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Finite state machine for retro arcade fighting game development

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ABSTRACT

Traditional fighting games are a competitive genre where players engage in one-on-one combat, aiming to reduce their opponent's health points to zero. These games often utilize two-dimensional (2D) graphics, enabling players to execute various character movements such as punching, jumping, and crouching. This research investigates the effectiveness of the finite state machine (FSM) method in developing a combo system for a retro fighting game, focusing on its implementation within the Godot Engine. The FSM method, which structures game behavior through states, events, and actions, is central to the game's control system. By employing the game development life cycle (GDLC) methodology, this study ensures a systematic and structured approach to game design. Special attention is given to the regulation of the combo hit system for the game's protagonist in Brawl Tale. The research culminates in the successful development of the retro fighting game Brawl Tale, demonstrating that the FSM method significantly enhances the fluidity and responsiveness of character movements. The findings suggest that the FSM method is an effective tool for simplifying and improving gameplay mechanics in retro-style fighting games.

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1. INTRODUCTION

Video games have grown increasingly popular in Indonesia, driven by factors like e-sports and the rise of digital media. Fighting games are a genre where players engage in one-on-one combat, aiming to reduce their opponent's health points to zero [1]. These games often feature 2D graphics and allow players to perform various character movements, such as punching and jumping [2].

This research focuses on developing a retro fighting game using the finite state machine (FSM) method, which is essential for controlling character behavior through states, events, and actions. By implementing FSM in the Godot Engine, this study aims to improve the fluidity and responsiveness of character movements, particularly in the combo system [3], [4]. Using the game development life cycle (GDLC) methodology, the research systematically approaches game design to enhance both technical performance and the overall player experience.

2. METHOD

Explaining the method in research is important because it shows how the study was conducted, helping readers understand the process and evaluate the results. It also allows other researchers to replicate the study and verify the findings [5], [6]. This research follows a systematic approach using the GDLC methodology, divided into key stages:

i) Initiation stage: the game's core mechanics and structure are defined, including rules and player interactions. Technologies and tools, such as the Godot Engine, are selected to support the gameplay.
ii) Pre-production stage: a detailed blueprint is created, outlining the technical framework. Software and tools essential for development, like the FSM method, are chosen to guide the design of assets and mechanics.
iii) Production stage: concept art, game assets, and mechanics are developed through collaborative efforts between artists, designers, and developers, translating the initial game vision into a functional product.
iv) Testing stage: internal testing identifies and resolves bugs and performance issues to ensure the game's stability before beta release.
v) Beta and release stages: the game is tested by external users to gather feedback, leading to final adjustments before public release.

Data collection includes primary data from playtesting and secondary data from literature on game mechanics, all processed to evaluate the effectiveness of FSM in improving character movement and gameplay.

2.1. Data collection

Explaining data collection in research describes how information is gathered to support a study's goals. It includes details about the tools, methods, and sources used, ensuring that others can understand and replicate the study. This explanation also helps readers assess the accuracy and reliability of the research findings. Primary data encompasses information acquired or gathered firsthand in situ by the investigator or relevant stakeholders. Secondary data refers to the information procured or assembled by the researcher, derived from existing sources.

2.2. Data design

Data design in research outlines how data will be collected, organized, and analyzed, ensuring clarity and replicability. It strengthens the validity of findings by presenting a systematic approach. Figure 1 details sequences within the arena match, illustrating players' control of their avatars, while the visual narrative blueprint for visual novels highlights the game's story-driven elements.

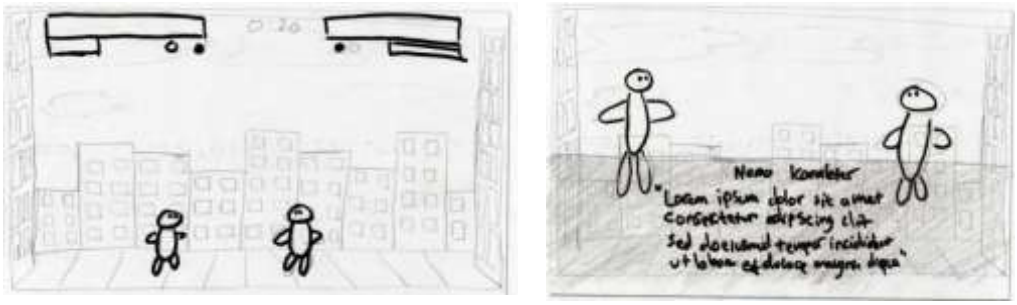

Figure 1. Storyboard for arena match (left) and visual novel (right)

2.3. Process design

A FSM is logical reasoning that shows the system's behavior with three things: state, event, and action [7], [8]. At one time, the system will be in an active state. The system can switch from another state if it gets a certain event input [1], [9], [10]. This state in Figure 2 shift is generally accompanied by actions the system can take when responding to occurring inputs. In this "Brawl Tale" game, the FSM method is applied to each character with the same hit button but different combos in different FSM plots. FSMs are essential in computer science and game design, describing character actions such as jumping, attacking, or standing still [11], [12]. For instance, in games like Super Mario, pressing the jump button moves Mario from an "idle" state to a "jumping" state [13]-[15]. FSMs connect these states through transitions, guiding character behavior based on player input and game rules, effectively serving as a roadmap for character actions [3], [7], [16].

Figure 2. FSM transition on movement character

2.4. Design layout

The graphical arrangement outlines the visual direction for the Brawl Tale video game, serving as a blueprint for its aesthetics and thematic elements. Figure 3 offers a preview of the preliminary design, showcasing character designs, backgrounds, and interface layouts. These visuals highlight the artistic vision and creative process behind crafting an engaging experience for players.

Figure 3. Initial view (left) and gameplay layout (right)

2.5. Test planning

This phase involves outlining the testing approach by defining test objectives, identifying methods, and allocating resources like time and personnel. The test plan includes creating test cases and scenarios based on project requirements, ensuring a systematic evaluation of the software. This preparation helps efficiently use resources and ensures the product meets the desired specifications.

The black-box testing assessed various character actions. The character walk test checked movement with directional keys, while character jump and jump on air verified jumping actions. The character hit normal and hit moment tests evaluated hits during walking and jumping. Special moves tested the execution of skills using button sequences, and gravity confirmed proper falling behavior after jumps. Collision hitbox checked hitbox changes, and animation movement ensured the character's animations responded correctly to player input. Results were noted as appropriate or not appropriate for each scenario.

3. RESULTS AND DISCUSSION

Previous studies on game development have extensively explored various aspects such as collision detection methods, game engines, and development frameworks. However, there appears to be a gap in the comprehensive integration of these technologies with user experience design and the assessment of long-term player engagement [4]. Additionally, while collision detection and game engine functionalities have been well-documented, there is limited research on their combined impact on both the technical performance and the overall narrative and gameplay experience. This study investigated the effects of implementing the FSM method within the context of a retro fighting game, focusing specifically on its influence on the fluidity of character movements and the effectiveness of the combo system [13].

While earlier studies have explored the impact of collision detection algorithms and game engines like Godot on game development efficiency and technical performance. They have not explicitly addressed its influence on enhancing gameplay mechanics such as combo systems or the overall user experience in action-oriented games. This study employs the FSM method, integrated within the GDLC, to enhance gameplay mechanics and overall user experience in the development of a retro fighting game. The FSM

method was selected for its ability to efficiently manage complex character movements and state transitions, which are critical in action-oriented games [17]. By systematically applying this method, the study aimed to address the challenges identified in previous research, particularly the need for more fluid and responsive gameplay. The results presented here will demonstrate the effectiveness of the FSM method in achieving these objectives, and the subsequent discussion will explore the implications of these findings in the context of current game development practices [16].

3.1. Data processing

Data processing plays a critical role in analyzing and synthesizing the various elements that contribute to the game's development. The assets, story draft, and gameplay mechanisms are meticulously examined to understand how they interact and influence the overall gaming experience. This process involves evaluating the effectiveness of the visual and audio assets in conveying the game's theme, analyzing the coherence and engagement level of the story draft, and assessing the gameplay mechanisms for their impact on player immersion and satisfaction [18]. By processing this data, the study aims to identify key insights and patterns that inform the success of the game design and suggest areas for further refinement or development.

3.1.1. Asset

Explaining assets refers to detailing the visual, audio, and interactive elements that make up a game. Assets include components such as character models, textures, sounds, and animations that contribute to the game's aesthetics and functionality. Understanding and explaining these assets help researchers and developers assess their impact on gameplay experience and technical performance.

a) Character animation spritesheet
   This entity demonstrates in Figure 4 the silhouette of the player currently engaged in gameplay.
b) Audio
   Sound recordings retrieved from the YouTube channel "unroyalty.com" and the website "Freesound" (https://freesound.org) were utilized.

Figure 4. Asset Ryan and Jaka 's characters

3.1.2. Gameplay mechanism

The gameplay mechanism in game development research is crucial for providing insights into how a game functions and engages players. It helps developers understand the underlying systems, interactions, and rules that define player experiences and game dynamics [19]. By clearly outlining the gameplay mechanism, researchers can communicate design choices and innovations, guiding future improvements and fostering collaboration among developers. Hit combo and skill usage is:

a) Hit combo usage
   Each character features three distinct types of hit combos as shown in Figures 5 and 6, each activated by repeatedly pressing a button. As a result, the animation sequence on the player sprite will appear sequential and dynamic with each successive hit.
b) Skill usage
   Characters in this context are endowed with skills that are activated in a bifurcated fashion: first, by directional inputs and subsequently, by the deliberate execution of specific skill commands as outlined in a predetermined sequence as in Figure 7.

Figure 5. Animated sprites every hit on the character Jaka (left) and Ryan (right)

Figure 6. Animated sprites jump and run-hit on the character Jaka (left) and Ryan (right)

Figure 7. Character Jaka (left) and Ryan (right) use the skills

3.2. Process implementation

FSM on this research used on node of Godot engine that is AnimationNodeStateMachine and usage code in GDScript in movement and usage skill on mechanism control character player as can be seen in Figure 8. Introduction will discuss AnimationNodeStateMachine used for to do transition on node AnimationPlayer one to other. Code in GDScript used for explain animation on AnimationNodeStateMachine. This code use 4 functions main from Script "Player.gd" that is “inputMovement()”, “_inputAir()”, “_inputHit()”, “_inputSkill()”. Could see whole from Script "Player.gd" via this website link https://bit.ly/35Hkeus.

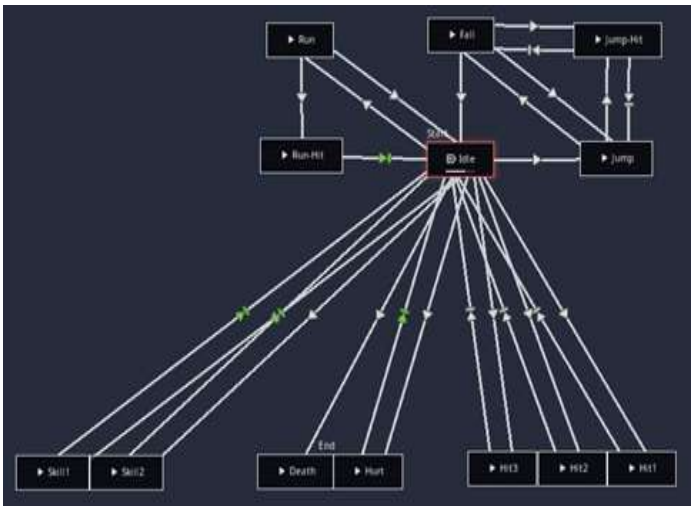

Figure 8. Finite state machine character player

3.3. Display - game content view

The game view content comprises a sequence of meticulously crafted images, each capturing pivotal moments within the game's narrative. These visuals are meticulously curated to evoke emotion, convey story beats, and immerse players in the game world. Through meticulous attention to detail, the developers ensure that each image aligns seamlessly with the overarching vision of the game [20]. The adjustments made to these images are carefully considered, adhering closely to the initial plan during the conceptualization phase [21]. This adherence to the original vision ensures consistency and coherence throughout the game's visual storytelling, enhancing the player experience as can be seen in Figure 9.

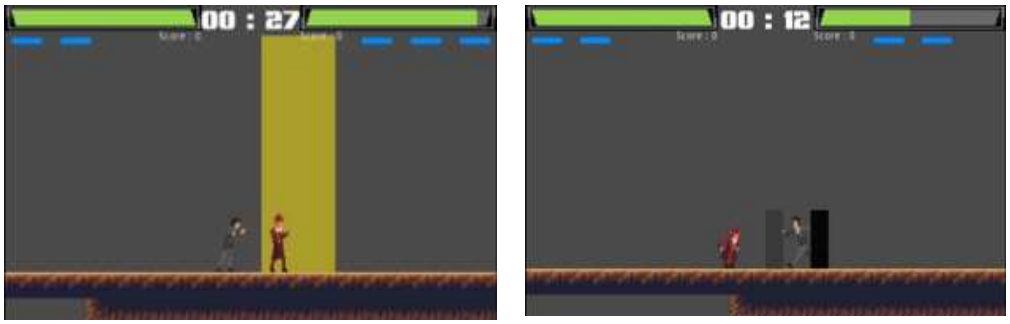

Figure 9. Character Jaka use skill 1 (left) and skill 2 (right)

3.4. Test results

The test results from the control player test are crucial in evaluating the effectiveness and playability of the game [22]. This test involved a selected group of players who were asked to engage with the game under controlled conditions, allowing the research team to monitor and record their interactions, responses, and feedback. The collected data provides insights into the game's usability, difficulty level, and overall player satisfaction. By analyzing these test results, the study aims to determine how well the game meets its design objectives, identify any potential areas for improvement, and assess whether the gameplay mechanics function as intended to create an engaging and enjoyable experience for players [23].

3.4.1. Control player test

Player control test experiments in game development are designed to assess game controls' responsiveness, intuitiveness, and overall effectiveness. Through controlled gameplay scenarios, testers evaluate the ease of player navigation, interaction with game elements, and mastery of mechanics as can be seen in Table 1. Feedback from these experiments guides refinements to enhance player agency, immersion, and enjoyment.

Table 1. Test combo hits and skills

Scenario test	Case test	Expected results	Test result system
Player wants to move character to left	Push arrow left (Player 1), J (Player2), Left analog controller	Character move to the left	In accordance
Player wants to move character to right	Push arrow right (Player 1), L (Player 2), Right analog controller	Character move to the right	In accordance
Player wants to make character can hit	Push Z button (Player 1), A button (Player 2), Controller Square button	Character will hit	In accordance
Player wants to make character can jump	Push X button (Player 1), S button (Player 2), Controller Cross button	Character will jump	In accordance
Player wants to make character can Secrete ability special	Push C button (Player 1), D button (Player 2), Controller	Character will take out skills	In accordance

3.5. Combo hits and skills test

Combo hit and skill experiments in game development aim to fine-tune combat mechanics and character abilities. Combo hit tests evaluate chaining attacks for fluidity and impact, while skill experiments assess the effectiveness and balance of special abilities as can be seen in Table 2. These experiments inform adjustments to enhance gameplay depth, challenge, and player satisfaction.

Table 2. Combo hits and skills test

Scenario test	Case test	Expected results	Test result system
Player want to character can hit sequentially with one button	Push Z button (Player 1), A button (Player 2), Controller Square button	Character To do animation o'clock by sequentially	Succeed
Player want to character can take out skills	Hit button combination for take out skills from games	Character Secrete skills	Succeed

3.6. Gameplay test

The gameplay test stage involves evaluating how the game is played by implementing various testing scenarios. These scenarios are closely related to specific test cases, which include the expected outcomes and the status of the results [24]. By comparing actual outcomes with expected ones, testers can identify any discrepancies and areas that may require improvement [4]. The gameplay tests are conducted independently to ensure unbiased results, providing a comprehensive understanding of the game's functionality and user experience [25]. Detailed information about these tests, including the scenarios and outcomes, is provided in Table 3, allowing for clear documentation and analysis of the game's performance.

Table 3. Gameplay test

Scenario test	Case test	Expected results	Test result system
Character Energy Points reduce when use skills	Players use character skills	Energy points of players are reduced	Succeed
Attacking players character enemy	Players use the choices character for attack character enemy	Character Health Points enemy reduce	Succeed
Players can win the match round	Character enemy Player health points finished	Player wins the round	Succeed
Players get points after win the match round	Player wins the match round	Player gets 1 point round	Succeed
Player wins competition win competition moment have 2 points round	Player wins 2 match rounds	Games showing victory players display and games done	Succeed

3.7. User test

Table 4 presents the results of the user test, evaluating various aspects of the Brawl Tale game, including character movement, combo hit system, skills system, running and jumping hits, and user interface (UI) experience. Respondents were asked to rate each feature as "Not enough," "Enough," or "Well." The majority of respondents gave positive feedback on movement, combo hits, and game performance on their devices, with most features rated as "Well" or "Enough." The skills system, however, received a higher proportion of "Not enough" responses, indicating an area for potential improvement.

Table 4. User test

Question	Evaluation		
	Not enough	Enough	Well
How opinion respondent with movement characters?	1 respondent	5 respondents	14 respondents
How opinion respondent with combo hit system?	3 respondents	8 respondents	9 respondents
How opinion respondent with skills system?	7 respondents	6 respondents	7 respondents
How opinion respondent with “running hit” and “jumping hit”?	5 respondents	5 respondents	10 respondents
is Brawl Tale game can running on Laptop/PC respondents	1 respondent	-	19 Respondents
Is respondent like control on games?	9 respondents	-	11 Respondents
How respondent opinion with the UI experience in the game?	4 respondents	14 respondents	12 respondents

4. CONCLUSION

The implementation of the Brawl Tale game provides several significant insights into game development using FSM. This research focused on creating an arcade game with a combo hit system, showcasing how FSM can streamline character movements within the game when implemented through GDScript. The game's character development is inspired by legendary fictional figures, with freelance artists contributing to sprite and animation design. For future research and development, enhancements in graphics for characters and objects are recommended to increase visual appeal. Additionally, incorporating features such as traps or obstacles can add complexity and challenge. Introducing artificial intelligence (AI) opponents could also provide a more engaging experience for players who wish to play solo in Brawl Tale.

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REFERENCES

[1] M. F. Syahputra, A. Arippa, R. F. Rahmat, and U. Andayani, "Historical theme game using finite state machine for actor behaviour," *Journal of Physics: Conference Series*, vol. 1235, no. 1, p. 012122, Jun. 2019, doi: 10.1088/1742-6596/1235/1/012122.

[2] K. Fathoni, R. Y. Hakkun, and H. A. T. Nurhadi, "Finite state machines for building believable non-playable character in the game of Khalid ibn Al-Walid," *Journal of Physics: Conference Series*, vol. 1577, no. 1, p. 012018, Jul. 2020, doi: 10.1088/1742-6596/1577/1/012018.

[3] P. M. Dower, W. M. McEneaney, and M. Cantoni, "A game representation for a finite horizon state constrained continuous time linear regulator problem," *Applied Mathematics & Optimization*, vol. 88, no. 1, p. 19, Aug. 2023, doi: 10.1007/s00245-023-09972-6.

[4] S. Kumar, Nitin, and M. Yadav, "Finite state machine for testing the GUI using genetic algorithm based on weightage given to different classes," in *Recent Developments in Electronics and Communication Systems*, IOS Press, 2023, pp. 689–697.

[5] A. Andi, J. Charles, O. Pribadi, C. Juliandy, and R. Robet, "Game development 'kill corona virus' for education about vaccination using finite state machine and collision detection," *Kinetik: Game Technology, Information System, Computer Network, Computing, Electronics, and Control*, Nov. 2022, doi: 10.22219/kinetik.v7i4.1470.

[6] M. Pratama, Y. Yanfi, and P. D. Nusantara, "WizardOfMath: a top-down puzzle game with RPG elements to hone the player's arithmetic skills," *Procedia Computer Science*, vol. 216, pp. 338–345, 2023, doi: 10.1016/j.procs.2022.12.144.

[7] A. F. Pukeng, R. R. Fauzi, Lilyana, R. Andrea, E. Yulsilviana, and S. Mallala, "An intelligent agent of finite state machine in educational game 'Flora the Explorer,'" *Journal of Physics: Conference Series*, vol. 1341, no. 4, p. 042006, Oct. 2019, doi: 10.1088/1742-6596/1341/4/042006.

[8] W. Park, "Intelligent camera using a finite-state machine (FSM)," in *Proceedings of the 2020 14th International Conference on Ubiquitous Information Management and Communication, IMCOM 2020*, 2020, pp. 1–9, doi: 10.1109/IMCOM48794.2020.9001707.

[9] L. D'Alotto, "Infinite games on finite graphs using grossone," *Soft Computing*, vol. 24, no. 23, pp. 17509–17515, Dec. 2020, doi: 10.1007/s00500-020-05167-1.

[10] M. W. Waterman, D. C. Frezzo, and M. X. Wang, "Adaptive learning using finite state machine logic," in *Proceedings of the Seventh ACM Conference on Learning @ Scale*, Aug. 2020, pp. 237–240, doi: 10.1145/3386527.3406720.

[11] A. Aurell, R. Carmona, G. Dayanıklı, and M. Laurière, "Finite state graphon games with applications to epidemics," *Dynamic Games and Applications*, vol. 12, no. 1, pp. 49–81, Mar. 2022, doi: 10.1007/s13235-021-00410-2.

[12] J. Černý, B. Bosanský, and B. An, "Finite state machines play extensive-form games," in *Proceedings of the 21st ACM Conference on Economics and Computation*, Jul. 2020, pp. 509–533, doi: 10.1145/3391403.3399517.

[13] M. R. K. Gogoi, "A software system for a finite state machine (FSM)," *International Journal for Research in Applied Science and Engineering Technology*, vol. 10, no. 7, pp. 795–806, Jul. 2022, doi: 10.22214/ijraset.2022.44711.

[14] A. Logg, C. Lundholm, and M. Nordaas, "Finite element simulation of physical systems in augmented reality," *Advances in Engineering Software*, vol. 149, p. 102902, Nov. 2020, doi: 10.1016/j.advengsoft.2020.102902.

[15] M. F. Abu Hassan, M. H. Md Saad, M. F. Ibrahim, and A. Hussain, "A finite state machine fall detection using quadrilateral shape features," *Bulletin of Electrical Engineering and Informatics (BEEI)*, vol. 7, no. 3, pp. 359–366, Sep. 2018, doi: 10.11591/eei.v7i3.1184.

[16] U. Ainuddin and M. Waqas, "Finite state machine and Markovian equivalents of the lac Operon in E. coli bacterium," *AIMS Bioengineering*, vol. 9, no. 4, pp. 400–419, 2022, doi: 10.3934/bioeng.2022029.

[17] A. E. Adeniyi *et al.*, "Development of two dimension (2D) game engine with finite state machine (FSM) based artificial intelligence (AI) subsystem," *Procedia Computer Science*, vol. 235, pp. 2996–3006, 2024, doi: 10.1016/j.procs.2024.04.283.

[18] D. Lacko, H. Machackova, and D. Smahel, "Does violence in video games impact aggression and empathy? A longitudinal study of Czech adolescents to differentiate within- and between-person effects," *Computers in Human Behavior*, vol. 159, p. 108341, Oct. 2024, doi: 10.1016/j.chb.2024.108341.

[19] P. Healy, K.-L. You, A. Xu, T. H. Thomas, and D. Babichenko, "A narrative serious game to teach self-advocacy skills in advanced cancer," *Procedia Computer Science*, vol. 206, pp. 162–172, 2022, doi: 10.1016/j.procs.2022.09.095.

[20] V. Beltrán-Palanques, "Assessing video game narratives: implications for the assessment of multimodal literacy in ESP," *Assessing Writing*, vol. 60, p. 100809, Apr. 2024, doi: 10.1016/j.asw.2024.100809.

[21] K. Krappala, L. Kemppinen, and E. Kemppinen, "Achievers, explorers, wanderers, and intellectuals: educational interaction in a Minecraft open-world action-adventure game," *Computers and Education Open*, vol. 6, p. 100172, Jun. 2024, doi: 10.1016/j.caeo.2024.100172.

[22] A. del Rio, J. Serrano, D. Jimenez, L. M. Contreras, and F. Alvarez, "Multisite gaming streaming optimization over virtualized 5G environment using deep reinforcement learning techniques," *Computer Networks*, vol. 244, p. 110334, May 2024, doi: 10.1016/j.comnet.2024.110334.

[23] M. Croissant, G. Schofield, and C. McCall, "Theories, methodologies, and effects of affect-adaptive games: a systematic review," *Entertainment Computing*, vol. 47, p. 100591, Aug. 2023, doi: 10.1016/j.entcom.2023.100591.

[24] I. Roca, Ó. Pastor, C. Cetina, and L. Arcega, "Co-evolving scenarios and simulated players to locate bugs that arise from the interaction of software models of video games," *Information and Software Technology*, vol. 169, p. 107412, May 2024, doi: 10.1016/j.infsof.2024.107412.

[25] M. Rocha, A. Simão, and T. Sousa, "Model-based test case generation from UML sequence diagrams using extended finite state machines," *Software Quality Journal*, vol. 29, no. 3, pp. 597–627, Sep. 2021, doi: 10.1007/s11219-020-09531-0.

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