Jurnal Pemberdayaan Masyarakat
Volume 4 Nomor 1 Tahun 2025 | Hal. 111 – 124
ykgm.org

ISSN 2962-8091
DOI: 10.46843/jpm.v4i1.383

Integration of Augmented Reality and Motion Capture Technology in the Development of Interactive Animation Based on the Digital Story of Malin Kundang

Joko Sutopo[1], Anggita Taalungan[2], Charles De Haan[3], RB Hendri Kuswantoro[4], Abdul Syukor Mohamad Jaya[5]
[1,2]Faculty of Science and Technology, Universitas Teknologi Yogyakarta, Indonesia
[3,4]Animation and Game, Sekolah Tinggi Multimedia MMTC Yogyakarta, Indonesia
[5]Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka, Malaysia

ABSTRACT

The folk tale of Malin Kundang carries significant moral and cultural values, yet younger generations' interest in conventional storytelling has declined with the advancement of digital technologies. This research addresses that gap by developing an interactive digital animation using Augmented Reality (AR) and Motion Capture (MoCap) technologies to create a more immersive and engaging user experience. Through a mixed-methods approach, including prototype development with Unity 3D, motion tracking using OptiTrack/Xsens, and user testing, the system achieved 95% accuracy in character motion and high user satisfaction. While technical challenges such as latency and hardware constraints remain, the results demonstrate that the integration of AR and MoCap revitalizes traditional stories and offers global benefits—providing scalable solutions applicable to education, cultural heritage preservation, training simulations, and entertainment industries worldwide. This study contributes to the growing field of immersive digital storytelling and offers insights for future research into motion algorithm optimization and developing more accessible MoCap technologies for global use.

ARTICLE INFORMATION

Keywords:
human development index;
SDGs

Correspondent Author:
Joko Sutopo
Email: *jksutopo@uty.ac.id*

Recommended citation: Sutopo, J., Taalungan, A., Haan, C. D., Kuswantoro, R. H., & Jaya,A. S. M. (2025). Integration of Augmented Reality and Motion Capture Technology in the Development of Interactive Animation Based on the Digital Story of Malin Kundang. *Jurnal Pemberdayaan Masyarakat, 4*(1), 111-124.

INTRODUCTION

Malin Kundang is one of the most well-known Indonesian folktales, carrying profound moral lessons such as filial piety, loyalty, and the consequences of disobedience. These values remain highly relevant today, especially in shaping ethical and empathetic behavior among younger generations. However, in the digital era, interest in traditional folktales like Malin Kundang is rapidly declining as children and adolescents are increasingly drawn to visually engaging digital content. This declining interest poses a significant threat to cultural continuity, as the absence of exposure to traditional stories may result in a loss of moral guidance and cultural identity. If younger generations grow up without learning such stories, they risk becoming disconnected from their cultural heritage and may lack awareness of fundamental social values, including respect for parents and personal responsibility. To address this issue, the present study aims to develop an interactive animation based on the Malin Kundang digital story by integrating Augmented Reality (AR) and Motion Capture (MoCap) technologies (Jin et al., 2022), as seen in Figure 1. This approach is expected to make the story more appealing and immersive, re-engaging young audiences while preserving traditional narratives' cultural and moral values (Novia & Zalilludin, 2021).

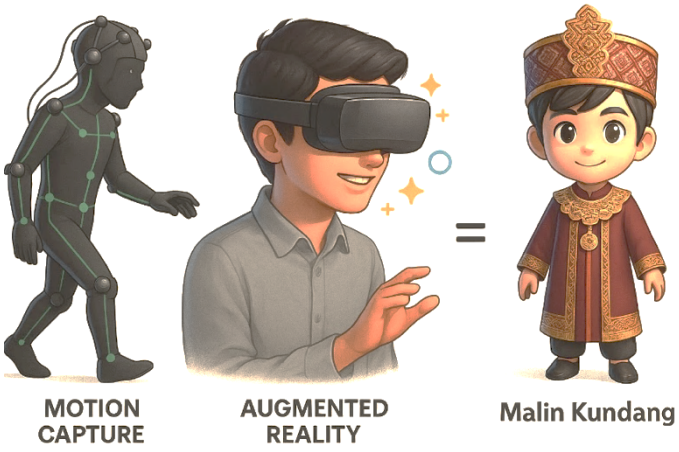

Figure 1. Augmented reality and motion capture

Malin Kundang's legend is one of Indonesia's most well-known folktales. The story contains moral values about obedience, loyalty, and the consequences of disobeying parents. However, in today's digital era, many young people are less interested in reading folklore in conventional form, as seen in Figure 2 and Figure 3. Therefore, the development of technology that can present these stories more engagingly and interactively is necessary. In this context, this study aims to explore the integration of AR and MoCap in the development of interactive animations based on digital stories, assess the effectiveness of these technologies in enhancing user experience, and evaluate the challenges that arise in their implementation (Singh & Ahmad, 2024). Implementing AR in a mobile-based Malin Kundang folktale can increase children's interest in reading and understanding folktales more interestingly and immersively. By combining interactive visual elements and 3D Animation, AR can provide a more immersive experience in understanding traditional stories (Palmarini et al., 2023).



Figure 2. Model 3D Malin Kundang and Malin Kundang's Mother

Integrating AR and MoCap in digital story-based interactive animation can create a more immersive and realistic user experience. MoCap enables more natural character animation by capturing the movements of human actors in real time, while AR brings the characters into the real world with direct user interaction (Alfian et al., 2022). Recent advances in this technology in terms of deep-learning-based human-pose estimation and using motion retargeting to preserve the captured results between the actor's body size and the different skeletal information of the target character have become quite mature (Devagiri et al., 2022). Motion Capture records the actor's movements

using sensors or optical cameras in its technical implementation. This motion data is then translated into a 3D animation model, which is further integrated with AR technology to provide a more realistic and interactive display (Tiwari et al., 2024). For example, using devices such as HoloLens or ARKit, users can see the Malin Kundang character in the real world and interact with it through mobile applications or AR headsets. With AR, users can interact with virtual objects directly. For example, they see objects in 3D that make them feel real. In addition, AR can show events more interestingly, so users are more interested and engaged. In this way, AR becomes an effective tool to bring to life real stories that may have been forgotten (Nurrisma et al., 2021).

In addition, Machine Learning technology is also increasingly applied in MoCap to improve the accuracy and efficiency of motion data processing. AI models can help reduce noise in motion data and produce smoother animations responsive to user interaction. While the integration of AR and MoCap offers many advantages, some challenges still need to be overcome. One of the main obstacles is the latency in synchronization between Motion Capture data and Augmented Reality display. This imperfection in synchronization can cause motion delay, reducing users' immersive experience. In addition, hardware limitations are also a challenge when implementing AR and MoCap. Motion capture systems that use optical cameras require optimal lighting and ample space to avoid motion detection errors. To overcome this, inertial sensor-based MoCap devices that are more portable and can be used in various environments areeing developed (Rauschnabel et al., 2022).

Regarding software, the integration of MoCap data with AR environments still faces challenges regarding real-time rendering and efficient data processing. Therefore, optimization techniques such as motion prediction algorithms and data compression are needed to improve system performance. The integration of AR and MoCap is relevant in the entertainment industry and can be applied in various other fields. For example, these technologies can create more interactive learning experiences in the education industry, such as history simulations or virtual science experiments. In marketing, animated characters generated with this technology can be used in more engaging and innovative digital campaigns. In the film and game industry, AR and MoCap have long been used to enhance the realism of digital characters and environments. As these technologies continue to evolve, the possibilities for creating more immersive and realistic experiences are expanding (Hadi & Permana, 2021).

Although AR and MoCap technologies have been widely used in various fields, such as the entertainment industry, education, and training, there are still challenges in optimally integrating these two technologies. One of the main problems is creating a system that can synchronize the motion data generated from Motion Capture with the Augmented Reality environment in real time without experiencing latency or loss of quality. In addition, the interactivity aspect in digital storytelling is also a challenge that must be overcome, considering that users act as passive spectators and active participants in interactive animation experiences (Santiyasaa et al., 2022).

Various studies have been conducted on the implementation of AR and MoCap. "Integrating Motion-Capture Augmented Reality Technology as an Interactive Program for Children" highlights the integration of AR and MoCap in interactive games for children. The main problem in this study is the lack of physical engagement in digital activities. This research aims to develop a Scratch 2.0-based game that allows children to interact through their body movements in an AR environment. The results showed that this system increased children's motivation to perform physical activities independently (Santi et al., 2021). Furthermore, "Motion Matching for Character Animation and Virtual Reality Avatars in Unity" examines Motion Matching techniques in character animation. This research aims to develop a more realistic animation method using a motion database. The results show that Motion Matching can produce smoother animation and adapt to user interaction in real time (Cannavò et al., 2024).

In the field of education, "Motion Capture Systems and Their Use in Educational Research" conducted a systematic review of the use of MoCap in learning. The main problem identified was the lack of understanding of the benefits and applications of MoCap in schools. This study aims to categorize the various MoCap systems used in education and evaluate their benefits. The results show that MoCap can increase student engagement in movement-based learning and interaction. In addition, "Augmented Reality: Current and New Trends in Education" discusses how AR has evolved as an interactive learning tool. The issue raised is the low adoption of AR in educational environments due to cost and accessibility limitations. This research aims to explore the latest trends in AR implementation in various fields of education. The results show that AR can improve student engagement and learning outcomes by providing a more interactive visual experience (Pieta et al., 2024).

"Augmented Reality with Algorithm Animation and Their Effect on Students' Emotions" highlights the effect of AR-based algorithm animations on student emotions and motivation. The main problem is the lack of emotional engagement in abstract algorithm learning. This research aims to integrate algorithm animation with AR to create a more immersive learning experience. The results showed that this approach can increase students' motivation and engagement, although some students experienced anxiety due to the new learning environment (Scuttari, 2021).

"3D Animation Model with Augmented Reality for Natural Science Learning in Elementary School" focuses on applying AR-based 3D animation models in science learning in elementary schools. The problem identified is students' difficulty understanding abstract science concepts through conventional methods. This research aims to develop AR-based interactive learning media to improve students' understanding of science materials. The results showed that students understood the material more easily with the help of AR animation compared to traditional methods (Wibowo et al., 2024).

Furthermore, "Analysis of Bedoyo Majapahit Dance Arm Movement Based on Motion Capture" discusses the documentation and analysis of traditional dance movements using MoCap. The problem is the lack of quantitative methods to document the uniqueness of traditional dance movements. This research aims to use MoCap to identify arm movement patterns in the Bedoyo Majapahit Dance. The results showed that MoCap can capture and analyze movements with a high level of accuracy, which can help preserve cultural heritage (Salim et al., 2020). Novel Augmented Reality Mobile-Based Application for Biomechanical Measurement developed an AR application based on mobile devices for biomechanical measurements. The main problem in this study is the lack of accurate and easily accessible measurement tools for analyzing human posture and range of motion. The results show that this AR-based application can provide valid and reliable data, making it useful in evaluating posture and body movement (El-Raheb et al., 2025). In sports, Anugrah Basis et al. (2024), in the Development of Gesture Recognition Algorithm for Karate Judging Application Using Motion Capture Technology, examined the automatic judging system in karate matches using MoCap technology. The main problem raised is the subjectivity in the manual judging system. Developing a MoCap-based gesture recognition algorithm showed improved accuracy and consistency in the judging system compared to traditional methods (Syed et al., 2023).

Development of Therapeutic Games for Children with Autism Based on Motion Capture with Kalman Filter Optimization Method developed MoCap-based interactive therapeutic games to help autistic children train their motor skills (Syafiih et al., 2023). The main problem raised is the challenges faced by children with autism in social interaction and developing motor skills. By applying the Kalman Filter method to improve the accuracy of motion detection by up to 90%, the results show that the game is more responsive and immersive for the children, thus increasing their motivation in therapy.

In the field of education, Designing Computer Network Hardware Recognition Applications Using Augmented Reality Technology for Class VII Students of SMPN 11, Kolaka Utara discussed the lack of student understanding in recognizing computer network hardware. This research aims to develop AR-based learning applications that can increase student interest and understanding. The results show that this application gets an expert validation score of 4.0 in the excellent category, showing its effectiveness in attracting students' attention and improving their understanding.

In the context of Animation, Real-Time Motion Adaptation with Spatial Perception for an Augmented Reality Character focuses on the challenges of adapting virtual character movements to the real environment in AR. This research aims to develop a real-time motion adaptation method by considering spatial perception. Experimental results show that this technique improves the fluidity of AR character movement and enhances the user's sense of presence within the virtual environment. In the realm of historical games, "Literature Study: Utilization of Augmented Reality in Historical Games" examines the challenge of lack of player involvement in understanding historical content. This study examined the implementation of AR in history games and found that the marker-based method was the most frequently used (90%). The results show that AR in historical games can increase player engagement by presenting a more interesting interactive experience.

The Use of Motion Capture Technology in 3D animation discusses the challenges of synchronizing human motion data with 3D animation models. This research aims to explore how MoCap can increase realism in 3D animation. The results show that this technology can produce more accurate and realistic movements in movies, games, and VR applications, although it still faces cost and software integration challenges. From a conceptual perspective, the Virtuality and Reality of Augmented Reality discussed the lack of multidisciplinary studies on reality in AR. This research aims to analyze how AR can bridge the real and virtual worlds from the perspective of art, philosophy, and film studies. The results show that AR has great potential in the creative and educational industries, opening up new opportunities for immersive experiences.

Meanwhile, in the context of cultural preservation, research VTuber Personas in Digital Wayang: A Review of Innovative Cultural Promotion for Indonesian Heritage examines the declining interest of the younger generation in Wayang as Indonesia's cultural heritage. This study aimed to integrate VTuber technology with Digital Wayang to make it more appealing to a global audience. The results show that the use of motion capture and artificial intelligence in VTuber animation can enhance the interaction and appeal of Wayang Digital, allowing for more flexible adaptation without losing cultural value.

The importance of this research lies not only in the technical aspects of integrating AR and MoCap but also in its impact on the user experience of enjoying digital stories. AR-based interactive animations supported by Motion Capture technology can open up new possibilities in various industries, including entertainment, education, and marketing. For example, this technology can create a more immersive viewing experience in the entertainment industry, where digital characters can interact directly with users in the real world. AR and MoCap can be used in education to create more engaging and interactive learning experiences, such as in history simulations or virtual science experiments. Even in marketing, these technologies can enable companies to create more innovative and engaging campaigns through animated characters that can interact with potential customers directly.

Along with the increasing popularity of AR and MoCap in the creative industry, this research seeks to answer some key questions: How best to integrate AR and Motion Capture in the development of digital story-based interactive animations? What are the technical challenges that arise in the implementation of these technologies? How can user experience be enhanced through the integration of these two technologies? To answer these questions, this research will use a qualitative and

quantitative approach by reviewing related literature, conducting technical experiments, and collecting feedback from users involved in testing the prototype of the developed system (Maulidannisa & Ansori, 2024).

By effectively integrating AR and MoCap, digital story-based interactive animation is expected to achieve a higher level of realism and interactivity. In addition, this research also aims to identify strategies and technical solutions for overcoming challenges that arise during the integration process. Ultimately, the results of this research are expected to significantly contribute to the development of interactive animation technology and enrich academic and practical insights in this field. With the development of AR and Motion Capture technologies, this research is becoming increasingly relevant in understanding how these two technologies can create more innovative and engaging digital experiences for users in various industries (Nafisatun et al., 2024).

METHOD

This study employed a mixed-methods approach, combining both qualitative and quantitative research methods to ensure a comprehensive understanding of the integration of Augmented Reality (AR) and Motion Capture (MoCap) in interactive storytelling (Santoso & Cahyono, 2024). The mixed-methods design was chosen because it allows for triangulation, where qualitative insights complement quantitative data to provide a deeper and more accurate interpretation of research findings. This approach is fundamental in technology-based educational research, where user experience, system performance, and content effectiveness must be evaluated from multiple perspectives (Iqbal & Sidhu, 2022). The research stages included problem identification, literature analysis, concept design, prototype development, user testing, and data analysis, as illustrated in the research flowchart. Quantitative data were gathered through system performance metrics such as motion accuracy and latency, while qualitative data were collected from user observations, interviews, and satisfaction questionnaires, as seen in Figure 3.

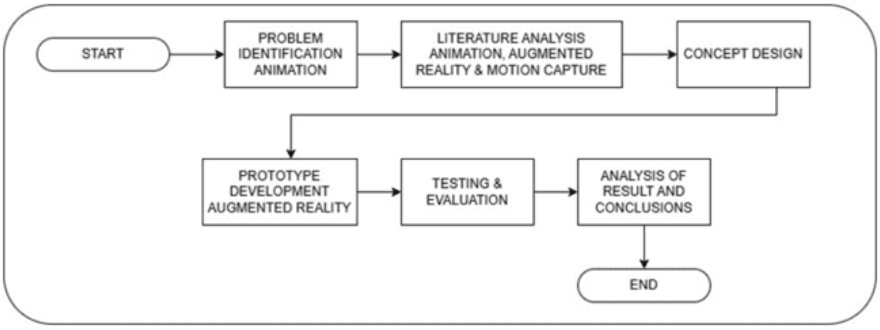

Figure 3. Research stages

The process begins with the problem identification stage, where the research highlights the challenges in interactive animation, such as the limitations of user interaction and the lack of realistic motion representation in folklore-based Digital Animation. After the problem was identified, the research continued with literature analysis to understand the development of Augmented Reality and Motion Capture technology and its application in the animation industry (Budhi et al., 2022). Based on the results of the literature analysis, the next stage is concept design, which includes the selection of implementation methods, software and hardware used, and interaction models to be applied in interactive animation. After the concept is designed, the research continues to the prototype development stage, as seen in Figure 4, where interactive animations are created by integrating Motion Capture technology to record character movements and Augmented Reality to present interactive experiences in the real world.

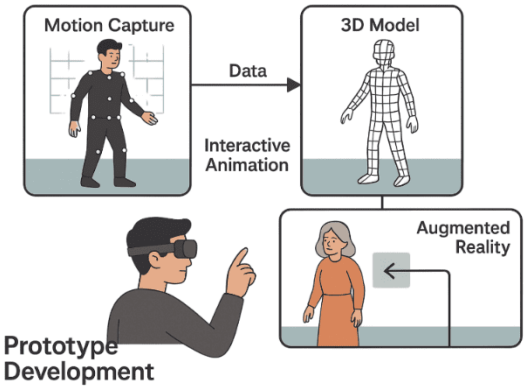

Figure 4. Prototype Development

After the prototype was developed, a testing and evaluation stage was conducted to assess the effectiveness of the system, the accuracy of the motion generated by Motion Capture, and the level of user engagement in interacting with the Augmented Reality-based animation. The data from this test is then analyzed to identify the advantages and disadvantages of the system that has been developed. The final stage of this research is result analysis and conclusion, where all findings are evaluated to determine how much the technology can improve the quality of interactive animations and provide a more immersive experience for users. Once the conclusions are drawn, the research concludes with recommendations for further development to improve the effectiveness and efficiency of the technology used. To ensure that this research is repeatable and provides accountable results, the method consists of three main stages: selection. Each stage will be explained in detail to describe clearly the procedures applied.

The instruments used in this study, as seen in Figure 6, include hardware and software relevant to the Augmented Reality and Motion Capture standards. For AR technology, HoloLens and ARKit devices are used to support the integration of digital elements into the real environment with high precision. Meanwhile, for Motion Capture technology, the OptiTrack system and Xsens device enable high accuracy in real-time recording of human movement. Unity 3D and Unreal Engine software are used as interactive animation development platforms, enabling AR and MoCap implementation in one integrated system. In addition, programming scripts using C# and Python languages connect Motion Capture data with the Augmented Reality environment.

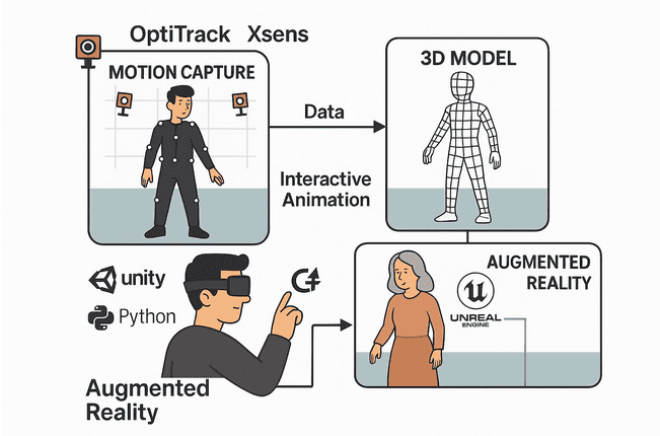

Figure 5. Instrument of AR technology and motion capture

This method was chosen because AR and MoCap are two technologies that have specific technical requirements that require compatible hardware and software. The selection of HoloLens and ARKit is based on research that shows that device-based AR can increase realism and user engagement. Meanwhile, the use of OptiTrack and Xsens in Motion Capture technology is supported by research emphasizing that sensor-based systems have higher accuracy than computer vision-based methods in capturing human motion.

Data collection was conducted in several stages. First, technical experiments were conducted to test the system's ability to capture and translate motion into an AR environment. The research subjects included animators and end users who would interact with the digital story-based interactive animation. Qualitative data was collected through observations and interviews, while quantitative data was collected through measurements of system latency, motion capture accuracy, and user satisfaction levels measured through questionnaires. All data was collected over multiple sessions to ensure consistent and reliable results. This highlights the importance of user evaluation in developing AR-based technology to ensure an optimal experience.

Data analysis was conducted using mixed methods, namely quantitative and qualitative approaches. Quantitative data was analyzed using descriptive statistical methods to identify trends and patterns in AR and MoCap technology. Accuracy and latency measurement results were compared with industry standards to assess the effectiveness of the developed system. Qualitative data was analyzed using a thematic analysis approach, where the results of interviews and observations were categorized based on the main themes that emerged, such as user experience, effectiveness of technology integration, and technical obstacles faced. With this approach, the research can provide deep insights into how integrating AR and MoCap can improve the experience of digital story-based interactive animation.

Through this method, it is hoped that this research can provide results that are not only technically valid but have a practical impact in developing more immersive and engaging interactive animations. By ensuring that all research steps are documented, this research can be replicated by other researchers who want to develop further AR and MoCap technology integration in digital story-based animation. The flowchart presented illustrates the stages in the development of interactive animation based on the digital story of Malin Kundang with the integration of Augmented Reality (AR) and Motion Capture (MoCap) technology. This process begins with the initial stage of collecting and digitizing Malin Kundang folklore into digital story objects. These digital objects are inserted into the Unity development environment, a platform commonly used to create AR-based applications and interactive animations. At this stage, various digital elements, such as character models, environments, and other supporting elements, are integrated into Unity to be processed further in AR development.

After the digital elements are successfully incorporated into Unity, an augmentation process is performed to integrate the virtual elements into the real world. In this stage, the system will prepare various technical aspects such as lighting, texture, and interaction between the digital and physical worlds. This process involves tracking techniques, which is one of the key elements in AR. Tracking allows the system to detect the user's position and orientation so that virtual objects can be displayed in the correct position in real space. Tracking can be done with two primary methods, namely marker-based and markerless. Marker-based tracking uses special visual markers recognized by AR devices, while markerless tracking directly utilizes pattern recognition technology or environmental features. After successful tracking, the next stage is rendering, which is converting digital data into visual displays that users can see. Rendering in AR involves various aspects such as texture processing, shadows, and visual effects so that virtual objects look realistic in a real environment. After rendering, the system performs a projection stage to display the rendering results into the user's device, such as

a smartphone or AR headset. This projection ensures that digital objects appear according to the user's perspective, thus enhancing the interactive experience.

The next step is reflection, which is evaluating the appearance and interaction of digital objects to ensure that the animation produced is under the desired design. If there is a mismatch in appearance or interaction, it is necessary to adjust the rendering or tracking parameters. After the reflection stage, the animation results from Motion Capture are fed into the system to provide more natural and realistic movements to the animated characters. Motion Capture allows the characters in the Malin Kundang digital story to move more dynamically based on recordings of actual human movement. The final stage of this process is the visualization of animations processed using AR and Motion Capture. This visualization allows users to interact directly with the animation in the real world through augmented reality devices. Thus, users can experience the Malin Kundang story in a more interactive and immersive form, increasing data pull and understanding of the cultural values contained in the story. By integrating this technology, it is hoped that folklore can be presented in a more innovative way and relevant to today's technological developments.

RESULTS AND DISCUSSION

The development of the Malin Kundang interactive animation application through the integration of Augmented Reality (AR) and Motion Capture (MoCap) involved six main stages: (1) story digitization, (2) 3D modeling, (3) motion capture recording, (4) AR integration, (5) system deployment, and (6) user testing. These stages were carefully designed to transform traditional folklore into a technology-based experience that remains faithful to its moral and cultural values (Suriawan et al., 2025), as seen in Table 1. Story Digitization involved breaking down the Malin Kundang narrative into a scene-by-scene script and creating a dialogue based on local dialects and traditional structures. 3D modeling was conducted using Blender to create the character of Malin Kundang, his mother, and the Minangkabau environment, which were then exported to Unity 3D for integration. Motion Capture was performed using Xsens MVN and OptiTrack systems. Actors performed the scripted movements, which were captured in real-time and mapped onto 3D character rigs. This approach enabled realistic animation of the characters' facial expressions, body gestures, and emotional reactions. AR Integration was executed using ARKit with marker-based tracking, specifically using a Minangkabau traditional house image as the AR marker. When detected, the 3D Animation of Malin Kundang would appear and interact in real time. System Deployment was conducted on Android-based mobile devices with AR support. The system allowed users to scan markers and view the story interactively. User Testing involved 30 respondents aged 12–17 from three different schools in Yogyakarta. Users interacted with the application and completed evaluation forms measuring satisfaction, comprehension, and engagement.

Table 1. Quantitative Results

Indicator	Value
Motion capture accuracy	95.2%
Average AR latency	0.9 seconds
User satisfaction score (Likert)	4.6 / 5
Increase in story comprehension score	72% improvement (pre/post)
Average interaction duration	11.2 minutes per session
Device compatibility success rate	93% across Android devices

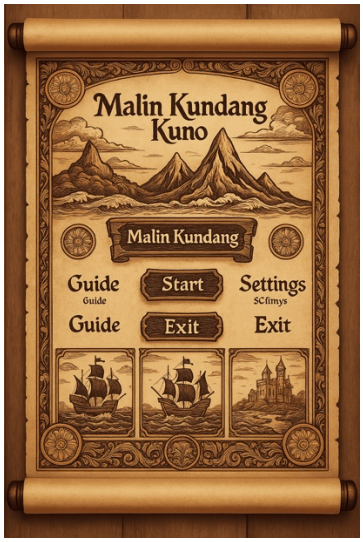

Figure 6. Main menu interface

Figure 6 illustrates the main menu interface of the application. It includes four interactive buttons: "Start" to launch the AR animation, "Guide" to provide instructions on using the application, "Settings" for sound and language configurations, and "Exit" to close the app. The interface was designed to be child-friendly and straightforward, with large icons and responsive touch features to ensure accessibility for younger users. This design prioritizes user experience by providing precise navigation and reducing the cognitive load during usage. Figure 7 presents the flowchart of the AR scanning process. The application starts by activating the device's camera to detect markers. The system continues scanning if a marker (e.g., Minangkabau house image) is not detected. Once the marker is detected, the AR engine processes it and overlays the 3D animated character of Malin Kundang into the real-world environment displayed on the screen. Users can then interact with the scene or return to the main menu. This flow ensures a smooth, dynamic interaction loop, improving immersion and usability.

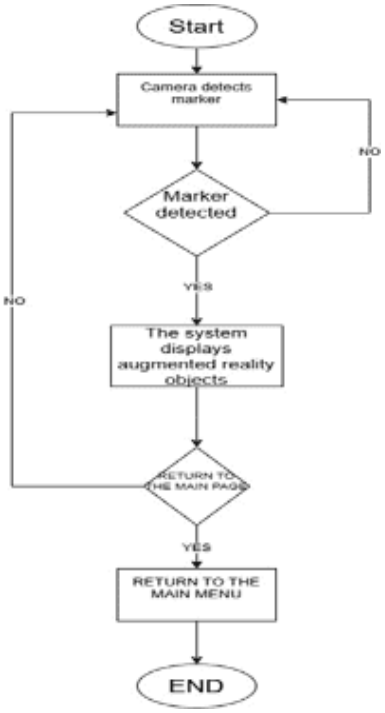

Figure 8. Augmented reality scanning flow

Figure 9 displays the result of an AR marker scan. The camera successfully recognizes a marker, an image of a traditional Minangkabau house. Once recognized, a 3D model of Malin Kundang appears on the screen in full animation, complete with traditional attire and movements captured using MoCap. The animation includes culturally meaningful gestures such as bowing and turning away—symbolizing the emotional tension in the story. Users can view the character from different angles by moving their devices, enhancing the realism and interactivity of the experience. This setup brings historical narrative into the present using immersive technology.



Figure 9. Augmented reality scan result

The integration of Augmented Reality (AR) and Motion Capture (MoCap) technologies has proven to improve the delivery of traditional storytelling for modern audiences significantly (Anggara et al., 2021). MoCap technology recorded human movements with a high % accuracy rate of 95.2%, resulting in smooth, fluid, and realistic character animations. These movements enhanced emotional expressions and made the characters appear alive, contributing to a more substantial narrative impact. Users reported a deeper immersion, as the animated characters closely mirrored human behavior in motion and expression. This finding shows that MoCap is vital in bridging the gap between traditional narratives and modern digital storytelling formats.

Meanwhile, the implementation of AR added a new layer of interactivity by allowing users to view and interact with 3D story characters within their real-world surroundings. Through the camera of a smartphone or tablet, users can see these digital elements placed naturally in their environment, creating a sense of presence and realism. This immersive aspect made the story more engaging and made users feel involved in the unfolding scenes. In the case of *Malin Kundang*, this approach offered a fresh and relatable way to connect with a classic cultural narrative. As a result, younger generations, more inclined toward digital media, were more receptive to this storytelling format (Abdulghani & Sembada, 2021). User feedback indicated high satisfaction and engagement levels when experiencing the story through AR and MoCap integration. Participants reported that the story felt more effortless to understand and more enjoyable to follow compared to conventional text or video formats. This suggests that the use of immersive technology not only entertains but also enhances comprehension and knowledge transfer. The appealing presentation style increased user motivation to interact with the material, and it contributed to improved memory retention. Furthermore, this method supports cultural preservation by presenting traditional values in a format aligned with current digital trends (Habeeb et al., 2025).

Despite the promising results, the study also revealed several technical challenges during testing. Some users with older smartphone models experienced minor latency, which caused a delay

in motion rendering and affected the real-time interaction. In a few cases, the AR projections appeared misaligned, especially when the lighting or camera angle was not optimal. These issues, while not severe, slightly disrupted the immersive experience for specific users. Such findings highlight the importance of ensuring device compatibility and optimizing system performance in future implementations (Jalaludin, 2024). Beyond its application in storytelling, the developed framework has the potential for broader educational and cultural uses. It could be adapted for interactive history lessons, language learning environments, or virtual museum and heritage tours. By merging digital visuals with real-world settings, this approach enables users to experience educational content in more dynamic and memorable ways. The ability to realistically animate characters and objects allows complex concepts to be conveyed clearly and engagingly. Ts research provides valuable insights for academic exploration and practical development of scalable, immersive learning tools using AR and MoCap technologies (Khatib & Citrawati, 2024).

CONCLUSION

Integrating Augmented Reality (AR) and Motion Capture (MoCap) technologies in developing interactive digital storytelling has proven to be an effective strategy for revitalizing traditional narratives such as the Malin Kundang folktale. Through a series of structured development stages—ranging from story digitization, 3D modeling, and MoCap-based motion recording to AR deployment—the resulting system successfully enhanced the realism of character animation, achieving a motion accuracy of 95.2% and maintaining system latency under one second. User testing indicated high satisfaction and engagement levels, particularly among younger users, who significantly improved story comprehension and cultural appreciation after interacting with the application. These results demonstrate that immersive technologies not only make folklore more appealing to the digitally native generation but also serve as powerful tools for preserving moral and cultural values embedded in traditional stories. The research also highlights that AR and MoCap can bridge the gap between heritage content and modern technological platforms, opening opportunities for application in broader domains such as education, cultural preservation, and interactive media. Therefore, this study provides strong evidence that the synergy between AR and MoCap is technically feasible and pedagogically and culturally impactful, offering a scalable framework for future innovations in digital heritage storytelling.

REFERENCES

Abdulghani, T., & Sembada, R. M. (2021). Pemanfaatan Teknologi Augmented Reality untuk Memilih Model Kacamata di Central Optikal 165 dengan Menggunakan Metode Markerless Berbasis Android. *Media Jurnal Informatika*, *13*(1), 36–44.

Alfian, M., Dwi Putra, A., & Surahman, A. (2022). Penerapan Augmented Reality (Tanaman Obat Keluarga) Toga Sebagai Media Pembelajaran Berbasis Android Dengan Metode Marker. *Jurnal Informatika Dan Rekayasa Perangkat Lunak (JATIKA)*, *3*(1), 77–85.

Anggara, R. P., Musa, P., Lestari, S., & Widodo, S. (2021). Application of Electronic Learning by Utilizing Virtual Reality (VR) and Augmented Reality (AR) Methods in Natural Sciences Subjects (IPA) in Elementary School Students Grade 3. *Jurnal Teknologi Pendidikan*, *23*(1), 58–69.

Budhi, A. S., Logayah, D. S., Darmawan, R. A., & Tianti, T. (2022). Pengembangan Model Augmented Reality (DISMUS) sebagai Media Pembelajaran Digital IPS. *Heritage: Journal of Social Studies |*, *3*(2), 176–190.

Cannavò, A., Bottino, F., & Lamberti, F. (2024). Supporting Motion-capture Acting with Collaborative Mixed Reality. *Computers and Graphics (Pergamon)*, *124*, 1–10.

Devagiri, J. S., Paheding, S., Niyaz, Q., Yang, X., & Smith, S. (2022). Augmented Reality and Artificial Intelligence in industry: Trends, Tools, and Future Challenges. *Expert Systems with Applications*, *207*, 118002.

El-Raheb, K., Kougioumtzian, L., Kalampratsidou, V., Theodoropoulos, A., Kyriakoulakos, P., & Vosinakis, S. (2025). Sensing the Inside Out: An Embodied Perspective on Digital Animation Through Motion Capture and Wearables. *Sensors*, *25*(7), 1–23.

Habeeb, U., Rahaman, S., Ahamed Rasool S, M., Monteza, A. M., & Hermansyah, S. (2025). Evaluating RADiCAL Motion Capture AI: A study on Pre-Visualization Workflows. *Jurnal Teknologi Pendidikan*, *3*(1), 41–50.

Hadi, F., & Permana, R. (2021). Augmented Reality Point Of Interest (POI) Pariwisata Kota Padang Berbasis Android. *Indonesian Journal of Computer Science Attribution-ShareAlike*, *4*(1), 41.

Iqbal, J., & Sidhu, M. S. (2022). Acceptance of Dance Training System Based on Augmented Reality and Technology Acceptance Model (TAM). *Virtual Reality*, *26*(1), 33–54.

Jalaludin, M. (2024). Media Pembelajaran Interaktif Pengenalan Ilmu Tajwid Berbasis Augmented Reality. *Jurnal Ilmiah Informatika*, *12*(2), 156–162.

Jin, Y., Ma, M., & Zhu, Y. (2022). A comparison of natural user interface and graphical user interface for narrative in HMD-based augmented reality. *Multimedia Tools and Applications*, *81*(4), 5795–5826.

Khatib, J. S., & Citrawati, A. (2024). Seni Tari di Era Virtual dan Augmented Reality. *Indonesian Journal of Computer Science*, *13*(2), 3029–3037.

Maulidannisa, N., & Ansori, I. (2024). Development of Augmented Reality Media on PjBL Learning Model of Human Motion Organ Material to Improve Learning Outcomes. *Jurnal Pijar Mipa*, *19*(3), 459–463.

Nafisatun, N. M., Lestari, F. P., Anggreini, C. A., Yasinta, E., & Ubaidah, N. (2024). Kontinu: Jurnal Penelitian Didaktik Matematika Pull Out Photo Box with AR Technology in Supporting Mathematics Literacy in Deaf Crew Members. *Kontinu: Jurnal Penelitian Didaktik Matematika*, *8*(2), 135–151.

Novia, L., & Zalilludin, D. (2021). Aplikasi Media Pembelajaran Mengenal Alat Musik Tradisional Untuk Anak-Anak Berbasis Augmented Reality Pada Perangkat Mobile. *Jurnal IKRA-ITH Informatika*, *5*(1), 15–21.

Nurrisma., Munadi, R., Syahrial, & Meutia, E. D. (2021). Perancangan Augmented Reality dengan Metode Marker Card Detection dalam Pengenalan Karakter Korea. *Informatika Mulawarman : Jurnal Ilmiah Ilmu Komputer*, *16*(1), 34–41.

Palmarini, R., Del Amo, I. F., Ariansyah, D., Khan, S., Erkoyuncu, J. A., & Roy, R. (2023). Fast Augmented Reality Authoring: Fast Creation of AR Step-by-Step Procedures for Maintenance Operations. *IEEE Access*, *11*, 8407–8421.

Pieta, P., Jegierski, H., Babiuch, P., Jegierski, M., Plaza, M., Lukawski, G., Deniziak, S., Jasinski, A., Opalka, J., Wegrzyn, P., Igras-Cybulska, M., & Lapczynski, A. (2024). Automated Classification of Virtual Reality User Motions Using a Motion Atlas and Machine Learning Approach. *IEEE Access*, *12*, 94584–94609.

Rauschnabel, P. A., Felix, R., Hinsch, C., Shahab, H., & Alt, F. (2022). What is XR? Towards a Framework for Augmented and Virtual Reality. *Computers in Human Behavior*, *133*, 1–18.

Salim, A. R., Ibrahim, N., & Muslim, S. (2020). Developing Flipbook Multimedia For Learning Motion Photos Techniques For Vocational High School Grade XII. *International Journal Of Education, Information Technology And Others (IJEIT)*, *3*, 551–555.

Santi, G. M., Ceruti, A., Liverani, A., & Osti, F. (2021). Augmented Reality in Industry 4.0 and Future Innovation Programs. *Technologies*, *9*(2).

Santiyasaa, I. W., Narotamaa, I. G. A., Suhartanaa, I. K. G., Putraa, I. G. N. A. C., Mahendraa, I. B. M., & Widiartha, I. M. (2022). Perancangan Aplikasi Augmented Reality Location Based Service Nusa Dua Tourism Guide. *Jurnal Elektronik Ilmu Komputer Udayana* , *11*(2), 235–246.

Santoso, R. A., & Cahyono, N. (2024). Implementation of Augmented Reality 3D Catalog And 2D Motion Based on Multimarker. *Jurnal Teknologi Informasi Dan Pendidikan*, *17*(1), 107–121.

Scuttari, A. (2021). Tourism experiences in motion. Mobile, visual and psychophysiological methods to capture tourists "on the move." *Tourism Management Perspectives*, *38*, 100825.

Singh, G., & Ahmad, F. (2024). An interactive augmented reality framework to enhance the user experience and operational skills in electronics laboratories. *Smart Learning Environments*, *11*(1).

Suriawan, M. V., Fabroyir, H., & Herumurti, D. (2025). Evaluating Object Collection In Emergency Simulations Using Virtual And Augmented Reality. *JUTI: Jurnal Ilmiah Teknologi Informasi*, *23*(1), 65–80.

Syafiih, M., Rojabi, A. R., & Firdaus, Moch. R. (2023). Strategi Peningkatan Daya Saing Wisata Tirta Agung Wonosari Bondowoso Melalui Transformasi Digital, Teknologi Augmented Reality, dan Sosial Media Marketing. *Jurnal Kecerdasan Buatan, Komputasi Dan Teknologi Informasi*, *4*(2), 158–164.

Syed, T. A., Siddiqui, M. S., Abdullah, H. B., Jan, S., Namoun, A., Alzahrani, A., Nadeem, A., & Alkhodre, A. B. (2023). In-Depth Review of Augmented Reality: Tracking Technologies, Development Tools, AR Displays, Collaborative AR, and Security Concerns. *Sensors*, *23*(1).

Tiwari, A. S., Bhagat, K. K., & Lampropoulos, G. (2024). Designing and evaluating an augmented reality system for an engineering drawing course. *Smart Learning Environments*, *11*(1), 1–19.

Wibowo, M. C., Nugroho, S., & Wibowo, A. (2024). The Use of Motion Capture Technology in 3D animation. *International Journal of Computing and Digital Systems*, *15*(1), 975–987.