Emotion-Driven Adaptive Game System: Design and Evaluation

Kyousuke Saga[1] and Kaoru Sumi*[1]

[1] Future University Hakodate, Hokkaido, Japan
kaoru.sumi@acm.org

Abstract. This study designed and evaluated an emotion-driven adaptive game system that dynamically modified difficulty level and genre in real time. The system estimated players' emotional states by combining facial expression recognition with in-game performance metrics such as stage completion time. Based on these estimates, the game automatically adjusted difficulty (easy, normal, hard) and switched among three genres (action, first-person shooter, and adventure). Physiological data such as heart rate were recorded to observe players' responses to adaptive changes, but these data were not used for real-time system adaptation. A user study with 26 university students indicated that adaptive changes influenced physiological responses, though overall subjective satisfaction did not differ between groups. These findings demonstrate the feasibility of emotion-adaptive games while also pointing to the need for improvements, including multimodal signal integration and broader genre options.

Keywords: Emotion-Adaptive Games, Game Design, Facial Expression, Dynamic Difficulty Adjustment, Player Experience

1 Introduction

Maintaining player immersion and providing an enjoyable experience are central goals in game design. According to the flow theory proposed by Csikszentmihalyi (1990) [1] and extended to games by Chen (2007) [2], players experience immersion when challenge and skill are balanced. If the game is too difficult, players feel anxiety, whereas if it is too easy, they feel boredom. Appropriately adjusting game difficulty is therefore a critical factor in sustaining engagement.

Player enjoyment also depends on personal preferences for game genres, which vary substantially across individuals. Prior work reports sex and gender differences in play and preferences, with systematic patterns across multiple genres (Lucas and Sherry, 2004) [4]; (Lange and Schwab, 2021) [3]. Consequently, fixed settings for both difficulty and genre can produce mismatches that reduce enjoyment and immersion.

To address these issues, adaptive game systems have been explored from two complementary directions. The first is dynamic difficulty adjustment (DDA) based on in-game performance and player-experience modeling, including real-time satisfaction optimization and content adaptation (Yannakakis and Hallam, 2009) [5]; (Peder-

J. Caro et al. (eds.), *Proceedings of the Workshop on Computation: Theory and Practice (WCTP 2025)*, Atlantis Highlights in Computer Sciences 24,
https://doi.org/10.2991/978-94-6239-638-8_14

sen et al., 2010) [6]; (Liu et al., 2009) [7]; (Gilleade and Dix, 2004) [8]. The second integrates affective computing to estimate players' internal states beyond performance metrics, drawing on reviews and recent advances in affect detection and emotion representation (Calvo and D'Mello, 2010) [9]; (Yannakakis et al., 2021) [10]. Early studies also combined facial expressions with biosignals for estimating emotion intensity (Hori et al., 1999) [11], and recent work relates physiological correlates to gameplay states in controlled tasks (Sato et al., 2024) [12]. In parallel, difficulty prediction using facial cues together with game performance has been investigated (Yin et al., 2024) [18]. These lines of research motivate systems that adapt not only difficulty but also content according to estimated affect and behavior.

Building on this line of work, the present study proposes and evaluates an emotion-driven adaptive game system that adjusts both difficulty and genre in real time. The system combines facial expression analysis with gameplay performance (stage completion time) to estimate players' emotional states. It is important to note that physiological data (e.g., heart rate) were recorded only to analyze players' reactions and were not used as input for the system's real-time emotion estimation or adaptation. Based on these estimates, difficulty is increased, decreased, or maintained, and genres are switched cyclically among action, first-person shooter, and adventure. To examine the effectiveness of this approach, we conducted a user study comparing the adaptive version of the game with a non-adaptive version.

The contributions of this study are as follows:

1. Design and implementation of a prototype system that integrates facial expression recognition with gameplay performance for adaptive control of both difficulty and genre.
2. A user study with 26 participants that evaluates the system using physiological (heart rate), subjective (questionnaire), and qualitative (free responses) measures.
3. Empirical insights into the strengths and limitations of emotion-driven adaptation, highlighting both its potential and the challenges that must be addressed for practical application.

2 Related Work

Research on adaptive games has primarily evolved along two complementary directions: dynamic difficulty adjustment (DDA), which seeks to balance challenge and player skill, and emotion recognition, which aims to capture players' internal states beyond performance metrics. While DDA has traditionally relied on observable in-game data such as scores or completion times, emotion recognition techniques offer the possibility of tailoring gameplay more directly to the player's affective experience. This section reviews prior work in these two areas, followed by studies that integrate both approaches, in order to clarify the position and novelty of the present research. Representative surveys and frameworks in DDA include work on real-time satisfaction optimization and player-experience modeling (Yannakakis and Hallam, 2009) [5]; (Pedersen et al., 2010) [6]; (Liu et al., 2009) [7]; (Gilleade and Dix, 2004)

[8], while affect detection and emotion representation are covered in comprehensive reviews (Calvo and D'Mello, 2010) [9]; (Yannakakis et al., 2021) [10].

2.1 Dynamic Difficulty Adjustment (DDA) in Games

Dynamic difficulty adjustment has been widely studied as a means of improving player experience by automatically tuning game difficulty according to player performance. Early approaches relied mainly on performance indicators such as scores, death counts, or completion times (Liu, 2009) [7]. Beyond performance-only schemes, research explored real-time adaptation to optimize satisfaction and to model player experience for content control (Yannakakis and Hallam, 2009) [5]; (Pedersen et al., 2010) [6], and also examined the use of frustration as a design signal for adaptation (Gilleade and Dix, 2004) [8].

More recently, emotion-based DDA has been investigated directly. Frommel et al. showed that coupling parameterized difficulty with self-reports of emotion can enhance engagement relative to fixed or linearly increasing difficulty (Frommel et al., 2018) [13]. Blom et al. modeled and adjusted in-game difficulty using facial expression analysis to capture engagement unobtrusively (Blom et al., 2019) [14]. Akula et al. demonstrated a pipeline that detects facial emotions and adjusts difficulty accordingly in an experimental game setting (Akula et al., 2022) [16]. In parallel, procedural content work has targeted personalized content selection and generation that can complement DDA mechanisms (Shaker et al., 2010) [15]. Overall, these studies highlight the potential of DDA, but also reveal the challenge of integrating reliable emotion detection into adaptive game design.

2.2 Emotion Recognition in Games

Emotion recognition has been applied to games to better capture players' internal states that are not observable from performance alone. Surveys summarize models, sensing modalities, and challenges in affect detection (Calvo and D'Mello, 2010) [9], and recent work argues for ordinal treatment of emotions to improve robustness in inference (Yannakakis et al., 2021) [10]. Facial expression analysis is a common approach in game contexts, including studies that relate facial cues to in-game difficulty and performance (Blom et al., 2019) [14]; (Yin et al., 2024) [18], and earlier combinations of facial measures with biosignals for estimating emotion intensity (Hori et al., 1999) [11].

However, facial expressions alone may be insufficient in many play situations, motivating multimodal sensing. For example, multimodal pipelines have combined physiological signals and gameplay-derived features to detect affect around gameplay phases with higher fidelity (Ganiti-Roumeliotou et al., 2024) [17]. Physiological correlates measured during controlled tasks also illuminate affective responses that are not always visible on the face (Sato et al., 2024) [12]. In addition, integrating facial cues with gaze, head pose, and performance features has been shown to improve difficulty prediction accuracy (Yin et al., 2024) [18]. These findings indicate that combining multiple modalities can improve the accuracy and reliability of emotion recognition in games.

2.3 Integration of DDA and Emotion Recognition

Despite growing interest in both DDA and emotion recognition, their explicit integration remains limited. Recent work links real-time emotion recognition signals directly to difficulty control, demonstrating feasibility while noting recognition errors and generalization limits in practical scenarios (Kutt et al., 2023) [19]. Studies that embed facial-emotion analysis into adaptive pipelines provide further examples of algorithmic emotion-driven adjustment (Akula et al., 2022) [16] and engagement-aware difficulty control (Blom et al., 2019) [14], while controlled, emotion-aware difficulty schemes based on player reports illustrate benefits and constraints of the approach (Frommel et al., 2018) [13]. Personalized content generation can also serve as a complementary lever, broadening adaptation beyond scalar difficulty (Shaker et al., 2010) [15].

In summary, combining DDA with emotion recognition has the potential to create more personalized and immersive game experiences. Limitations remain regarding the reliability of emotion estimation and the relatively narrow scope of adaptive elements considered to date. Building on these insights, the present study explores a system that adapts not only difficulty but also game genre in real time, using a hybrid of facial expression analysis and gameplay performance.

3 System Design

In order to evaluate the feasibility of emotion-driven adaptation, we developed a prototype game system. This section outlines the overall system, its game content, and the mechanisms used for adaptation.

3.1 System Overview

We developed a prototype game system in which both difficulty and genre change dynamically according to players' estimated emotional states. The game is presented in a first-person perspective to enhance immersion (Fig. 1). The system monitors two types of input: facial expression data and in-game performance, specifically stage completion time. Based on these inputs, the game automatically adjusts difficulty across three levels (easy, normal, hard) and alternates among three genres: action, first-person shooter (FPS), and adventure (Figs. 2–5).

3.2 Emotion and Performance Estimation

Each genre features distinct gameplay mechanics and clear conditions.

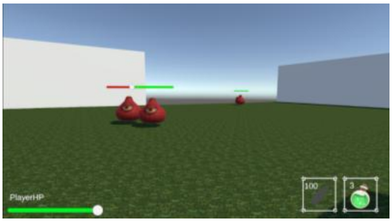

Fig. 1. Player's point of view

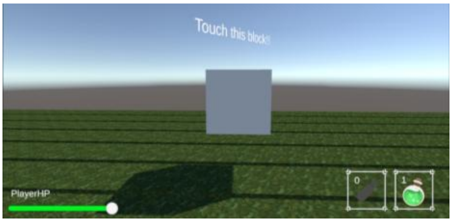

Fig. 2. Stage start block

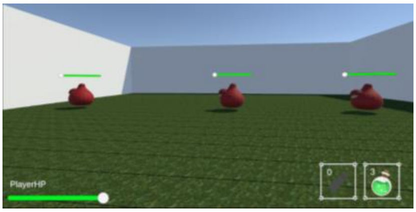

Fig. 3. Action game stage

Fig. 4. FPS game stage

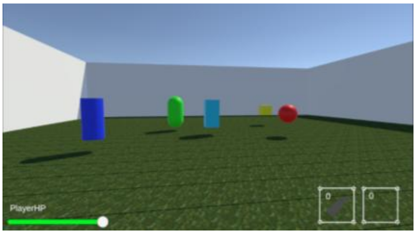

Fig. 5. Adventure game stage

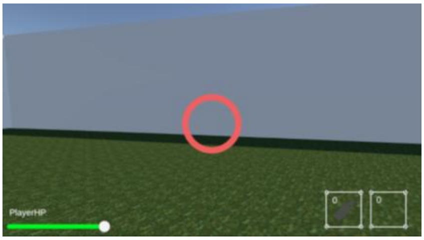

Fig. 6. Correct answer screen (adventure)

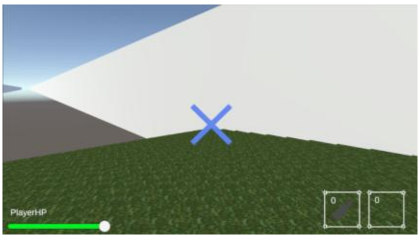

Fig. 7. Incorrect answer screen (adventure)

Fig. 8. Action game instructions

Fig. 9. FPS game instructions

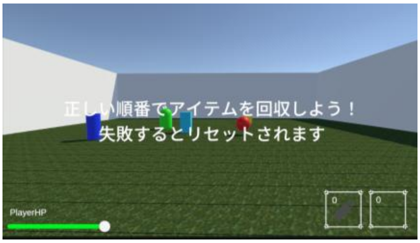

Fig. 10. Adventure game instructions

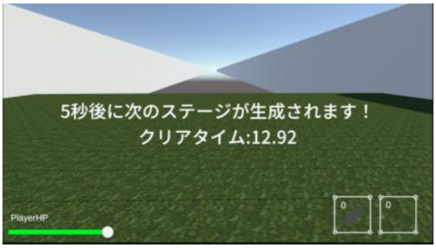

Fig. 11. Stage clear message

- **Action genre**: Players attack red enemies with a sword and can heal themselves (Fig. 3). The stage is cleared when all enemies are defeated.
- **FPS genre**: Players use a gun to defeat robotic enemies while avoiding fire (Fig. 4).
- **Adventure genre**: Players collect colored items in a predetermined order, without attack or recovery actions (Fig. 5–7). Incorrect collection resets the stage.

For each stage, short text prompts are displayed to remind players of the genre-specific objectives (Figs. 8–10). After clearing a stage, the system displays the completion time before generating the next one (Fig. 11).

3.3 Adaptation Mechanism

The adaptation process combines emotion estimation and performance metrics. First, facial expressions are classified into weighted values representing positive, negative, or neutral states. If the cumulative value over a stage exceeds a positive threshold, the system maintains the current settings. If the value falls below a negative threshold, the system checks completion time to determine whether the game is too easy or too difficult, and adjusts difficulty accordingly. If three consecutive stages yield near-neutral values, the system interprets this as boredom or indifference and changes the game genre.

Difficulty adjustment is based on completion time thresholds. If a stage is cleared in less than 20 seconds, difficulty is increased; if it takes longer than 80 seconds, difficulty is reduced; otherwise, the system attempts to change the genre to maintain engagement. Genre changes follow a cyclic order (action → adventure → FPS → action).

This combination of facial expression data and gameplay metrics enables the system to provide adaptive experiences, while also revealing the limitations of relying on facial expressions alone, as will be discussed in later sections.

4 Experiment

To examine the effects of the proposed system, we conducted a user study. This section describes the participants, procedure, and evaluation methods used in the experiment.

4.1 Participants and Conditions

The experiment was conducted with 26 students from Future University Hakodate (21 male and 5 female, aged 18–24). Participants were divided into two groups: 14 students played the adaptive version of the game (adaptive group), and 12 students played the non-adaptive version (non-adaptive group). The mean age across participants was 20.0 years (SD = 1.53), with no significant differences between groups.

4.2 Procedure

Prior to gameplay, participants completed a demographic questionnaire (gender, age) and a short health screening to ensure safe use of the biometric sensors. Participants in the non-adaptive group also filled out a form to select their preferred difficulty level. All participants read a game manual and performed a three-minute practice session to familiarize themselves with the controls (no adaptation was applied during this phase). Afterward, biometric sensors and headphones were fitted, and participants played either the adaptive or non-adaptive game version for 15 minutes. Following gameplay, they completed a post-experiment questionnaire and provided open-ended responses regarding their experiences.

4.3 Measures

The following three types of measures were used:

- **Physiological observation:** Heart rate was monitored during gameplay to examine general responses to adaptive changes.
- These data were used only for exploratory comparison and were not a primary evaluation measure.
- **Subjective measures**: A post-experiment questionnaire based on the Game Engagement Questionnaire (GEQ), with additional items, was administered to assess satisfaction, immersion, and perceived difficulty.
- **Free responses**: Participants provided written comments on whether they noticed the adjustments and how they perceived the gameplay experience.

4.4 Evaluation Method

For the questionnaire results, independent two-sample t-tests were conducted to compare the adaptive and non-adaptive groups. For heart rate data, mean values 5 seconds before and after difficulty increases or genre transitions were compared to test for significant changes. Free responses were categorized according to whether players noticed the adjustments and whether their comments indicated positive or negative experiences, and were analyzed qualitatively.

5 Result

This section presents the results of the experiment, focusing on physiological, subjective, and qualitative measures. The primary goal of the analysis was to determine whether the adaptive game system influenced players' experiences compared to the non-adaptive version. First, heart rate data were examined to capture physiological arousal in response to changes in difficulty and genre. Next, post-experiment questionnaire results were analyzed to assess subjective satisfaction, immersion, and frustration. Finally, open-ended responses were reviewed to provide qualitative insights into how players perceived the adaptive mechanisms. By combining these three perspectives, we aim to provide a comprehensive understanding of both the effectiveness and the limitations of emotion-driven adaptation in games.

5.1 Heart Rate Variability

Heart rate data were analyzed to examine physiological responses to difficulty adjustments and genre transitions.

For difficulty increases, significant changes in heart rate were observed in a subset of participants. For example, one participant's average heart rate increased from 75 BPM during the five seconds before a difficulty increase to 130 BPM in the five seconds after the increase (p = 0.029). This result indicates that difficulty adjustments strongly induced physiological arousal (Table 1).

For genre transitions, significant increases were observed specifically when switching from the adventure genre to the FPS genre. For instance, one participant's heart rate rose from 71.6 BPM before the transition to 81 BPM afterward. Similar patterns were observed in other participants, with increases from 73 BPM to 80.4 BPM and from 74 BPM to 84.8 BPM. No significant changes were detected for other genre transitions (Table 2). These findings suggest that FPS gameplay elicited stronger physiological arousal compared to the other genres.

Table 1. Average heart rate before and after a difficulty increase

Condition	Average heart rate (BPM)
Before	75
After	130

Table 2. Average heart rate before and after transitions from the adventure genre to the FPS genre

Condition	Average heart rate (BPM)
Before	71.6 / 73 / 74
After	81 / 80.4 / 84.8

5.2 Questionnaire Results

The post-experiment questionnaire results showed no overall significant differences between the adaptive and non-adaptive groups. However, one item (Q22: "I felt mildly irritated or uncomfortable with the game content") revealed a significant difference. The adaptive group reported higher irritation than the non-adaptive group, suggesting that the adjustments occasionally increased frustration rather than reducing it.

For other items related to enjoyment (Q8), satisfaction (Q4), or concentration (Q14), no significant differences were found. These results imply that the adaptive system influenced physiological responses but did not lead to a clear improvement in subjective satisfaction.

5.3 Free Responses

Open-ended responses provided additional insights into how players perceived the adaptive mechanisms.

In cases where adaptation was successful, participants reported that adjustments improved challenge and engagement. For example, participants noted that "the game became more challenging when the number of enemies increased to five" (Participant 13-1) and "the tension of being chased by enemies made it fun" (Participant 16-1). These comments suggest that difficulty adjustments in action and FPS stages provided meaningful variation aligned with player skills.

However, several participants indicated that adaptation did not always work as intended. One participant stated, "I got bored because the number and placement of enemies stayed the same" (Participant 5-1), suggesting that boredom was not adequately detected from facial expressions. Another reported, "At first it felt fresh and fun, but later I got used to it and felt bored" (Participant 9-1), indicating that the adaptation failed to sustain engagement.

Particularly in the adventure genre, negative feedback was frequent. Participants commented, "I lost concentration when I had to reset after a mistake" (Participant 10-1) and "I felt frustrated when the game was reset" (Participant 11-1). These remarks suggest that the reset mechanism and reliance on luck caused discomfort, highlighting the need for a redesign of the adventure stages.

Overall, free responses showed that difficulty adjustments in action and FPS stages were partially effective, but emotion estimation based solely on facial expressions often failed to capture boredom or frustration. Moreover, the design of the adventure genre itself contributed to dissatisfaction, underscoring the importance of skill-based rather than chance-based progression.

6 Discussion

The results of this study provide insights into the strengths and limitations of an emotion-driven adaptive game system.

6.1 Physiological Responses to Adaptation

Observations of heart rate suggested that adaptive changes in difficulty and genre influenced players' physiological arousal. These responses indicate that the system's adjustments could affect engagement at a physiological level, although the results were exploratory and not the main focus of the study.

The tendency for increased arousal during more challenging stages or preferred genres (such as FPS) is consistent with prior findings on player engagement. However, since physiological signals were used only for post-hoc observation, these results should be interpreted as supportive rather than conclusive evidence of system effectiveness.

6.2 Subjective Responses and Questionnaire Findings

Although physiological observations suggested some adaptive effects, questionnaire results showed no overall improvement in subjective satisfaction.

Only one item (Q22: *"I felt irritated or frustrated during the game"*) differed significantly, indicating that participants in the adaptive group felt greater irritation. This finding suggests that increased physiological arousal did not necessarily lead to a more positive experience; in some cases, adaptation may have caused discomfort. The mismatch between physiological and subjective outcomes highlights a key limitation of emotion estimation based solely on facial expressions, particularly during solitary gameplay where facial variability is limited.

Because the system could not fully detect subtle negative emotions such as boredom or mild frustration, it sometimes failed to adjust difficulty or genre appropriately.

These results emphasize the challenge of developing adaptive systems that accurately interpret player affect while maintaining both effectiveness and enjoyment.

6.3 Insights from Free Responses

The open-ended responses provided further insights into the system's limitations. Players reported that difficulty adjustments in the action and FPS stages were effective when they offered clear and skill-based challenges, such as an increased number or speed of enemies.

However, boredom often persisted when enemy placement remained unchanged, suggesting that facial expressions alone were insufficient to estimate emotions such as disengagement or mild frustration.

The adventure genre, in particular, received negative feedback because its reliance on item order and reset mechanics introduced elements of randomness that reduced enjoyment.

These observations indicate that adaptation strategies need to be aligned with genre-specific design principles to sustain engagement.

In addition, the use of only three genres (action, FPS, and adventure) may have limited the system's ability to match individual player preferences and skills, contributing to occasional frustration and inconsistent satisfaction.

Overall, the free responses complement the quantitative results by revealing design-specific and perceptual factors that limited the system's effectiveness.

6.4 Limitations of Emotion Estimation

A key limitation of this study is the reliance on facial expressions as the primary indicator of emotion. Solo gameplay often elicits limited facial variability, making it difficult to capture subtle changes in affective states. As a result, the system sometimes failed to recognize boredom or frustration in real time. This limitation points to the need for integrating additional modalities such as electrodermal activity (EDA), heart rate variability (HRV), or electroencephalography (EEG), which may provide more robust and nuanced emotion estimation.

7 Future Work

Building on the findings of this study, several directions for future research are proposed to enhance the effectiveness and applicability of emotion-driven adaptive games.

7.1 Multimodal Emotion Estimation

Because facial expressions alone were insufficient to capture subtle emotional changes during gameplay, future systems should incorporate multiple sources of information.

Integrating facial expressions with additional physiological and behavioral indicators, such as heart rate, skin conductance, or motion and gaze patterns, may enable more reliable estimation of players' emotional states.

A multimodal approach would also help reduce the limitations of solitary gameplay, where facial variability tends to be low.

Furthermore, incorporating lightweight real-time feedback from players (for example, brief self-reports or implicit behavioral cues) could further refine system adjustments and improve adaptive accuracy.

7.2 Expanding Genre Adaptation

The present prototype was limited to three genres (action, FPS, and adventure), while players' preferences are highly diverse.

Restricting adaptation to such a narrow range may have reduced the system's ability to reflect individual interests and skills.

Future work could explore a wider variety of genres or introduce more flexible adaptation within each genre to better match different player preferences.

Such improvements may lead to a more personalized and engaging game experience, helping the system sustain player satisfaction and motivation over time.

7.3 Long-Term Player Modeling

This study focused on short-term gameplay sessions of approximately 15 minutes. For practical applications, it is necessary to investigate long-term trends in physiological and emotional responses. By accumulating player data over multiple sessions, adaptive systems could construct personalized player models that account for individual learning curves and sustained engagement patterns.

7.4 Smoother Transitions and Reduced Frustration

Results indicated that some adjustments increased irritation rather than improving experience. To address this, future systems should implement smoother transitions in difficulty and genre, supported by clear feedback to players. Introducing intermediate difficulty levels or more gradual adjustments may reduce frustration and improve acceptance of adaptation.

7.5 Application to Game Design

Finally, future work should explore how emotion-driven adaptation can be integrated into commercial game design. By providing personalized game experiences tailored to individual players' skills and preferences, adaptive systems have the potential to increase long-term engagement and expand the design space for player-centered game development.

8 Conclusion

This study presented the design and evaluation of an emotion-driven adaptive game system that modified both difficulty and genre in real time based on players' facial expressions and in-game performance. A user study with 26 participants compared the adaptive and non-adaptive versions of the game.

Observations of heart rate suggested increased physiological arousal during adaptive changes, supporting the feasibility of emotion-driven adjustment. However, subjective questionnaire results showed no overall improvement in satisfaction, and one item indicated greater irritation in the adaptive group. Free responses further revealed that while difficulty adjustments in action and FPS stages sometimes enhanced challenge and engagement, boredom and frustration were often not detected, particularly in the adventure genre.

These findings indicate that emotion-driven adaptation can influence physiological engagement but does not necessarily lead to higher subjective satisfaction. The study also identified important limitations, especially the challenge of estimating emotions from facial expressions alone and the limited range of genres.

Future work should aim to integrate multimodal signals for more accurate emotion estimation, broaden genre adaptation, model long-term player behavior, and design smoother adaptation mechanisms. Addressing these challenges could enable emotion-adaptive systems to provide more personalized and engaging experiences, contributing to the advancement of player-centered game design.

Acknowledgements
This work was supported by the New Energy and Industrial Technology Development Organization (NEDO), Project JPNP23025.

References

1. Csikszentmihalyi, M.: Flow: The Psychology of Optimal Experience. Harper Perennial, New York (1990).
2. Chen, J.: Flow in games (and everything else). Communications of the ACM 50(4), 31–34 (2007).

3. Lange, B.P., Schwab, K.: Gender differences in game preferences: A large-scale survey on genre appeal. Frontiers in Psychology 12, 657430 (2021).
4. Lucas, K., Sherry, J.L.: Sex differences in video game play: A communication-based explanation. Communication Research 31(5), 499–523 (2004).
5. Yannakakis, G.N., Hallam, J.: Real-time game adaptation for optimizing player satisfaction. IEEE Transactions on Computational Intelligence and AI in Games 1(2), 121–133 (2009).
6. Pedersen, C., Togelius, J., Yannakakis, G.N.: Modeling player experience for content creation. IEEE Transactions on Computational Intelligence and AI in Games 2(1), 54–67 (2010).
7. Liu, C., Agrawal, P., Sarkar, N., Chen, S.: Dynamic difficulty adjustment in computer games through real-time anxiety-based affective feedback. International Journal of Human-Computer Interaction 25(6), 506–529 (2009).
8. Gilleade, K., Dix, A.: Using frustration in the design of adaptive videogames. In: Proceedings of the 2004 ACM SIGCHI International Conference on Advances in Computer Entertainment Technology (ACE '04), pp. 228–232. ACM, New York (2004).
9. Calvo, R.A., D'Mello, S.: Affect detection: An interdisciplinary review of models, methods, and their applications. IEEE Transactions on Affective Computing 1(1), 18–37 (2010).
10. Yannakakis, G.N., Cowie, R., Busso, C.: The ordinal nature of emotions: An emerging approach. IEEE Transactions on Affective Computing 12(1), 16–35 (2021).
11. Hori, M., Koseki, O., Yokoyama, K., Watanabe, Y.: Estimating the strength of emotions using facial expressions and biometric signals: In the case of fun and amusement. IEEJ Transactions on Electronics, Information and Systems 119(6), 668–675 (1999) (in Japanese).
12. Sato, Y., Salem, A., Sumi, K.: Physiological correlates while playing Tetris: A comparative study between males and females. In: Proceedings of the 1st IEEE International Workshop on Interactive Systems, Affective Computing Technologies and Applications (ISAC 2024), in conjunction with the 48th IEEE International Conference on Computers, Software, and Applications (COMPSAC 2024), Osaka, Japan (2024). IEEE. https://doi.org/10.1109/COMPSAC61105.2024.00328.
13. Frommel, J., Fischbach, F., Rogers, K., Weber, M.: Emotion-based dynamic difficulty adjustment using parameterized difficulty and self-reports of emotion. In: Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play (CHI PLAY '18), pp. 163–171. ACM, New York (2018).
14. Blom, P.M., Methorst, S., Bakkes, S., Spronck, P.: Modeling and adjusting in-game difficulty based on facial expression analysis. Entertainment Computing 31, 100307 (2019).
15. Shaker, N., Yannakakis, G.N., Togelius, J.: Towards automatic personalized content generation for platform games. In: Proceedings of the Sixth AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment (AIIDE 2010). AAAI Press, Stanford (2010).
16. Akula, H., Rayala, D., Kolla, M.: Dynamic game difficulty adjustment based on facial emotion recognition. In: Proceedings of the International Conference on Data Science, Machine Learning and Applications (ICDSMLA 2022). Communications in Computer and Information Science, vol. 1717, pp. 223–233. Springer, Singapore (2022).
17. Ganiti-Roumeliotou, E., Ziogas, I., Dias, S.B., Alhussein, G., Jelinek, H.F., Hadjileontiadis, L.J.: Beyond the Game: Multimodal Emotion Recognition Before, During, and After Gameplay. In: Proceedings of the 46th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC 2024), pp. 1–7. IEEE, Orlando (2024).

18. Yin, L., Zhang, H., He, R.: Game difficulty prediction based on facial cues and game performance. Applied Sciences 14(19), 8778 (2024).
19. Kutt, K., Ściga, Ł., Nalepa, G.J.: Emotion-based dynamic difficulty adjustment in video games. In: Proceedings of the 2023 IEEE 10th International Conference on Data Science and Advanced Analytics (DSAA), pp. 1–5. IEEE, Piscataway (2023).