Republic of the Philippines
Laguna State Polytechnic University
Province of Laguna

COLLEGE OF COMPUTER STUDIES

Animar: Integrating Augmented Reality in Stop-Motion Animation for Immersive Storytelling

Submitted by:
Caballes, John Lyold D.
BSIT 3C AMG-B

INTRODUCTION

Animation has long been an influential force in education, entertainment, and advertising, continuously adapting to new technologies and storytelling methods (Pallant & Price, 2023). Among various animation techniques, stop-motion animation stands out for its tactile craftsmanship and distinctive visual appeal (Honess Roe, 2019). Despite its enduring popularity, stop-motion animation presents challenges related to labor-intensive production and passive audience engagement (Morisawa & Nakamura, 2022). Traditional stop-motion lacks real-time interactivity, making it difficult for viewers to actively engage with animated narratives.

To bridge this gap, Augmented Reality (AR) has emerged as a promising solution. AR enhances storytelling, immersion, and user interaction by overlaying digital elements onto real-world environments (Papagiannis, 2020; Speicher et al., 2019). When integrated into animation, AR transforms passive viewing into active participation, creating interactive storytelling experiences where audiences can engage with characters and modify narratives (Azadegan et al., 2022).

This research introduces Animar, an Augmented Reality-Enhanced Stop-Motion Animation System that combines the handcrafted artistry of stop-motion with AR-driven interactivity. By implementing real-time object recognition, dynamic storytelling, and digital customization, Animar transforms stop-motion animation into a user-driven experience (Raudaskoski & Mantere, 2023). Through AR, viewers gain the ability to interact with animated characters, explore customizable environments, and influence story developments, enhancing engagement beyond conventional animation techniques (Kim & Han, 2021).

Beyond entertainment, Animar has educational applications, providing a dynamic learning tool for students and educators. Research suggests that interactive storytelling improves attention span and comprehension, particularly in multimedia and digital arts education (Jitsupa, 2022. Farrokhnia, 2023). By allowing learners to engage with animated content through augmented interactions, AnimaR offers an innovative platform for experiential learning and creative expression.

Despite advancements in AR, literature on AR-enhanced stop-motion animation remains scarce. Most research focuses on AR's application in 2D and 3D animation, leaving stop-motion largely unexplored (Casas & Koseky, 2023). This study aims to address this research gap by demonstrating how AR can modernize stop-motion animation, creating a more immersive, interactive, and participatory storytelling experience through Animar By

integrating traditional animation craftsmanship with emerging AR technologies, this study contributes to the evolving discourse on interactive digital media. The findings may serve as a foundation for future developments in AR-enhanced animation, influencing both creative industries and educational applications, while redefining the relationship between audience interaction and animated storytelling.

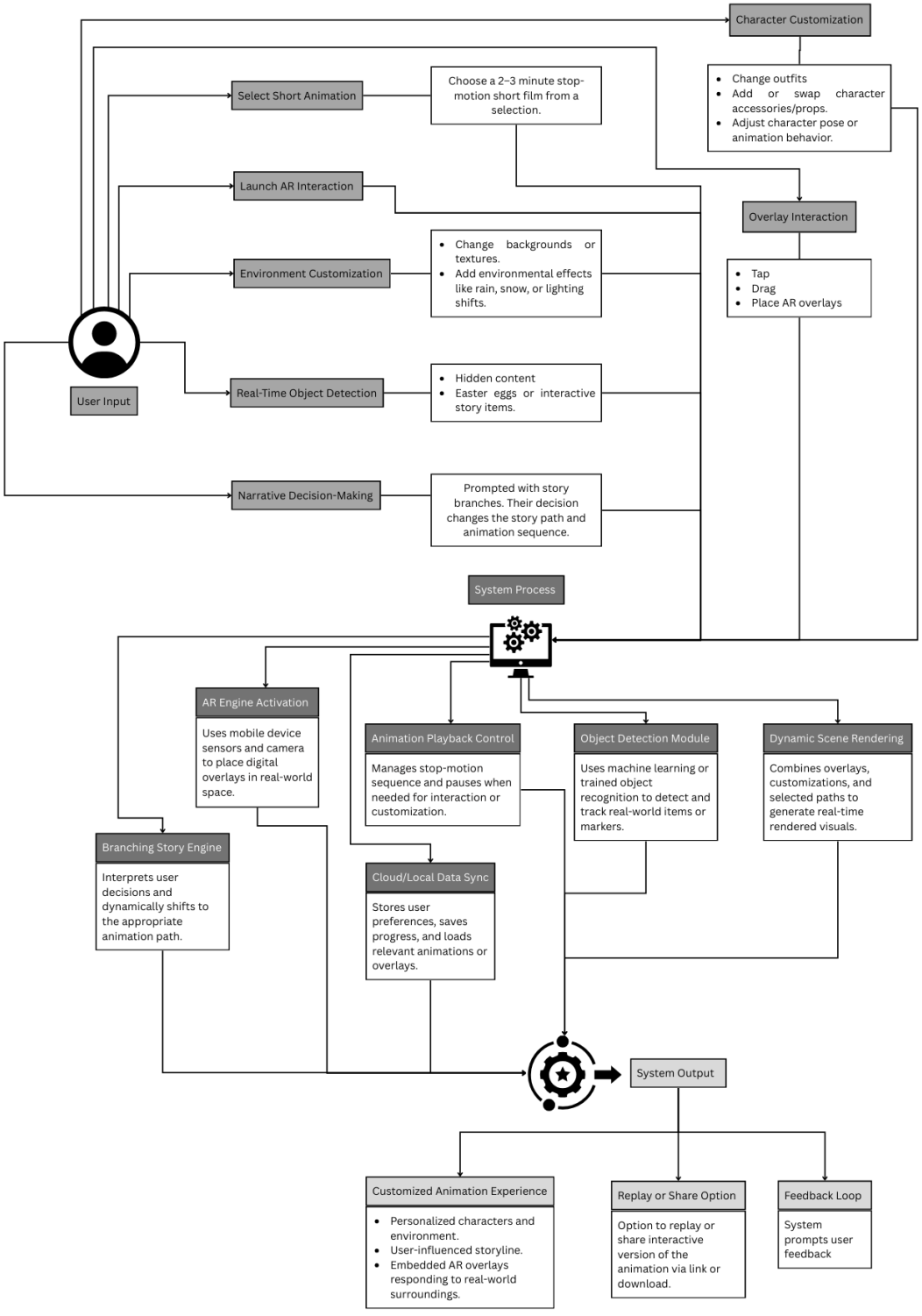
General Objectives

This study aims to create a system and animation entitled “Animar: An Augmented Reality-Enhanced Stop-Motion Animation System for Interactive Storytelling”.

Specific Objectives:

1. To design and develop an AR-powered system that seamlessly integrates AR overlays into stop-motion.
    1.1. Interactive overlays
    1.2. Real-world interaction
2. To implement real-time object detection that allows users to scan objects within the animation to reveal hidden objects/details or interactive elements.
3. To enable characters and environment customization.
    3.1. Modify character outfits, props and backgrounds.
4. To introduce interactive storytelling features, where users can make narractive choices that affect the storyline and animation outcome.
5. To evaluate the effectiveness of Animar in enhancing audience engagement and interactivity in stop-motion through user testing and feedback analysis.

Conceptual Framework



Animar conceptual model establishes the most important elements and dependencies that determine the development and operational behavior of the system. It begins with the user's ability to control and personalize through various interactive options. Users can select a stop-motion animation of 2 to 3 minutes, activate the augmented reality (AR) interaction, and alter

the environment by altering backgrounds or adding effects like rain, snow, or lighting changes. In addition, the system incorporates real-time object detection, where users can uncover hidden content or interactive objects that enhance the storytelling.

One of the most striking features of the system is the addition of narrative decision-making. Users are shown branches of the story throughout the course of the animation, and their choices dynamically alter the story and order of animation. Character modification is another large feature, and users can adjust clothing, accessories, and animation behaviors. With this, overlay interactions such as tapping, dragging, or introducing AR elements let users, effectively, directly interact with the animated scenes within their real-world space.

The system component that is dedicated to system processes in the design outlines the technical support for user interactions. The augmented reality engine uses mobile cameras and sensors to create overlays on the real world, and the animation playback control handles timing and stop-motion animation pauses to ensure seamless interaction. A machine learning object detection module identifies real-world objects, enabling animations to be customized to their physical world. All these processes are combined through a branching narrative engine that assesses user choices and changes the animation accordingly. In addition, the system utilizes cloud and local data synchronization mechanisms to maintain user preferences, session progressions, and animation assets. This offers seamless and customized user experience across sessions. Dynamic scene rendering combines selected paths, environmental adjustments, and augmented reality overlays to generate real-time visual outputs that match inputs from the user.

The end product produced by the system is a fully customized animation experience. This is in terms of personalized characters, settings, and storylines governed by users, supplemented by AR overlays that adapt to real surroundings. The users are also afforded the capacity to replay or share their interactive animations and are asked to leave comments, which can be used by the system to enhance subsequent sessions.

In brief, this model illustrates how Animar combines user interaction, interactive story-telling, and smart system response to create a unique, interactive, and responsive animation platform. It emphasizes the importance of personalization, real-time interaction, and feedback integration in designing an interactive and fun digital experience through the use of stop-motion and augmented reality technologies.

Scope and Limitation of the Study

The study focuses on designing, developing, and testing Animar, an Augmented Reality-Enhanced Stop-Motion Animation System, that will enhance user interaction with real-time object detection, customization, and interactive storytelling. The study is geared towards animation students, digital artists, and stop-motion animators looking for an improved and interactive form of storytelling. The system will feature AR object detection, allowing users to scan objects in an animation to reveal hidden content or trigger additional interactions. The system will also provide customization, where users will be able to modify character designs, accessories, and backgrounds, and interactive storytelling, where users will be offered the choice of making decisions that affect the narrative. The system development will be through the implementation of Unity with AR Foundation for AR integration, Python and MySQL for data storage, and the Rapid Application Development (RAD) practice for the sake of keeping it flexible and constantly improving. The usability of Animar will be tested through usability testing, surveys, and engagement analysis, with regard to how augmented reality enhances audience engagement in stop-motion animation.

Even with its innovative approach, the study has some limitations. The system is specifically designed only for stop-motion animation, i.e., it does not support 3D animation or live-action shooting. The user test will also be restricted to a test group of animation producers and students, not a general wider population. The customizability features, though enabling real-time adjustments, will remain rudimentary compared to industrial animation software. Another limitation is the system's dependency on AR-capable smartphones or tablets, thereby potentially limiting accessibility for users with older devices. Animar does not also encompass high-end visual effects (VFX) or AI-driven animation enhancement since the study is more interested in interactive engagement than with sophisticated animation techniques.

Overall, this research investigates how augmented reality (AR) can make stop-motion animation more engaging and, in the process, transform the art form from a passive viewing experience into an interactive and immersive art form. Since the research is on fundamental AR integration, the follow-up studies can build on AI-based enhancements, broader testing audiences, and more animation techniques included to further drive interactive storytelling within the animation universe.

Review of Related Literature

Stop-motion animation has long been celebrated for its handcrafted aesthetic and tangible artistry (Zhao, 2023). Despite its enduring appeal, it faces challenges in maintaining audience engagement in an era dominated by interactive and immersive media (Shtets & Melnyk, 2024). To address this, researchers have explored ways to integrate modern technology into stop-motion workflows, ensuring its continued relevance in digital storytelling (Shibhalini, 2023).

Augmented Reality (AR) has emerged as a transformative medium that enhances engagement, immersion, and user interaction in digital storytelling (Weng, 2022). In animation, AR introduces real-time object detection, dynamic overlays, and personalized interactions, reshaping traditional storytelling methods (Farrokhnia, 2023). Studies suggest that AR fosters active audience participation, allowing users to explore and modify narratives rather than passively consuming content (Jitsupa, 2022).

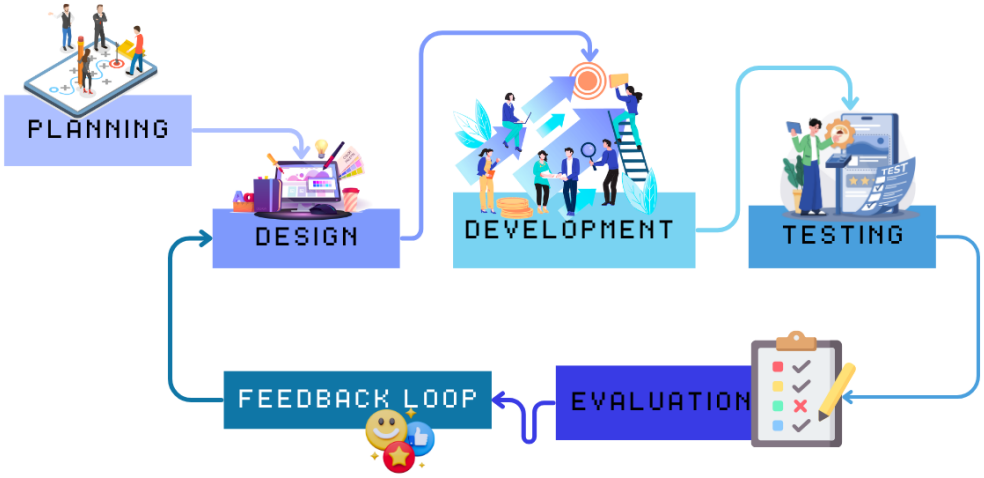
Interactivity plays a crucial role in audience engagement, and AR-powered stop-motion animation offers users control over character actions, environment modifications, and plot development (Weng, 2022). Educational applications of interactive storytelling indicate increased attention spans, comprehension, and retention, particularly for young audiences and students (Jitsupa, 2022). This positions AR-enhanced stop-motion animation as a promising tool for learning-based media beyond entertainment (Farrokhnia, 2023).

The evolution of stop-motion animation has seen growing adoption of 3D printing, CGI, and AR technologies (Shibhalini, 2023). While traditional stop-motion relies on hand-sculpted puppets and frame-by-frame animation, AR introduces real-time animation adjustments, bridging physical craftsmanship with digital precision (Zhao, 2023). This hybrid approach allows animators to retain the organic textures of stop-motion while enhancing flexibility through digital tools (Shtets & Melnyk, 2024).

Despite the advancements in AR and digital animation, literature focusing on stop-motion integration remains limited. Most studies examine AR applications in 2D or 3D animation, leaving stop-motion largely unexplored (Shibhalini, 2023). The development of AnimaR seeks to bridge this gap by examining how AR can transform stop-motion animation into an interactive, dynamic, and immersive storytelling experience (Weng, 2022). By integrating real-time object recognition, character customization, and user-driven narrative pathways, this research contributes to expanding AR applications within the field of stop-motion animation.

Methodology

The proponents employed the Rapid Application Development (RAD) model to efficiently design and develop an AR-powered stop-motion system. RAD emphasizes quick iterations, flexibility, and user involvement throughout the development process, making it well-suited for the creation of systems that require constant feedback and iterative improvement.



Planning

The planning phase is crucial to the successful development of the AR-powered stop-motion system. Initially, the proponents gather requirements by conducting interviews with key stakeholders, including animation experts, AR specialists, and potential end-users. The requirements include technical specifications for AR integration, understanding the needs for animation playback, and determining which stop-motion features (puppet movements, scene changes) will be enhanced with AR technology. Additionally, the team collects references from similar projects in AR and animation to inform their development. This phase also includes a detailed timeline outlining the system's major milestones, such as prototype completion, feature implementation, and user testing sessions.

Design

In the design phase, the proponents focus on creating the user interface (UI) and user experience (UX) wireframes for the AR-powered system. The UI/UX design is critical for ensuring that users can easily interact with both the stop-motion and AR features. The proponents use wireframing tools (Figma or Adobe XD) to design the system's layout, incorporating key features such as AR rendering controls, animation playback options, and interaction buttons. System architecture is also defined during this phase, including how the AR layers will be integrated into the stop-motion scenes and how the system will handle real-

time rendering and animation synchronization. Early prototyping helps identify potential usability issues and allows for early-stage user feedback.

Development

The development phase focuses on building the core functionalities of the AR-powered stop-motion system. The system is developed using appropriate technologies and frameworks to facilitate smooth integration of AR with stop-motion animations. For AR rendering, tools like ARKit (for iOS) or ARCore (for Android) are employed, enabling the system to display interactive AR elements on top of the stop-motion animation. The development team also focuses on coding the animation playback functionality, ensuring that animations are smooth, and AR elements react accurately to user inputs. In this phase, frequent code revisions are made, incorporating feedback from earlier user interactions and prototype testing. The development process is iterative, with each version refined based on real-time testing and evaluations.

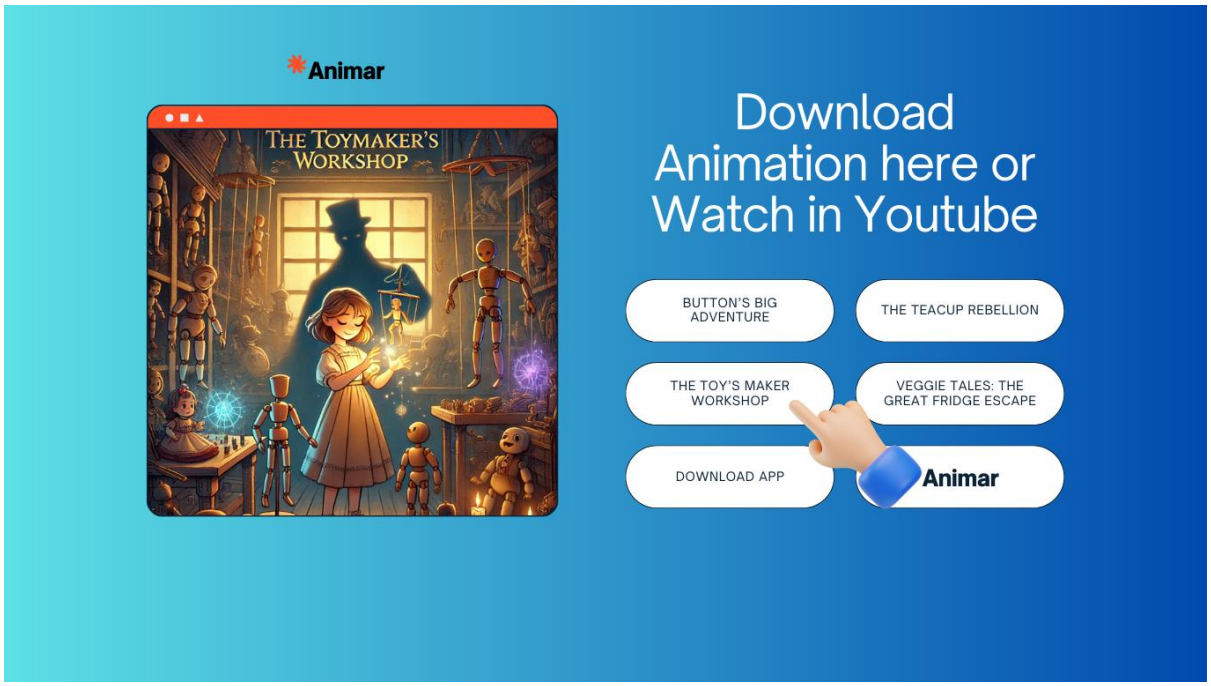
Testing

Each feature is tested with unit testing to ensure primary functionalities such as rendering of augmented reality (AR), playback of animations, and user interaction. The proponents use testing libraries and tools to benchmark the performance and stability of the system. The user testing is performed at various stages to ensure that the system is user-friendly and in compliance with the users' expectations. Feedback from technical users (animators, AR developers) and non-technical users (general public) is gathered to measure ease of use, usability, and quality of integration of AR with stop-motion. The system is also tested on various devices and platforms to ensure compatibility and responsiveness.

Evaluation

The evaluation process is tasked with the organized gathering of precise feedback from end-users and stakeholders after the first deployment of the system. Feedback is crucial in establishing the level to which the AR-based stop-motion system meets the project requirements and user needs. Surveys, interviews, and observational studies are employed by the proponents in gathering data regarding user experience, system performance, and possible improvements. Based on the gathered data, the system is improved and enhanced to remedy any issues or recommendations noted. Continuous evaluation and iteration guarantee that the system becomes better, hence ensuring a seamless user experience while maintaining the integrity and authenticity of the stop-motion medium.

Storyboard



The opening screen introduces users to the Animar platform, where multiple interactive stories are featured. This menu reinforces the platform's hybrid nature offering both interactive and passive viewing modes. Users can download an interactive version or simply watch a linear version. The playful and imaginative tone sets the stage for engaging, child-friendly content.

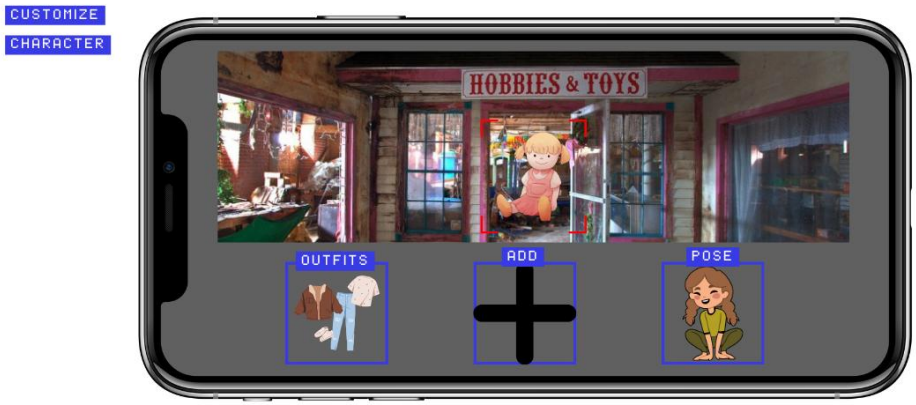
User Interaction:

- Select a story by tapping/clicking.
- Visually explore different story thumbnails.
- Decide which adventure to personalize.
- Choose between interacting with the story or watching it unfold.

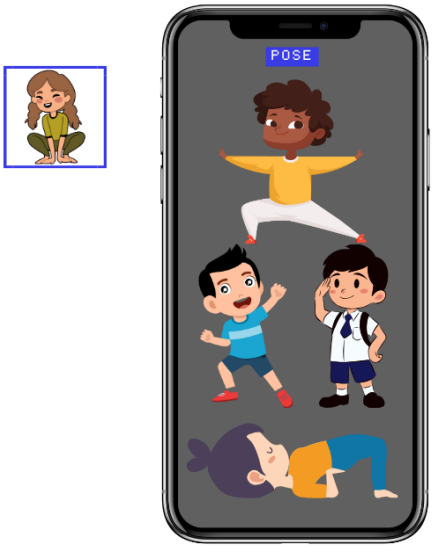
This marks the start of the core interactive experience. Each tool allows users to manipulate the animation in unique ways, either by modifying visuals or affecting the story path.

User Interaction:

- Tap to activate layers, change costumes, or trigger real-world integration.
- Provides animators with editable assets.
- Promotes creativity and experimentation.



The user becomes the **co-creator** of the character's appearance and animations. It feels like dressing up a digital puppet with animation-ready controls.



User Interaction:

- Drag-and-drop outfit changes.
- Adjust pose by selecting templates or rotating limbs.
- Ideal for young users and animators learning

Users aren't just editing characters they have full access to scene creation tools. This includes changing backdrops, lighting, object placement, and more.

User Interaction:

- Tap on scenery to modify.
- Place AR objects via camera or draw your environment with basic tools.
- Blends digital animation with user imagination.

This is an example of Narrative Decision Making. The user's choice here could influence the direction, ending, or new scenes.

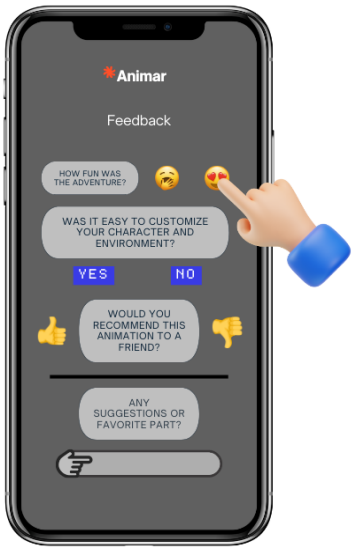
User Interaction:

- Choice screen pauses the animation.
- Tapping "Yes" leads to an indoor sequence (a haunted dollhouse).
- Tapping "No" redirects or offers new exploration areas.

After the story concludes, the platform invites users to save their version or replay with different choices. This promotes replayability and gives users ownership of their animated stories.

User Interaction:

- Save to personal gallery or share.
- Re-enter story with different narrative paths.
- Encourage users to re-customize scenes or characters.



After completing the story, users are prompted to reflect on their experience. This gives them a voice and helps the system adapt and grow with user input. It also creates a loop of communication between creators (animators) and viewers (users).

References

Casas, R., & Koseky, J. (2023). Augmented Reality in Animation: Integrating AR into Stop-Motion Techniques. International Journal of Interactive Media and Digital Arts, 12(3), 189–204.

Farrokhnia, R. (2023). Augmented reality in interactive storytelling. *Springer AI and AR Studies*, 14(2), 134-147. https://link.springer.com/chapter/10.1007/978-3-031-47655-6_8

Farrokhnia, R. A. (2023). Inclusive digital storytelling: Artificial intelligence and augmented reality to re-center stories from the margins. Lecture Notes in Computer Science, 14383, 117–137. https://link.springer.com/chapter/10.1007/978-3-031-47655-6_8

Honess Roe, A. (2019). Stop-motion animation: Frame by frame in cinema. Edinburgh University Press.

Jitsupa, N. (2022). Interactive stop-motion animation for educational engagement. *Journal of Digital Storytelling and Immersive Media*, 9(3), 229-244. https://icce2022.apsce.net/uploads/P1_C6_84.pdf

Kim, S., & Han, J. (2021). Integrating augmented reality in interactive storytelling. International Conference on Media and Arts Technologies, 9(1), 122–135.

Morisawa, H., & Nakamura, Y. (2022). The evolution of stop-motion animation in modern digital storytelling. Asian Animation Research Journal, 24(3), 189–204.

Pallant, C., & Price, S. (2023). The future of animation: Innovations in storytelling and technology. Animation Studies Review, 32(4), 78–92.

Papagiannis, H. (2020). Augmented reality in creative storytelling. Augmented Media Journal, 15(2), 102–115.

Raudaskoski, S., & Mantere, J. (2023). AR and interactive media: Transforming animated narratives. Journal of Emerging Media Technologies, 17(1), 55–70.

Shibhalini, M. (2023). Hybrid techniques in stop-motion animation: Integrating AR, 3D printing, and CGI. *International Journal of Animation Studies*, 15(1), 78-92. https://link.springer.com/chapter/10.1007/978-3-031-28993-4_20

Shtets, Y., & Melnyk, A. (2024). The impact of student-generated stop-motion animation in science classes: A systematic review. *Academia Digital Education Review*, 7(1), 88-103. https://www.academia.edu/74598970

Speicher, M., Hall, B., & Nebeling, M. (2019). Augmented reality frameworks for immersive experiences. Human-Computer Interaction Journal, 36(2), 230–248.

Weng, J. (2022). Augmented reality applications in animation and audience engagement. *Digital Media Innovations Journal*, 5(4), 183-201. https://icce2022.apsce.net/uploads/P1_C6_84.pdf

Zhao, T. (2023). Stop-motion storytelling: Exploring methods for animating the worlds of rare genetic disease.

Republic of the Philippines
Laguna State Polytechnic University
Province of Laguna

COLLEGE OF COMPUTER STUDIES

Title Defense Rating Sheet

Date: _____ Group No. _____ Time: _____
Name of Proponents: _____
_____
_____
_____

Research Title: _____

CRITERIA	DESCRIPTION	WEIGHT	SCORE
TOPIC ALIGNMENT	The proposed title is timely and aligned to Capstones/Research Agenda Thrust and Priority	20%	
NOVELTY	Had checked the novelty of the proposed topic, identified the gap in the existing literature and /or introduced new ideas	20%	
PURPOSE	The purpose of the proposed capstone/thesis topic is clearly stated and properly identified	20%	
REVIEW OF RELATED LITERATURES AND SYSTEM	Provided sufficient reviews of related studies and system relative to the proposed topic	20%	
FEASIBILITY	The proposed topic is reliable, practical and feasible	20%	
TOTAL			

PRE-PROPOSAL VERDICTS

[ ] **APPROVED**. Minor revisions are necessary but they do not have to be presented in front of and checked by all panelists. **86 – 100**

[ ] **APPROVED WITH REVISIONS**. Major revisions shall be incorporated in the final copy of the revised Project Proposal summary. These must be checked by the panelists. **70 – 85**

[ ] **DISAPPROVED**. The Proponents/Researchers failed to propose a researchable or scholarly Thesis / Capstone Project. **Below 70**

_____ _____
Role on the Defense Signature over Printed Name of Evaluator

Republic of the Philippines

Laguna State Polytechnic University

Province of Laguna

COLLEGE OF COMPUTER STUDIES

COMMENT FORM

Date: _____ Group No.: _____ Time: _____

Name of Proponents: _____

_____

_____

Research Title: _____

_____

Consolidated Comments / Suggestions / Recommendation:

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Co-Author

Name	Function	Conforme Signature
	Panel 1- Chair	
	Panel 2	
	Panel 3	

Form 9

CCS-SR-_____