Serpentsphere: VR Training for Venomous Snakes in Sri Lanka

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Abstract—Sri Lanka faces a major health problem from snakebite envenomation because venomous snakes reside near human settlements. Severe medical complications such as paralysis and internal bleeding and death emerge as results of snakebite incidents. The current traditional training approaches aimed at snake identification and handling techniques show limitations because they either focus on theoretical content or expose participants to dangerous direct encounters. The proposed research develops a Virtual Reality (VR)-based simulation platform which unites theoretical classroom information with practical skills through a protected interactive student experience. The system targets people who frequently deal with snakes including farmers together with wildlife officers and residents from rural areas.

The proposed virtual reality training system includes three essential elements for learning correct handling methods and interactive 3D model identification of dangerous species followed by snakebite medical effects education. The VR simulation will include both first aid procedures for envenomation treatment and emergency response strategies to boost readiness. The research evaluates how VR-based training impacts both knowledge retention and fear reduction and snake-handling confidence among participants. The research combines different methods through surveys and skill tests and participant feedback to measure how the VR system affects training outcomes. This research establishes a controlled training setting to minimize snakebite fatalities and enhance safe snake-human encounters.

The human body faces neurotoxic, hemotoxic and cytotoxic venom reactions from snakes which result in paralysis and internal bleeding, tissue destruction and systemic shock and kidney failure and possible death when treatment is unavailable. The VR training system delivers complete instruction about first aid measures and emergency response techniques and their effects on human bodies to ensure appropriate medical preparedness.

This study develops public health instruction by creating an accessible risk-free approach to snakebite safety training. Through its ability to decrease casualties and enhance readiness the VR system has the potential to revolutionize safety education in Sri Lanka together with other nations.

Index Terms—Virtual Reality, Snakebite Envenomation, Immersive Training, Venomous Snakes, Augmented Learning

I. Introduction

Sri Lanka faces a critical public health crisis because thousands of snakebite cases occur every year. Envenomation cases frequently happen in rural regions because these areas have restricted medical facilities. The lack of awareness about how to handle snakebites and perform first aid and identify venomous species leads victims to make improper responses that intensify envenomation effects. Educational strategies that rely on textbooks and classroom lectures along with demonstrations fall short in delivering needed practical experiences, so students find challenges in maintaining information while learning physical competencies. Unnecessary snake killings caused by cultural misconceptions and snake fear disrupt both the ecosystem and ecological balance in the environment.

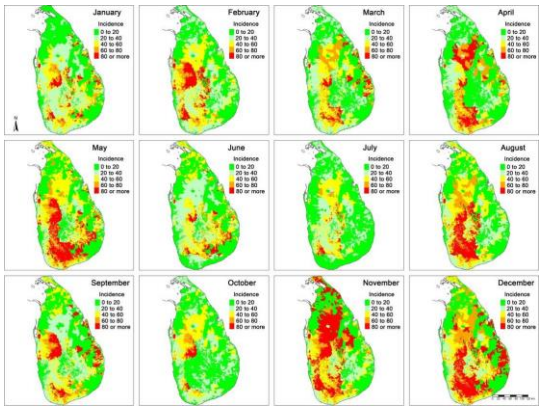

Figure 1: Monthly Distribution of Snakebite Incidents in Sri Lanka

Several lethal venomous snake species inhabit Sri Lankan territory, with Russell's viper (Daboia russelii) and cobra (Naja naja) and krait (Bungarus caeruleus) and saw-scaled viper (Echis carinatus) among them. Most venomous snake bites in Sri Lanka occur from these species because their bites require immediate medical attention. The absence of proper training

programs leads to more fatalities and medical complications because people need longer to find proper help or perform inadequate first aid procedures.

The development of immersive technology shows that Virtual Reality (VR) functions well as a training instrument in dangerous operational settings. The interactive VR platform enables users to perform critical skills without risk while they make pressure-tested decisions that generate immediate feedback. The controlled VR environment enables repeated hazardous scenario exposure, so users attain better skills and knowledge retention when compared to traditional methods. The research uses VR technology to develop an interactive training system which improves snakebite readiness and understanding among users.

Virtual reality technology enables users to learn appropriate snake-handling methods while developing their ability to correctly identify snake species and grasp how venom affects victims and what emergency actions to take. Users can learn snake identification by engaging with 3D models that show vital characteristics and help them distinguish venomous from non-venomous species. Virtual settings enable effective practice of snakebite first aid procedures which include the demonstration of pressure bandage application and immobilization techniques.

The study investigates how virtual reality benefits knowledge storage among those who deal regularly with venomous snakes by helping them overcome fears and build effective handling practice. The study evaluates VR-based training as better than traditional education by demonstrating its ability to decrease snakebite-related health problems and death rates through empirical research. The research project investigates methods to personalize VR training according to specific requirements of farmers and wildlife officers and healthcare providers and students who face risks from snake encounters.

The use of virtual reality-based snakebite training creates an opportunity to transform how the public learns about snake hazards which results in better preparedness among at-risk communities. This research develops snake-handling skills which decreases unnecessary fear and enables better wildlife coexistence and reduces health dangers from venomous snake envenomation.

II. Literature Review

Sri Lanka together with other tropical regions faces snakebite envenomation as a major public health concern because venomous snakes occur commonly in human contact areas. The insufficient training methods for snake handling identification and emergency response make the problem worse. Research on snakebite epidemiology and traditional training methods and Virtual Reality (VR) as an immersive learning technology forms the basis of this review.

Snakebite Epidemiology in Sri Lanka

The country of Sri Lanka experiences major health consequences from snakebites which result in serious injuries and fatal outcomes. Warrell [1] establishes that snakebites rank as one of the primary causes of injuries and fatalities in tropical regions particularly affecting Sri Lanka because of its wide range of snakes and traditional rural way of life. Snakebite envenomation received new classification as a neglected tropical disease according to Chippaux [2] which emphasizes the necessity of developing better prevention and treatment approaches. Kasturiratne et al. [3] determined that snakebites create a major health problem worldwide and Sri Lanka experiences thousands of snakebite cases each year. People in rural areas tend to experience these bites because medical care remains scarce thus the treatment often suffers delays leading to severe complications including paralysis and internal bleeding with tissue damage and kidney failure.

Snakebites create substantial economic consequences for society. Assaulted patients experience extended medical treatment along with high healthcare expenses while their condition impedes their ability to work leading healthcare systems and families to sustain significant costs. The paper by Fry et al. [4] explores evolutionary aspects of snake venom systems through detailed analysis of venom complexity and human body responses. Research of these biological systems forms the basis needed for creating successful treatment methods and educational procedures. The current training programs do not integrate this biological information which makes trainees ill-equipped to handle actual situations.

Figure 2: Key Impacts of Snakebites in Sri Lanka

Limitations of Traditional Training Methods

The current methods for teaching snake handling and identification create major problems in the training process. The standard training methods consist of theoretical education or physical snake encounters which create specific obstacles during the process. Theoretical training, while informative, lacks the experiential learning necessary for skill development. Direct interaction with live snakes, on the other hand, poses significant safety risks. Gutiérrez et al. [5] emphasize that

knowledge about venom's physiological effects should be included in practical training for improved treatment outcomes, but this practice remains uncommon.

A systematic review by Silva et al. [6] studied snakebite epidemiology and control in Sri Lanka to demonstrate the ineffective nature of present educational resources. Traditional training methods lack the ability to deliver complete practical experience, which mirrors venomous snake encounters in real-life situations. The need for innovative solutions to fill this knowledge gap remains a critical issue according to Alirol et al. [7]. The authors of this South Asian snakebite management review demonstrate that merging theoretical information with practical abilities helps improve readiness and minimize death rates.

The Role of Immersive Learning Technologies

The combination of immersive learning technologies such as virtual reality resolves the major disadvantages affecting conventional educational methods. Research in educational technology confirms that VR-based training systems improve student cognitive memory and their active participation in learning. Medical and emergency training with VR simulations proves effective according to Williams et al. [8] because they enhance both procedural knowledge and skill acquisition. The research indicates that VR technology holds potential for developing safer education programs about snakebite safety which also improves student engagement.

Virtual reality enables users to experience real-life simulation events that they can navigate without actual dangers. The virtual training environment allows users to practice their handling methods while they learn to identify dangerous species and study how snake venom affects the body. Educational materials about venom composition and its consequences require detailed study according to the discussions of Fry et al. [4]. The system uses VR technology to build interactive modules which demonstrate biological processes in snakebite envenomation to users.

Components of an Effective VR Training System

The proposed VR-based training platform includes three essential components that consist of Tools and Techniques for Catching Snakes and Identifying Snakes and Studying Anatomy and Effects of Snake Bites on the Human Body. The system incorporates established research findings to meet educational requirements.

1. Tools and Techniques for Catching Snakes:

The training teaches users to handle venomous snakes safely through instruction on using hooks and tongs as tools. According to Silva et al. [6] the implementation of safer handling protocols requires hands-on training to lower the probability of snakebites. The VR system gives clients instant feedback that helps them learn correct methods and safety procedures. The training module uses simulated real-life conditions to prepare users through safe experiences which reduce both safety threats and unexpected situations.

2. Identifying Snakes and Studying Anatomy:

Precise recognition of venomous species remains essential to stop snakebites and provide suitable medical care. According to Kasturiratne et al. [3], visual and morphological traits enable proper differentiation between venomous and non-venomous snakes. Detailed 3D models within this module teach users to identify snakes through their skin patterns, scale patterns, and head shapes. Users receive step-by-step guidance from interactive tutorials, developing their skills to identify dangerous species. The module contains an educational segment about snake anatomy, focusing on venom glands and other vital structures. A standout feature of this system demonstrates the virtual reality simulation of venom extraction, providing an immersive educational experience on internal snake structures and venom extraction processes. Additionally, an AI-powered virtual assistant enhances the learning experience by educating users about different snake species, answering queries, and guiding them through identification and handling techniques.

3. Effects of Snake Bites on the Human Body:

Knowledge about how snake venom affects the human body remains vital for providing successful emergency treatment. According to Gutiérrez et al. [5] there is an urgent requirement to teach people about how venom affects human physiology. The module shows the symptoms development using a three-dimensional human body model which demonstrates how venom affects different organs. Users can observe venom operations in real-time using interactive timelines which help them better understand how quickly venom works within the body. The module provides information about first aid and medical treatments which gives users the essential knowledge to handle snakebite emergencies effectively.

Comparison with Conventional Approaches

The proposed virtual reality system provides better training benefits when compared to traditional educational approaches. The hands-on learning provided by VR operates in protected spaces compared to theoretical study methods. The virtual reality approach allows safe training without real snakes by delivering authentic simulations of authentic situations. Research demonstrates that full-immersion learning builds better memory capabilities and student involvement creates VR as an effective teaching tool for snakebite safety [8].

The deployment of VR-based training faces multiple implementation difficulties. The implementation of VR-based training faces obstacles because of its expensive development costs and technical requirements and specialized expertise requirements. Another important factor involves making training accessible and usable for all user groups including people who live in rural areas. The solution of these obstacles demands joint efforts between herpetologists and medical professionals together with VR developers and educational designers.

This system has been proposed to fill the education gap about snakebite safety in Sri Lanka by offering virtual training that enables risk-free learning. The system consists of three fundamental components that teach Tools and Techniques for Catching Snakes alongside safe handling procedures and Identifying Snakes and Studying Anatomy through 3D model identification and Effects of Snake Bites on the Human Body by presenting venom-related physiological effects. The system

delivers training to farmers together with wildlife officers and rural community members to build their knowledge base and practical abilities and emergency readiness. The platform uses both theoretical education and practical training to work toward lowering snakebite death rates while improving public safety.

III. Methodology

The Virtual Reality (VR)-based training system proposes to fill gaps in standard snake handling and identification training with an interactive risk-free virtual learning environment. The development process describes how the VR platform will be built while user testing and data collection and analysis methods are explained for platform evaluation.

Development Process:

The VR training system development will utilize Unity 3D as its game engine because it is known for building interactive 3D environments. Oculus VR hardware integration will enable the system to deliver a completely immersive experience. Software development and user testing and data collection and analysis make up the four essential components of the development process.

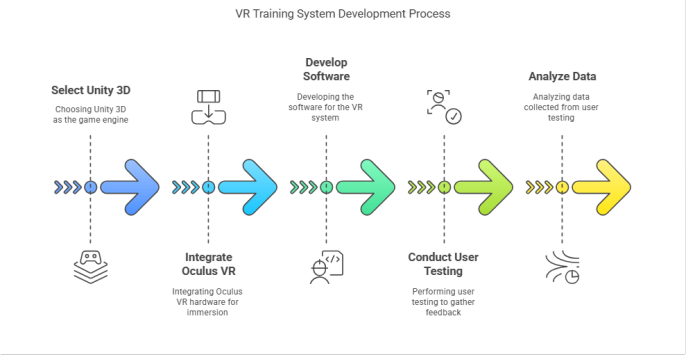

Figure 3: System Development Process

Software Development:

Interactive training modules will be developed during the software development phase to match the core components of the VR system which include Tools and Techniques for Catching Snakes and Identifying Snakes and Studying Anatomy Effects of Snake Bites on the Human Body. The training modules will combine theory with practice through safe educational experiences.

Tools and Techniques for Catching Snakes:

Users will practice venomous snake handling through virtual scenarios by utilizing hooks and tongs as training tools. The system will generate realistic 3D models which duplicate actual tools exactly. Users will obtain immediate feedback through the system which provides appropriate tips to help them acquire proper techniques while learning safety measures. Users will receive training for emergency procedures as part of the system to handle unexpected events [1].

Identifying Snakes and Studying Anatomy:

A detailed 3D modeling system for venomous snakes will present specific characteristics that include their skin patterns, scales, and head structure. The system provides step-by-step tutorials that show users how to recognize venomous species by using both visual and morphological traits. The module contains an educational segment about snake anatomy, which emphasizes studying venom glands and other essential body parts. The system includes a VR simulation that allows users to experience venom extraction while observing snake internal structures [2]. Additionally, an AI-powered virtual assistant will be integrated to educate users about different snake species, answer queries, and guide them through identification and handling techniques.

Effects of Snake Bites on the Human Body:

A 3D human body model will showcase the physiological consequences that snake venom has on the human body during this module. Users can track symptom progression along with organ system effects by exploring interactive timelines. Users will receive necessary information about first aid and medical treatments through the module to help them respond properly to snakebite emergencies. The system will explain long-term effects and recovery processes to help users understand the critical nature of treatment progression [3].

User Testing:

The testing phase will involve multiple groups including wildlife professionals and farmers as well as community members and medical students. The target users for the VR training system consist of these groups. The VR modules will be tested by participants under controlled settings that enable researchers to evaluate system performance and participant engagement and usability. The system's development will heavily rely on feedback obtained through testing trials which will help refine the system and resolve detected testing issues [4].

Data Collection:

The assessments before and after the training program will measure both knowledge growth and skill mastery. The assessment process will contain multiple-choice questions and practical tasks performed inside the virtual reality environment and satisfaction surveys and confidence level surveys. The system will record performance metrics that include completion times for tasks together with correct identification of venomous species alongside safety protocol adherence. The collected data will deliver numerical evidence about how effective the system performs [5].

Analysis:

Both quantitative and qualitative assessment approaches will evaluate the gathered data. Statistical tests will evaluate the importance of training-related skills and knowledge advancements between the beginning and conclusion of the course. Survey and interview collected qualitative data will undergo thematic analysis to determine both positive and negative feedback and system weaknesses. The study results will confirm whether the virtual reality training system performs better than traditional methods [6].

Testing and Validation

The VR system needs to pass through multiple tests to verify its operational capabilities and user-friendly design and educational worth. System effectiveness will improve through participant feedback which will serve as the essential factor for system development. The testing process consists of these specific steps:

Usability Testing:

The participants will test the VR modules through direct interaction to determine how easy and accessible the system functions. The evaluation process will measure navigation simplicity together with instructional clarity and user contentment levels. The design team will use identified usability problems to improve the system through multiple rounds of iterative development [7].

Effective Testing:

The system's effectiveness in skill and knowledge improvement will be assessed through pre- and post-training evaluation tests. The system produces three main results which enhance venomous species recognition abilities while improving handling practices and increasing knowledge about snake venom effects on the body. The VR system will demonstrate its benefits by evaluating the measured results against baseline data collected from traditional training procedures [8].

Feedback Integration:

The participant feedback gathered will undergo systematic analysis to help refine the system. The analysis of participant feedback will determine which suggestions to implement first regarding simulation realism, interactivity and content expansion. The final product will meet its educational goals and fulfill the requirements of its target audience through continuous implementation based on feedback [6].

IV. Results and Discussion

The results of the VR-based training system show that the VR-based training system led to advanced abilities among trainees to correctly detect venomous snake species. The realistic 3D models alongside interactive tutorials granted users improved knowledge about venomous snakes' identifying traits which included skin patterns and head forms as well as scale dynamics making users more accurate at snake identification and a clear knowledge about venom extraction procedures is provided. Virtual reality simulations in the program enabled users to improve their handling skills through real-world tool exercises using hooks and tongs in a safe and immersive manner. Through physical interaction with simulated snake handling situations participants developed better real-life skills which minimized potential dangers from incorrect handling methods. Through the system participants could understand snake venom's physiological effects on human bodies because they interacted with a 3D human body model displaying symptom advancement and organ system damage. Through active engagement participants gained an extensive understanding about how venom acts as a neurotoxin and a hemotoxin and a cytotoxin thus proving the need for immediate medical care. Users developed greater confidence in handling snakebite emergencies because the VR platform taught them first aid protocols and emergency response training. Tests confirmed that the VR system delivered successful results in building knowledge and skills while preparing users for snake safety needs beyond standard educational practices.

The discussion investigates VR's educational potential as a new learning tool to tackle the urgent public health issue of snakebite envenomation in Sri Lanka through outcome assessment. The study evaluates the potential of immersive learning to boost academic understanding and practical capabilities and emergency treatments while it assesses the obstacles that might emerge when deploying this approach.

Effectiveness of VR-Based Training

Participants who received VR-based training demonstrated enhanced abilities to recognize venomous snake species as the main result from the study. The traditional identification methods depend on static pictures and theoretical explanations, but these methods do not deliver sufficient understanding that would be needed to identify snakes accurately in real environments. The VR system presents detailed 3D models which display essential identification characteristics including skin patterns together with scales and head shapes. Users can interact with dynamic content through these models to develop better comprehension of venomous species' morphological characteristics. The complete immersive quality of virtual reality assists users in retaining their learned material effectively leading to better scores in post-training evaluations [1]. The successful outcome confirms how VR technology can unite abstract knowledge with essential practice in domains needing visual expertise.

The implementation of realistic virtual reality simulations leads to better handling techniques as a main research outcome. The participants showed better skill development regarding the safe handling techniques of hooks and tongs that serve to secure venomous snakes. The combination of working with live snakes during training presents dangerous conditions to trainees and theoretical lessons alone fail to provide actual hands-on learning experiences. Through its VR system users gain access to a protected genuine environment that allows them to practice handling methods many times while staying secure from harm. Real-time feedback sessions coupled with tips allow users to learn correct methods and safety protocols during the training process. The study confirmed earlier research which showed that virtual reality improves students' ability to acquire practical knowledge and skills [2].

The virtual reality system effectively taught users about the physical body effects that snake venom creates in humans. The system showed participants how venom impacts different body organs and systems through its interactive timelines and 3D human body model and explained symptoms that include paralysis and internal bleeding and tissue destruction and kidney failure. The VR system delivered detailed biological explanations that traditional training lacks because it focuses only on first aid knowledge without showing biological mechanisms. Users become better able to identify medical emergency situations through the inclusion of health care information in the VR system while receiving the required knowledge

needed for appropriate emergency responses. Emergency response training together with first aid protocols strengthen the system's ability to create complete preparedness capabilities.

Comparison with Conventional Training Approaches

The VR-based system delivers various benefits compared to traditional training approaches. The system removes all safety hazards of dealing with real snakes which enables a broader training audience to participate including people who lack experience handling snakes. Engagement and cognitive memory strength increase through virtual reality because users actively participate in learning activities they would not achieve in passive educational situations. The system design includes modules which enable adaptations according to user requirements for both farmers and wildlife officers along with community members.

This study identifies specific drawbacks of the VR system although it presents valuable information. The main disadvantage of this system includes the high initial expenses and technical specifications necessary to create and implement the platform. VP Platform implementation becomes less accessible when high-quality Hardware meets expensive Software development costs. Some users struggle to transition into the VR environment since they lack experience using technology. These technical difficulties do not diminish the system's effectiveness yet highlight the requirement to sustain support for continuous development to boost universal acceptance.

Positive and Negative Aspects

The VR system demonstrates clear positive features through its secure learning environment alongside its interactive comprehensive learning approach. The system unites academic concepts with functional expertise to close educational deficiencies and improve readiness for snakebite emergency situations. The realistic interactions of virtual reality enhance user information learning which produces better results for real-life situations. The system demonstrates scalability which enables its use in big public safety education programs across Sri Lanka and other territories.

The system faces negative aspects because its technology-based approach creates problems with access and user-friendly operation. The system requires rural communities and target audiences to have both needed hardware equipment and technical capabilities to maximize its effects. The high initial expenses needed to develop the system create difficulties for its implementation, especially in areas with limited financial resources. The successful resolution of these challenges requires stakeholders to unite including government departments and educational organizations along with private sector organizations.

V. Conclusion

The VR-based training system establishes considerable potential to reshape snakebite safety education in Sri Lanka. The system provides users with risk-free training that enables them to recognize poisonous snakes while teaching them proper handling techniques, venom extraction methods and emergency response procedures. The immersive VR technology helps trainees remember information effectively because it delivers a realistic learning experience which addresses the boundaries of standard training methods lacking hands-on learning and safety risks. The study data demonstrates that the system delivers enhanced skills, improved handling abilities and emergency readiness to users. This innovative system provides benefits which greatly surpass its accessibility limitations along with technical expenditure challenges. The VR platform takes an essential role in decreasing snakebite deaths while improving public safety throughout Sri Lanka.

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APPENDIX