BAB 1 PENDAHULUAN

1.1 Project Background

Over the past three decades, the gaming industry has undergone a remarkable transformation. What once consisted of simple two-dimensional arcade games has now evolved into expansive, immersive virtual worlds (*Rani & Balakrishnan, 2021*). This shift reflects a growing demand for gaming experiences that are engaging, challenging, and satisfying. But achieving the perfect balance between these elements is no easy task, especially with players of different skill levels, backgrounds, and expectations. This diversity poses a significant challenge for game developers: how do you create a game that's not too easy (which risks boring the player) but also not so difficult that it becomes frustrating (*Charles & Black, 2022*).

To address this, many games use static difficulty settings. Players are typically given the option to select from modes like Easy, Medium, or Hard at the start of the game. However, it’s far from a perfect solution. Players' abilities and preferences aren’t fixed; a level that feels just right at one point might feel too easy or too hard later. As a result, players often end up feeling disconnected from the experience, which can reduce their overall enjoyment (*Kim & Lee, 2023*).

This is where Dynamic Difficulty Adjustment (DDA) comes in. DDA is a system that automatically adjusts the game's difficulty in real-time based on the player's performance and actions (*Yannakakis & Hallam, 2020*). By combining adaptive AI techniques, DDA systems can track player inputs, analyze performance metrics, and even gauge emotional responses. With this data, the system can fine-tune the game's difficulty, ensuring a more personalized and enjoyable experience (*Smith & Taylor, 2024*). This research aims to explore how adaptive AI can be used to implement real-time, customizable difficulty adjustments in video games. By developing a clear framework for these systems, we hope to create gaming experiences that are not only more engaging but also inclusive for players of all skill levels (*Kim & Lee, 2023*).

1.2 Problem Statement

Even Though rapid advancements in AI and game design, most modern video games still rely on outdated difficulty mechanisms that fail to adapt in real-time. This approach is flawed for several key reasons:

i. Enemy AI Requires Reactive and Layered Behavior:

They respond to being blocked or parried, can detect the player through stealth mechanics, and sometimes adapt their behavior based on the player's actions. Designing such layered behavior in visual scripting often leads to overly complex node structures that are difficult to maintain or debug.

ii. AI Behavior:
Designing enemy AI that can react dynamically to player actions, providing a challenging yet fair combat experience.

iii. Hack and Slash games often lack intelligent difficulty balancing:
In many hack and slash games, difficulty settings are static and do not adjust based on player performance. This leads to gameplay that is either frustratingly difficult for novice players or too easy for experienced ones, reducing player retention and satisfaction.

By addressing these problems, the project not only attempts to replicate a challenging and fluid combat experience but also contributes to the body of knowledge on using visual scripting for complex game development. This encourages inclusivity in the game development community by empowering non-programmers to build high-quality action games.1.3 Project Objectives

This project focuses on the design and implementation of an adaptive AI-driven DDA framework with the following objectives:

i. Design Enemy AI Behavior:

Create enemy characters with behaviors that include patrolling designated areas, detecting the player through proximity or line-of-sight logic, engaging in combat, and reacting to player actions like parries or backstabs. Utilize visual state machines to manage enemy states such as Idle, Patrol, Alert, Attack, and Death.

ii. Integrate combat mechanics:

A combo system with animation blending, and blocking and parrying functionalities. Additionally, incorporate health and stamina management systems to add depth to player actions.

iii. Implement Combat Interaction System:

Develop a lock-on targeting system to allow players to focus on specific enemies during combat. Design a damage system that calculates incoming and outgoing damage, providing visual feedback for actions to enhance the player's immersive experience.

1.4 Project Scope

The goal of this project is to create and deploy an adaptive AI system for video games' Dynamic Difficulty Adjustment (DDA). The three primary components of the scope, ensure the system's effective deployment, testing, and usability.

1.4.1 Scope of System

The scope of the proposed system focuses on implementing adaptive AI for dynamic difficulty adjustment in video games, addressing the need for personalized and engaging player experiences. The following details the specific areas covered by the system:

i. Real-Time Gameplay Data Collection and Analysis:

To create a gaming experience that adapts to each player, the system collects and analyzes real-time gameplay data. This involves focusing on performance metrics, such as player accuracy, success rates, failure patterns, and level completion time. Behavioral patterns, including reaction times, decision-making styles, and in-game tactics, are also monitored. Additionally, emotional indicators, such as behaviors signaling boredom or disengagement, are tracked to ensure the experience remains engaging. Before using the data for real-time adjustments, it is pre-processed to ensure accuracy and consistency.

ii. Adaptive AI for Real-Time Difficulty Adjustment:

the AI system analyzes player performance and behavior in real time, enabling dynamic changes to game difficulty. Adjustments are made to key elements like enemy AI, where behaviors and strategies align with the player’s skill level, and level complexity, which adapts

based on the player's performance. Machine learning techniques, such as reinforcement learning, are employed to ensure personalized adjustments that avoid frustration or boredom.

iii. Game Environment Simulation and Testing:

To ensure the reliability of the adaptive AI, extensive testing is conducted. Simulated player behaviors are used to assess how well the AI responds to diverse play styles. Feedback loops are employed to continuously refine the difficulty adjustment mechanism, improving its precision and adaptability over time.

iv. Player Feedback Integration:

Player feedback is actively incorporated to further personalize the gaming experience. Feedback is collected at the end of each session, allowing players to evaluate the game's difficulty. This input is used to optimize the system's adjustments, ensuring that future sessions align better with player preferences and expectations.

By integrating real-time data collection, adaptive AI, continuous testing, and player feedback, the system aims to deliver an immersive, challenging, and personalized gaming experience for players of all skill levels.

1.4.2 Scope of User

To create a more user-friendly experience, the system prioritizes customization options and transparency for players. This approach allows players to feel more in control of their experience while also understanding how the system is adapting to their gameplay.

1. Customizable Gameplay Preferences:

Players will have the freedom to adjust their gaming experience according to their preferences. Key customization options include initial difficulty settings, where players can select their preferred starting difficulty level (e.g., easy, normal, or hard). This will serve as the baseline for future difficulty adjustments. Additionally, players preferring a more traditional, fixed difficulty experience will have the option to disable dynamic adjustments and stick to one consistent difficulty level.

2. Enhanced User Interface (UI):

   The user interface will ensure clarity and accessibility in how the game adapts to player performance. Features such as real-time performance displays allow players to see key metrics like accuracy and completion times, while AI interaction cues provide notifications about how the AI is adjusting. This ensures that players remain aware of the system's actions and how their gameplay influences difficulty adjustments.

By focusing on customization, the system delivers a player's experience that is fair, adaptable, and engaging for a wide range of users.

1.5 Project Significance

Dynamic Difficulty Adjustment (DDA) systems powered by adaptive AI represent a significant advancement in modern game design. These systems allow games to accommodate players with varying skill levels while maintaining a fun, immersive, and engaging experience for everyone.

By using DDA, gameplay becomes more personalized, preventing players from feeling frustrated by challenges that are too difficult or bored by tasks that are too easy. The system adapts in real-time based on player performance and emotional cues, ensuring that players stay engaged and motivated throughout their gaming sessions. Recent studies have shown that such adjustments lead to higher player retention and deeper immersion (Garcia-Ruiz et al., 2022; Zohaib, 2021).

The proposed system offers a scalable solution to a common challenge in game development: how to design games that are both accessible to new players and challenging for experienced ones. By integrating reinforcement learning and sentiment analysis, the system can automatically adjust the difficulty without the need for manual fine-tuning. This not only reduces development costs but also delivers a more dynamic and player-centric experience (Romero-Mendez et al., 2023).

On a broader scale, the use of adaptive AI for DDA aligns with industry trends toward greater personalization and inclusivity in gaming. By offering tailored gameplay experiences, developers can attract and retain a more diverse player base, increasing both player satisfaction

and overall revenue. This project not only advances the field of game design but also contributes to the growing area of human-AI interaction, where technology adapts to human behavior in more intelligent and intuitive ways.

1.6 Chapter Summary

This chapter introduced the foundational elements of the project titled "Implementing Adaptive AI for Dynamic Difficulty Adjustment in Video Games." It began with an overview of the project's background, emphasizing the rapid growth of the gaming industry and the limitations of traditional difficulty settings. Conventional game design, which relies on fixed difficulty levels (easy, normal, hard), often fails to meet the diverse and ever-changing needs of players. As a result, players may feel either bored or frustrated, leading to lower engagement.

To address this issue, the potential of adaptive AI systems was highlighted. Unlike static difficulty settings, adaptive AI can analyze player performance in real-time and adjust the game's difficulty accordingly. By incorporating sentiment-driven insights, the system can also respond to players' emotional states, offering a more personalized and engaging experience.

The problem statement outlined the key limitations of existing systems, such as their inability to adapt, personalize, and recognize player emotions. These gaps underscore the importance of developing an innovative solution that dynamically adjusts difficulty based on player skill and emotional state. To address these challenges, the project established clear objectives focused on developing, integrating, and evaluating a system for AI-driven dynamic difficulty adjustment.

The scope of the project was divided into three main components:

i. System: Covers the technical development and integration of the adaptive AI system.

ii. User: Focuses on player experience, customization, and transparency.

iii. Admin: Involves the tools and controls available to administrators, such as system monitoring, updates, and feedback management.

The significance of the project was also emphasized, highlighting its potential to offer more engaging and personalized player experiences. For developers, this system could streamline the development process, reduce manual tuning, and attract a broader player base. For the industry, adaptive AI can boost player satisfaction, increase player retention, and drive growth and innovation in game development.

In essence, this chapter lays the foundation for the project by presenting its rationale, objectives, and anticipated impact. It highlights the need for a player-centered approach to difficulty adjustment, leveraging modern AI techniques to deliver richer, more engaging gaming experiences. The next chapter will explore the theoretical framework and prior research in this field, providing a critical review of existing methodologies and identifying the gaps this project aims to address.