scenario' in collaboration with the Department of Sports & Excercise Science, Atlantic Technological University. The originiating project titled **'Biometric Data Collection for Performance Optimization in a Digital Game Scenario'**, posed the question 'can a playerś biometric data be used to optimize their performance in a first-person shooter game'? And a subsequent follow up project which sought to create a Chart API capable of displaying all relevant information previously displayed on different pages on a single page.
The former research was geared towards creating a platform for collecting performance data in a similar scenarios (Weapons, controls, user perspective, ect:) obtainable in PUBG :Battlegrounds in the form of a Unity Desktop `Application`. Collection and storage of Biometric data from an `Activity Monitor` in the form of a `Smart Watch`. With the eventual goal of finding correlation between their performance and their Biometric data.

2.2 Performance Metrics

For the purpose of measuring users performance in in a first-person shooter game scenario, three categories of metrics where developed to measure users performance. They are listed as follows: Fine-Motor Control, Visual metrics and Audio metrics.

2.2.1 Fine Motor Control

Fine motor refers to the controlled and coordinated incremental movements made by the hand when handling items. This metrics assesses how quickly users are able to adjust their aim to targets appearing on the screen. Two take away from this classification is the Response Time (seconds) which quantifies reaction time and Accuracy (%) which quantifies users fine adjustment capabilities.

2.2.2 Visual Reflexes

The game scenario under study for most of the time involves users having multiple legitimate targets to shoot, and having to engage them simultaneously. This metrics accesses users visual reflexes by considering the Target Accuracy which is the measure of the number of successful targets hit with the total number of target spawned expressed in percentage. Shot Accuracy which is the measure of the number of successful shots to the number of targets hit. Finally the Average Response Time which is the average time it takes for a target to appear before being hit.

2.2.3 Audio Reflexes

User audio reflexes are accessed using the Response Time, which measures the time it takes to identify the source of a sound within the users environment

2.3 Biometric Data

The collection and analysis of biometric data play a significant role in understanding the relationship between physical fitness and gaming performance. This research aims to investigate how various physical parameters, such as HRV (Heart Rate Variability), Heart Rate Max, Heart Rate average, Active Sleep and Quality of Sleep, influence a user's performance in a digital game, in this case PUBG: Battlegrounds. The research will also explore the potential of using biometric data to suggest the most suitable settings for different game scenarios. By using wearable technology, which can monitor metrics such as heart rate, sleep, and activity, this study seeks to establish a correlation between the player's physical condition and their performance in a digital game scenario. The importance of fitness data in this context cannot be overstated. Heart Rate Variability (HRV), maximum heart rate, active sleep, and sleep quality are all essential indicators of a person's physical condition. THese metrics offers a comprehensive insight into the user's physical condition, which can be used to improve their gaming performance.

2.3.1 Heart Rate Variability (HRV):

is a measure of the variation in time between each heartbeat, and it is closely linked to the body's stress levels. HRV is widely used as a measure of the body's autonomic nervous system, which controls the body's stress response. A higher HRV is associated with a lower stress level, while a lower HRV is associated with a higher stress level. A research from E. Ortega[**?**] highlights the importance of HRV in sports science, as a way of understanding the psychological state of

atheletes before competions. It found a positive correlation between HRV, self-efficacy, and performance among sport shooters. Advanced shooters demonstrated lower average heart rates and employed mental skills more effectively than less experienced shooters. This suggests HRV as a valuable asset, when tranferring the psychological state of the athlete to the performance in a digital game. It allows for a better understanding of the player's stress levels, and how it affects their performance. This personalized approach can enhance player experience, and potentially improve their performance in the game.

The Heart Rate Variability measurements typically requires a chest strap, and measurements typically span from 5 minutes to 24 hours, it is commonly used in clinical settings to evaluate cardiac conditions.[?] Short-term HRV analysis lasting less then 5 minutes have been proven to provide more accurate estimations compared to longer measurements.[?] Based on this, the research will focus on short-term HRV measurements, as it is more practical for the user, and it provides accurate estimations. It will be more detailed in the methodology section.

Heart Rate Max: is the maximum number of times the heart can beat in a minute, and it is a measure of the body's cardiovascular fitness. It is an important indicator of the body's physical condition, and it is used to evaluate the body's ability to perform physical activities, reflecting their cardiovascular fitness. In this research, understanding HRmax is vital for assessing participants fitness and endurance. It could indicates how well players can handle stress and maintain their concentration over extended periods of time. By analysing alongside other biometric data this research could uncover valuable insight into optmizing players performance in a digital game scenario.

Heart Rate Average: is the average number of times the heart beats in a minute, and it is a measure of the body's physical activity. It is also an important indicator of the body's physical condition, and it is another measure of the body's cardiovascular fitness. It is used to evaluate the body's ability to perform physical activities, reflecting their cardiovascular fitness.

Active Step: Active steps, as a mesure of physical activity, is an important indicator of the body's physical condition. It is used to evaluate the body's ability to perform physical activities, reflecting their cardiovascular fitness. Counting the numbers of steps taken daily can help track overall physical activity, and it is a good indicator of the body physical condition. It is also used to evaluate the body's ability to perform physical activities, reflecting their cardiovascular fitness.

Quality of Sleep: are important indicators of the body's recovery and readiness for physical activity. Active sleep is a measure of the body's physical activity during sleep, and it is an important indicator of the body's recovery and readiness for physical activity.High-quality sleep, marked by sufficient duration and minimal disruptions, is fundamental for overall health impacting mood, cognitive

function. A research that evaluated Sleep and performance in Eathletes [?] uderscores the critical role of sleep in Eathletes performance in Esports, showing its impact on cognitive functions as a crucial factor for competitives success. Adequate sleep improves information processing, visual motor functioning, attention, working memory, and other functions essential for decision-making and reaction time. On the other hand, sleep depravation can significantly impair these cognitive abilities, potentially to poor performance. For this research it proves the importance of sleep in the context of gaming performance, and how it can be used to predict the player's readiness and tune their performance in a digital game scenario.

2.4 Classification Model

2.5 Regression Model

Chapter 3

Methodology

Describe the way you went about your project. Was your approach to the problem valid? You need to discuss both your software development methodology and your research methodology.

Chapter 4

Technology Review

This chapter is the literature review part of the dissertation and should be tightly coupled to the context and objective from the introduction. A thorough Technology Review proves that you researched what you were doing!

Chapter 5

System Design

Provide a detailed explanation of the overall system architecture Use UML, system architecture diagrams, screenshots, code snippets and algorithms to illustrate your design.

5.1 Working with Images

You can embed an image in a LaTeXdocument using the technique shown below. System diagrams and images with a small numbers of colours (100s, not 1000s) should be stored in PNG format. Although LaTeXdoesn't care where you place your images, it is good practice to place them in a single sensible directory and apply some sort of hierarchy to them, e.g. the path images/chapter1 might contain all of the images for Chapter 1 of your dissertation.

Figure 5.1: System Architecture.

Note that LaTeXwill place the image wherever it deems fit. Don't bother trying to change where a table or figure is placed until your document is ready for final layout.

Chapter 6

System Evaluation

Evaluate your project against the objectives set out in the introduction. This chapter should present results if applicable and discuss the strengths and weaknesses of your system. This is a clear opportunity for you to demonstrate your critical thinking in relation to the project.

6.1 Working with Tables

Note that LaTeXwill place the table wherever it deems fit. Don't bother trying to change where a table or figure is placed until your document is ready for final layout.

Hexadecimal to Binary					
Hex	Binary 2	Hex	Binary	Hex	Binary
1	00000001	B	00001011	15	00010101
2	00000010	C	00001100	16	00010110
3	00000011	D	00001101	17	00010111
4	00000100	E	00001110	18	00011000
5	00000101	F	00001111	19	00011001
6	00000110	10	00010000	1A	00011010
7	00000111	11	00010001	1B	00011011
8	00001000	12	00010010	1C	00011100
9	00001001	13	00010011	1D	00011101
A	00001010	14	00010100	1E	00011110

Table 6.1: Conversion from Hexadecimal to Binary

Chapter 7

Conclusion

Briefly summarise your context and objectives. Remind the reader about the overall rationale and goals of the project. Highlight your findings from the System Evaluation chapter.