Technical Resource Allocation in Unity: Optimizing Frame Rates and Player Experience

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Abstract

This paper presents the findings of a study focused on investigating the impact of various resource allocation strategies in game development on frame rates and player experience within a self-designed platformer game. The primary objective of this research was to determine which specific resource allocation, among those studied, has the most significant influence on both Average Frames Per Second (FPS) and Player Experience (PE). In addition to this primary objective, several secondary questions were explored, including whether aspects of players' gaming experiences influence Player Experience (PE). Our hypothesis suggests that certain resource allocation strategies may lead to trade-offs between FPS and PE. For example, lower-quality system performances are expected to yield higher FPS but lower player satisfaction, while medium and high-quality attempts are likely to provide better player experiences at the expense of FPS. We anticipate that the difference between the results of the medium and high-quality attempts may be relatively small.

Through comprehensive analysis and experimentation, this study provides insights into the optimal resource allocation strategies to enhance both FPS and PE in platformer game development.

Introduction

Achieving an equilibrium between performance and visual quality constitutes a fundamental challenge in the realm of gaming. Optimizing games, a critical aspect in attaining this equilibrium, has a direct impact on frame rates, a vital metric in the gaming experience (Pixio, 2023). Frame rate, typically measured in frames per second (FPS), represents the number of frames displayed each second, with significant implications for gameplay immersion. According to Lynch (2023), a lower frame rate negatively impacts the gaming experience by reducing visual quality and introducing noticeable delays in player actions. On the other hand, a higher frame rate significantly improves the gaming experience by delivering enhanced visuals and more responsive gameplay.

Creating captivating gaming experiences requires game developers to master the art of frame rate optimization. This paper concentrates on this crucial aspect of game development, specifically focusing on Unity. As a widely-used game development engine, Unity offers adaptable capabilities for creating games across diverse platforms, including personal computers, mobile devices, and gaming consoles. The choice of Unity for this project is influenced by its beginner-friendly nature, which aligns with my status as a novice game developer. The user-friendly interface and comprehensive collection of official tutorials available in Unity provide an ideal setting for me to conduct experiments with frame rates. As a result, the central theme of this research project is the critical skill of optimizing frame rates, with Unity serving as a practical and accessible platform for my exploration and hands-on learning.

The aim of this study is threefold: first, to assess the impact of various resource allocation strategies on frame rates and player experience within the Unity game development environment; second, to provide evidence-based suggestions for novice game developers regarding optimal resource allocation strategies; and lastly, to establish a foundation for future research in the field of game performance optimization and resource allocation within the Unity game engine. By addressing these objectives, this study ultimately seeks to provide valuable insights and practical guidelines for game developers striving to create captivating and fluid gaming experiences.

Methodologies

Game Development

To thoroughly investigate the impacts of resource allocation strategies within the Unity game development environment, we made a custom platformer game from the ground up. This game, namely *SPEEDCUBE*, comprises 27 levels, each lasting 30 seconds, with each level implementing distinct resource allocation strategies. These strategies entail manual adjustments of three critical technical variables: Audio, Graphics, and Physics. From here on, these three variables will be addressed as Actual Audio (AA), Actual Graphics (AG), and Actual Physics (AP). We systematically categorized these variables into three levels - Low (1), Medium (2), and High (3) - as outlined in Table 1. Consequently, *SPEEDCUBE* presents a number of unique combinations of resource allocation strategies, shown in Table 2, exploring every possible configuration of the three variables, totaling to $3^3 = 27$ combinations.

Participant Selection

24 individuals participated in the study, representing a diverse age range from 12 to 25 years old. This selection criteria aims to capture a broad spectrum of perspectives, including individuals who have grown up with gaming and those with varying degrees of gaming experience. Additionally, all participants were proficient in the English language, as the survey instrument used for data collection required respondents to provide feedback in English. The survey gathered demographic information, gaming preferences, and subjective ratings on various aspects of gameplay, enriching the dataset with valuable insights into participants' experiences and perceptions.

Data Analysis

Data Collection The dataset comprises 11 variables essential for data analysis. These variables include the actual settings of Audio (AA), Graphics (AG), and Physics (AP), recorded as categorical variables ranging from 1 to 3, representing low, medium, and high settings respectively. Additionally, it includes participants' ratings on Graphics (GR), Audio (AR), Physics (PR), Enjoyment (ER), Comfort (CR), and Overall Satisfaction (OR), each ranging from 1 (poor) to 5 (excellent). The participant's score, measured on a scale from 0 to 1000, and the Average Frames Per Second ($AVGFPS$), ranging from 30 to 60, are also recorded. Furthermore, participants provided their Gaming Interest and Experience Rating ($GAMING$), scored from 1 (minimal) to 5 (extensive), and were assigned a Participant Number (PCP) from 1 to 24. Player Experience (PE) is calculated as a weighted sum of all rating variables, ranging from 1 to 5. Additionally, the dataset includes normalized data for AA (NAA), AG (NAG), AP (NAP), AVGFPS ($NAVGFPS$), and PE (NPE), with values ranging from 0 to 1. Finally, $NAVGFPSPE$ represents the normalized data of the combined average frames per second and player experience ($0.5AVGFPS + 0.5PE$), also ranging from 0 to 1.

Analysis Use of R language and random forest package.

Results

Discussion

Table 1: *Details of the Technical Resources*

Technical Variable	Quality	Description
Actual Audio (AA)	1	No sound effects
	2	Maximum volume
	3	Appropriate volume
Actual Graphics (AG)	1	No shadow & matte textures
	2	Shadow enabled & in-between textures
	3	Shadow enabled & metallic textures
Actual Physics (AP)	1	No impact on collision
	2	Minimum impact
	3	True impact

Table 2: *Details of the Resource Allocation Strategies*

LEVEL	AA	AG	AP
1	3	3	3
2	3	3	2
3	2	2	1
4	1	1	2
5	3	2	1
6	1	2	3
7	1	1	3
8	1	2	2
9	2	3	3
10	3	3	1
11	2	3	2
12	3	1	2
13	2	2	2
14	2	1	1
15	2	1	3
16	2	2	3
17	2	1	2
18	2	3	1
19	1	1	1
20	3	1	3
21	1	2	1
22	1	3	1
23	3	2	3
24	3	2	2
25	3	1	1
26	1	3	2
27	1	3	3

Table 3: *Demographic Information of Participants*

Variable	Categories	Frequency
SEX	Male	8
	Female	16
AGE	12-17	5
	18-25	19
GAMING	1 (low)	1
	2	2
	3	8
	4	8
	5 (high)	5

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