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Development of MIGUI: An Immersive Virtual Reality Prototype for Welang-Weling Recognition and Snakebite First Aid Education

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ABSTRACT

Indonesia has approximately 600 species of reptiles, with a notable concentration of snakes. According to the National Research and Innovation Agency from Indonesia (BRIN), there are 349 types of snakes. Many of them live near human settlements. Among these, the venomous snakes—such as *Bungarus fasciatus* (Welang) and *Bungarus candidus* (Weling)—share similar striped patterns. Both of them are frequently found near homes, farms, and woods. Sometimes people are confused by a similar pattern that leads to panic and venomous snakebite accidents. This misinformation, combined with limited access to emergency response education, increases the risk of fatal bites. Although virtual reality (VR) has demonstrated potential in delivering immersive education, its application in mitigating snakebite remains limited. This study uses the Multimedia Development Life Cycle (MDLC) method to develop this prototype. MIGUI combines 360-degree video and 16:9 videos introducing Welang and Weling snakes with a short-film simulation presenting snakebite first aid procedures. This study aims to develop MIGUI as a VR-based educational prototype that integrates Welang-Weling recognition and snakebite first aid information. MIGUI is intended for future educational use in communities with higher exposure to snake encounters. Further research is needed to evaluate its usability and educational effectiveness with broader and more representative users.

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1. Introduction

Indonesia is one of the tropical countries with rich fauna diversity, especially reptile species. Reptiles have many groups and types of animals, so they are often difficult to recognize and may require specific handling (Kartika et al., 2021). One of the reptiles most commonly found in Indonesia is snake (Octaviani, Sudibyo, Amrul, & Nasution, 2018). Snake habitats are often close to humans, including rice fields, yards, trees around houses, and residential areas. Tropical countries have a high abundance of snake species, making venomous snakebite cases an important public health concern. According to the World Health Organization (2023), approximately 5.4 million people are bitten by snakes every year, with around 1.8 to 2.7 million cases of envenoming and 81,410 to 137,880 deaths annually. Afroz et al. (2024) stated that venomous snakebite

represents a major and frequently neglected public health issue, especially among rural communities throughout tropical and subtropical zones.

Snakebite cases often occur in regions such as Southeast Asia, South Asia, and sub-Saharan Africa. The presence of venomous snakes and the lack of public knowledge in handling snakebites also contribute to the high number of victims. Snakebite management has not received adequate attention from health service systems, both nationally and internationally. Snakebite is also classified as one of the neglected tropical diseases (Dafa & Suyanto, 2021). The clinical challenges of effectively treating snakebites are most substantial in low-resource rural areas, which is where these incidents occur most frequently (Warrell & Williams, 2023).

Indonesia, as one of the countries in Southeast Asia, has a high number of snakebite cases because many people work in agriculture. However, national policies related to snakebite control programs and national guidelines for handling this case are still not available (Nugraha, 2022). This lack of attention is unfortunate because snakebite does not only cause death, but also amputation and disability, which can have a major impact on victims (Antonio & Hartati, 2022). Puspaningtyas, Dewi, and Imanadhia (2022) also added that the groups most at risk of snakebites are rural communities, such as farmers, herders, and people in areas with limited access to health services. Several deaths also occur among teenagers and children, especially toddlers. Therefore, a comprehensive approach is needed, including handling steps before and after the patient arrives at health services.

In Indonesia, 349 snake species have been identified, and the number may continue to increase. This means that around 10% of the total snake species in the world are found in Indonesia. Indonesia's geographical condition strongly supports the growth and development of many snake species. In snake evolution, there are two main categories of species, namely venomous snakes and non-venomous snakes. One of the venomous snakes that is quite familiar to the public is the Weling snake, which has a distinctive black and white pattern. Because of physical similarities between species, misidentification cases often occur, especially between Welang (*Bungarus fasciatus*) and Weling (*Bungarus candidus*). Snakebite reports collected from several public health centers and hospitals show that people still find it difficult to distinguish these snake species (BRIN, 2022).

Many people still cannot distinguish which snakes are highly venomous, moderately venomous, or non-venomous. Some people only rely on head shape for identification, with the assumption that a triangular head always means the snake is highly venomous. This understanding is not always correct, because not all venomous snakes have triangular heads. For example, the long-nosed whip snake (*Ahaetulla nasuta*) has a triangular head but is not deadly. On the other hand, venomous snakes such as Welang and Weling have oval heads but are very dangerous. A common characteristic of highly venomous snakes is the presence of a pair of fangs at the front. Therefore, it is important for the public to receive correct knowledge about the characteristics and handling of venomous snakes (Dharma & Winarno, 2021). Knowledge about snakebite is strongly needed to reduce disability and death rates in Indonesia (Kementerian Kesehatan RI, 2023).

However, the lack of public knowledge can be understood because snakes, as legless animals with long scaly bodies, often have similar shapes and colors between one species and another (Antonio & Hartati, 2022). Strengthening the prevention of disability and death among snakebite victims is needed through the wider distribution

of public knowledge about first aid (Saputro, Pujiastuti, & Astuti, 2025). Knowledge about snake behavior is also important for prevention. Venomous snakes tend to stay calm and attack when they feel threatened, while non-venomous snakes usually choose to escape when approached. Bright body colors can also be one sign that the snake may be venomous. These similarities and different traits show that snake recognition becomes difficult when people do not have enough information.

First aid for snakebite is an important issue in snakebite cases. First aid for snakebite is often treated similarly to handling a fracture, by using a wooden support and wrapping it with an elastic bandage to limit movement. The bitten area should not be moved too much so that the venom does not spread faster, and the bandage should not be too tight. After first aid is given, the victim must immediately be taken to a health facility. Sucking blood from the bitten area is not recommended. WHO also recommends immobilization around the bitten area as the main first aid step (Permana, 2019). This becomes important in rural areas where access to medical treatment may not be immediately available (Puspaningtyas, Dewi, & Imanadhia, 2022; Warrell & Williams, 2023). Therefore, educational information should not only about venomous snakes but also explain appropriate first aid responses after a snakebite.

Previous studies show that the difficulty in identifying venomous snakes and understanding the importance of first aid can still occur even among individuals with health education backgrounds (Jayathilaka & Weeratunga, 2024). Dharma and Winarno (2021) conducted online training about the introduction of venomous snakes during the pandemic. However, this training had not yet reached the interactive aspect that allow users to experience a real simulation. On the other hand, Antonio and Hartati (2022) emphasized the importance of accurate visuals in snake classification using the convolutional neural network method. This shows that media intended for public education must be supported by scientific and easy-to-understand visuals, so that the message delivered does not create misunderstanding.

From the perspective of public health, Dafa and Suyanto (2021) revealed that venomous snakebite cases often occur in rural areas and are not handled quickly because of limited information and medical access. Therefore, they suggested community-based education that can directly reach the public. This is strengthened by Puspaningtyas, Dewi, and Imanadhia (2022), who conveyed that high-risk groups such as farmers and children need visual and practical education that can be understood quickly. These conditions show that there is a need for an educational media learning experience that combines snake recognition and snakebite first aid information.

This research refers to literature on virtual reality-based educational media, virtual reality has potential to offer unique immersive learning experiences (Depita, Rahmiaty, & Tinarbuko, 2023). Immersive virtual reality has also been applied in various educational fields, where the learning content, design elements, and interaction design become important parts of the virtual reality learning experience (Radianti et al., 2020), supported by the notion that various scientific fields can be supported by virtual reality (Obadiah, 2021). Siahaya (2024) explained that virtual reality is a technology that produces realistic experiences according to the real environment. Virtual reality allows users to experience an environment they have never visited before.

In the educational context, virtual reality has been explored as an immersive learning medium, although the outcomes of this educational learning still depend on the learning design and context of implementation (Hamilton et al., 2021). In addition, virtual reality objects can be presented in three-dimensional forms, such as 360-degree

videos that allows users to look around every corner of the space (Siahaya, 2024). In this research, the use of 360-degree video provides users with a wider visual environment, while 16:9 video provides a more controlled visual frame for presenting specific information. These formats become relevant to MIGUI because the application presents both the characteristics of Welang and Weling snakes and a simulation of snakebite first aid procedures through video.

Based on previous studies, snake education, visual snake classification, snakebite first aid, and virtual reality have generally been discussed through different approaches. Previous studies focused on online snakebite education (Dharma & Winarno, 2021), snake classification visualization (Antonio & Hartati, 2022), or immersive media applications (Depita, Rahmiaty, & Tinarbuko, 2023; Obadiah, 2021). However, the integration of Welang-Weling recognition and snakebite first aid education within one immersive virtual reality prototype is still limited. This becomes the educational media problem addressed by MIGUI. The main contribution of MIGUI is the integration of Welang-Weling recognition and first aid educational content within one immersive virtual reality video-based prototype.

Therefore, this study aims to develop MIGUI using the Multimedia Development Life Cycle (MDLC) as an immersive virtual reality prototype integrating Welang-Weling recognition and snakebite first aid educational content. This research focuses on the development of the prototype rather than proving that MIGUI improves public knowledge or educational effectiveness. Further testing with broader and more representative users is needed to evaluate its usability and educational effectiveness.

2. Method

This study used the Multimedia Development Life Cycle (MDLC), consisting of six stages: concept, design, material collecting, assembly, testing, and distribution (Akbar et al., 2023). MDLC provides a structured workflow for producing interactive multimedia and can be applied to virtual reality applications that require systematic planning, asset production, integration, and testing (Yudhanto, 2021). MDLC was selected because MIGUI integrates different multimedia components, including 360-degree video, 16:9 video, audiovisual content, interface design, and Unity-based VR integration. Therefore, a structured development process was required to organize the planning, asset production, assembly and prototype preparation stages. Although MDLC includes testing as one of its stages, formal usability and educational effectiveness evaluation was outside the scope of this research. Therefore, this research focuses on the development of the MIGUI prototype and preparation for further research.

In the concept stage, the researcher team identified the main problem is limited public understanding of venomous snakes, especially Welang and Weling, and insufficient information of first aid snakebite procedures. This problem led to the idea of developing MIGUI, an immersive VR video-based educational prototype that combines venomous snake recognition and snakebite first aid information. In the design stage, the researchers prepared the user interaction flow, script, and audiovisual structure. The script and visual content were developed after consultation with Sioux Community who have experience in reptile education and snake handling. The consultation focused on the visual characteristics of Welang and Weling explanation, scene staging, and the representation of snakebite situations. Information related to snakebite first aid was developed based on the health-related references used in this

study, while the Sioux community mainly provided consultation regarding snake characteristics and the audiovisual representation of the scenario.

The design included two main menus: one for Welang-Weling characteristics and one for snakebite first aid videos. Each menu contained two video formats: 360-degree video and 16:9 video. User interaction was limited to menu navigation, content selection, and viewing the selected 360-degree or 16:9 video. The 360-degree video format was used to provide a wider immersive view of the space, while the 16:9 format provided controlled visual framing for specific educational information.

In the material collecting stage, the researchers produced 360-degree and 16:9 videos at a location provided by Sioux Community that represented the accident that snake appeared. Both video formats were recorded using a GoPro camera that could be configured for 360-degree and 16:9. The videos were recorded in 4K resolution at 24 frames per second, while the audio was recorded using the GoPro's built-in recording system. The recorded footages include of Welang and Weling characteristics explanation and a short-film re-enactment by Sioux community members presenting first aid actions after a snakebite.

In the assembly stage, the selected videos were edited using Adobe Premiere Pro 2024 and integrated into a VR prototype using Unity 2022. The video files were encoded using the H.264 format. The prototype was developed for viewing through Oculus Quest 2 HMD and operating using the Oculus Quest 2 controller. Several trial and error processes were conducted during the assembly state to ensure that the application flow, video playback, menu navigation, and interaction elements functioned properly.

The prototype was prepared for further evaluation after the assembly stage. Future research with broader and more representative users, including communities with higher exposure to snake encounters. In the distribution stage, the prototype was prepared for further development and future evaluation. The intended future users include rural communities and other groups with higher exposure to snake encounters. However, implementation with these target users requires additional usability and educational effectiveness evaluation before the prototype can be considered ready for broader educational use.

3. Result and discussion

According to the MDLC method that has been described, in the first stage the researchers understood the concept based on the script created by Angelia Lionardi after discussions with the Sioux Community. This community was established with the aim of providing a positive perspective about snakes to the general public, especially regarding their characteristics. The discussion resulted in a virtual reality concept that would use 360° videos and 16:9 videos to introduce the characteristics of Weling and Welang snakes. In addition, there was a short story about first aid actions after a snakebite, which would be performed by three members of the Sioux Community in both 360° and 16:9 versions.

The use of both 360-degree and 16:9 video formats was intended to provide different educational experiences within the prototype. The 360-degree video allows users to observe the surrounding environment from multiple viewing directions, creating a wider immersive perspective during the learning process. This format is particularly useful for presenting the environmental context of snake encounters and first aid situations. The use of 360-degree video for educational purposes is also

consistent with previous studies that describe this format as supporting immersive observation and situational learning experiences (Rosendahl & Wagner, 2024)

In contrast, the 16:9 videos provide a more controlled visual frame that directs user attention to specific information, such as the characteristics of Welang and Weling snakes with the voice over explanation and one sequence of first-aid snakebite actions. Therefore, both formats were included to support different learning needs within one application. However, since the Sioux Community is located in Yogyakarta while the researchers and research team were based in Gading Serpong, a preliminary re-enactment was conducted in a different location, as shown in Figures 1 and 2. Furthermore, these figures represent the results of the initial video output testing to determine whether they were in accordance with the intended concept or not.

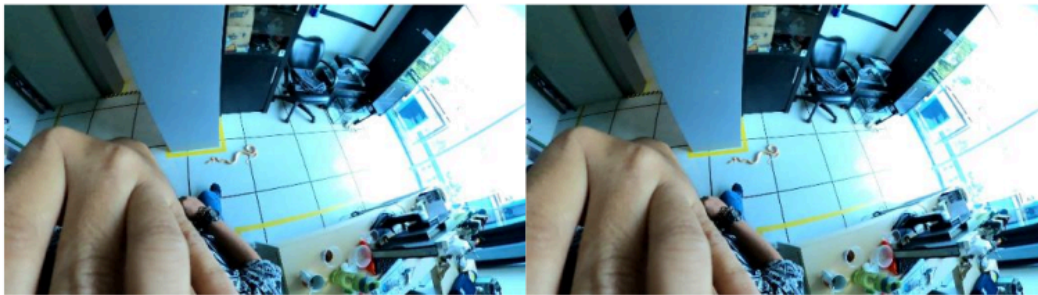


Figure 1. (a) re-enactment of venomous snakebite first aid in 360-degree video formats; (b) re-enactment of venomous snakebite first aid in 16:9 video formats.

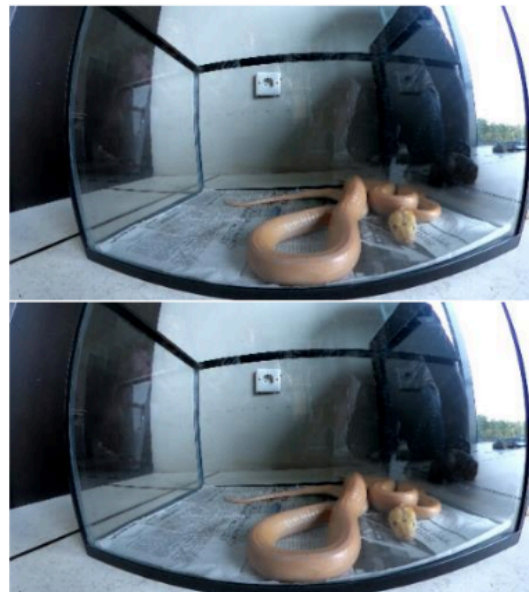


Figure 2. (a) re-enactment of venomous snake characteristics in 360-degree video formats; (b) re-enactment of venomous snake characteristics in 16:9 video formats.

Then, the design stage was carried out to determine the interactive flow of the MIGUI (2024) application prototype, as shown in Figure 3. From this figure, it can be seen that the initial appearance of the prototype is the main menu, which provides two options. Each option will display two video versions of the selected object that users want to watch.

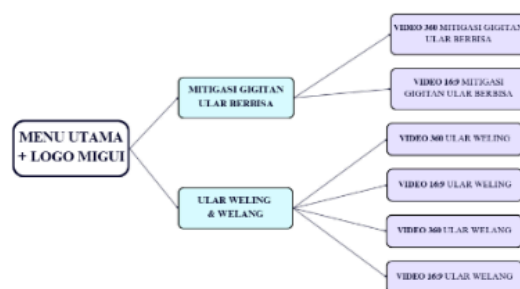


Figure 3. (a) interactive flow of the MIGUI prototype.

MIGUI is primarily designed as a VR video-based educational prototype rather than a fully interactive 3D simulation. User interaction is limited to menu navigation, content selection, and video viewing. This approach was selected because video-based production allows the use of real snake footage and a re-enactment of a real-life first-aid demonstration while maintaining visual accuracy and production feasibility. In addition, the use of real footage allows users to observe the actual visual characteristics of Welang and Weling snakes as well as the sequence of snakebite first-aid actions demonstrated by real actors rather than recreated through 3D assets.

After that, the material collection stage began by preparing the floor plan and staging to arrange the positions of the actors in the short film about venomous snakebite mitigation, as shown in Figure 4. These guidelines helped the researchers direct the actors during the 360° video shooting. Then, the material collection was carried out by recording six video footages for the content needs of the MIGUI (2024) prototype application. The footages shown in Figures 5 and 6 consist of the short film about snakebite first aid in both 360° and 16:9 versions, as well as 360° and 16:9 videos introducing the characteristics of Welang and Weling snakes.

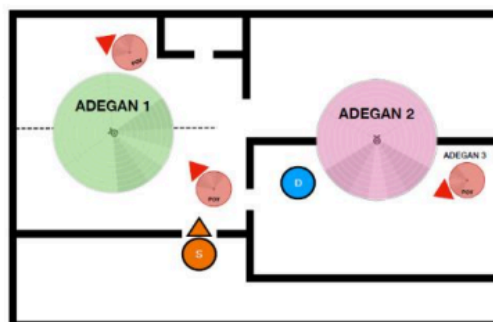


Figure 4. floor plan and staging for the snakebite first aid short-film production.

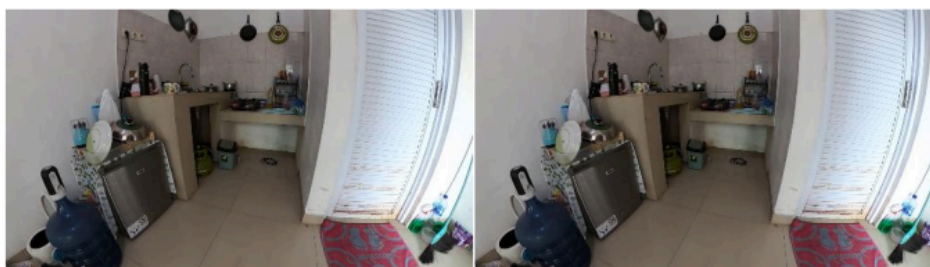


Figure 5. (a) floor plan and staging for the snakebite first aid short-film production in 360-degree version. (b) floor plan and staging for the snakebite first aid short-film production in 16:9 version.

production in 16:9 version.



Figure 6. (a) 360-degree video of Welang (b) 16:9 video of Welang (c) 360-degree video of Weling (d) 16:9 video of Weling

These footages became the materials that would be processed as the content of the application. The materials were first reviewed to select the footages that met the requirements and could be processed into the next stage. Figures 7 and 8 show the software used to develop the MIGUI (2024) prototype. The footage was recorded using GoPro camera in both 360-degree video and 16:9 formats with 4K resolution at 24fps. Adobe Premiere Pro 2024 was used to edit the videos, while Unity 2022 was used to develop the virtual reality application based on the design shown in Figure 3. The final prototype application was deployed for Oculus Quest 2 using the Oculus controller for navigation. Video assets were compressed using the H.264 codec, resulting a final prototype application size approximately 50-100MB. After that, several trial-and-error processes were conducted inside Unity to ensure that the application worked properly.

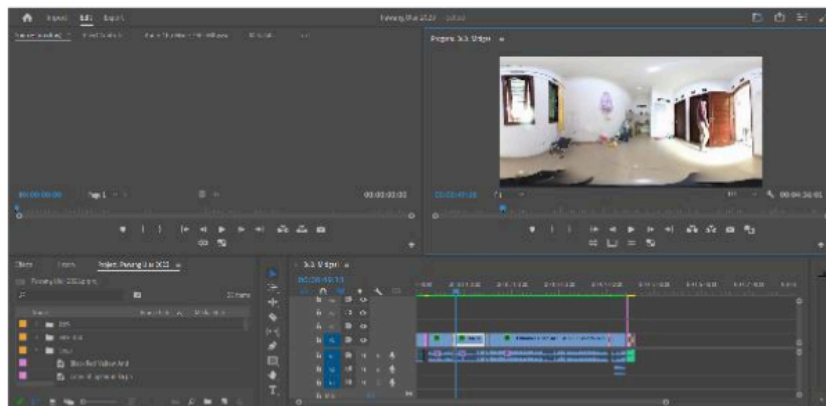


Figure 7. (a) Adobe Premiere Pro was used to edit MIGUI video footage



Figure 8. (a) Unity was used to develop the MIGUI virtual reality prototype.

Finally, the distribution stage was carried out by saving the program into the storage media, and the application will be further developed to reach better results in the future development and evaluation. The resulting prototype integrates Welang-Weling recognition and snakebite first-aid educational content within a single VR video. The development process demonstrates that 360-degree and 16:9 video formats can be integrated into one immersive application. However, broader usability evaluation and educational effectiveness assessment remain necessary before the prototype can be shared for public education.

4. Conclusion

The results of this study show that the development of the MIGUI educational media prototype integrates Welang-Weling recognition and snakebite first aid information using 360-degree and 16:9 video formats. Developed through Multimedia Development Life Cycle (MDLC), the prototype combines real snake footage, real human actors, first-aid simulation, and virtual reality technology within a single educational application.

The use of both 360-degree and 16:9 videos was intended to provide complementary learning experiences. The 360-degree offers a wider view of environment, while the 16:9 format provides a focused of visual characteristics. This approach allows users to observe the characteristics of Welang and Weling snakes as well as snakebite first-aid procedures through real audiovisual representations. The development process demonstrates the potential of virtual reality as a medium for delivering snake-related educational content. In addition, the use of original footage collected in collaboration with the Sioux Community supports the visual accuracy of the educational materials presented in prototype. As a result, MIGUI contributes to the development of immersive educational media that combines venomous snake recognition and snakebite first aid information within a single virtual reality application.

The use of immersive visual environments is consistent with previous studies that describe VR capable of providing broader spatial observation and immersive audiovisual experiences (Hamilton et al., 2021; Radianti et al., 2020). However, MIGUI does not provide full object-based interaction because the educational content is primarily presented through recorded video. Therefore, its contribution should be understood as an immersive VR video-based learning prototype rather than a fully interactive 3D simulation.

Several technical limitations were identified during prototype development including video playback performance and audiovisual optimization within HMD environment. The video quality not always optimal when played through the HMD, and lagging could also occur during video playback. This becomes an important input that technical aspects such as resolution, file size, and the number of videos included in one application need to be considered in further development. Improving the video quality and simplifying the number of video assets may help improve application performance and user comfort.

Another limitation is related to the first-aid content. The snakebite first-aid content was based on health related references used in this study, but formal validation by medical or health professionals was not conducted. Future development should involve health professional to validate the first-aid content before public implementation.

Overall, this study emphasizes the importance of visual and immersive approaches in developing educational media for snakebite mitigation. In the future, collaboration with reptile experts, application developers, and health institutions is needed to improve MIGUI into educational media that can be prepared for wider community use, especially in areas that are more exposed to snake encounters.

This research focuses on the development of the MIGUI prototype rather than evaluating its educational effectiveness. Therefore, further studies involving broader and more representative users are needed to evaluate usability, user experience, and the effectiveness of the prototype as an educational medium. Future research can also expand the snake species presented in the application, improve the technical quality of the video, and further develop the interaction available in the prototype. Practically, after further evaluation and development, MIGUI has potential to be used in the schools, public health centers, and disaster training programs. The approach presented in this study may also provide opportunities for developing virtual reality-based educational media for other health and disaster mitigation topics.

Conflicts of Interest: The authors declare no conflict of interest.

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