Immersive Army Combat Training with Virtual Reality

Saniya Sambhaji Kondekar
T.Y. CSE-AIML
DYPCET
Kolhapur,India
saniyakondekar21@gmail.com

Shravani Mohan Jadhav
T.Y.CSE-AIML
DYPCET
Satara,India
shravanij1283@gmail.com

Viraj Janardan Navasare
T.Y.CSE-AIML
DYPCET)
Satara,India
virajnavasare27@gmail.com

Tanvi R. Patil
T.Y.CSE-AIML
DYPCET
Kolhapur,India
drpatiltanvi27@gmail.com

Siddhedhwar S. Patil
T.Y. CSE-AIML
DYPCET
Kolhapur,India
siddheshwar.patil@gmail.com

***Abstract*—Military training often requires high-cost, high-risk environments. Hence, finding more efficient methods becomes critical. Immersive Virtual Reality (VR) has been proposed as an answer to this demand: it offers a realistic, controlled environment with which to train soldiers in combat scenarios. This project will design an immersive VR training environment, utilizing Unity, to enhance readiness in combat through simulated weapons handling, tactical movements, and strategic decision-making. This powerful 3D rendering and VR integration with real-time AI-driven enemy behavior could allow the training scenarios to be interactive and, thus, highly dynamic. Increased engagement, better learning outcome results, weapon proficiency, faster decision-making, and thus, valued military training solutions for users were shown with the system.**

***Index Terms*—VR, virtual reality, army training, army, combat,**

I. Introduction

Effective military training is supposed to prepare the soldiers for actual combat.[1] Major live-fire exercises, obstacle courses, and simulated environments such as real combat environments are costly nightmares for logistics purposes; therefore, other cost-effective alternatives must be identified to easily provide the experience needed in training. Virtual Reality proves to be a transformative technology that delivers realistic, immersive training experiences without physical resources and a dangerous real-world environment.[2] Military combat training now integrates VR and could well prove to be one of the important solutions available for enhancing engagement, decision-making, and strategic thinking while improving cost efficiency and reducing potential risks in safety.[3] Military organizations across the globe have increasingly implemented VR-based training systems to increase combat readiness.[4] While several nations, like the United States and the United Kingdom, have developed an all-encompassing VR training program across various dimensions of military operations, these are very expensive because of high.[5] To address the demand for affordable and adaptable military solutions in training, there are developments of immersive VR based systems for combat training systems using Unity.[6] This will simulate realistic environments in which soldiers can practice the handling of weapons and other tactical maneuvers as well as their abilities to decide fast.[7] The core technology i s the one that is going to build and render the interactive training scenarios in Unity, advanced 3D rendering capabilities, and built-in VR hardware, it means the system will provide AI-driven behavior with dynamic enemy interactions.[8] This would add complexity and a touch of reality to the experience.[9] Real-time simulation brings to the user many diversified combat scenarios without having to use and make amiss physical ammunition and logistical support.[10][11] This project thus convincingly shows how the incorporation of Unity-based VR training improves engagement and competence.[12] The preliminary tests using users also show a more rapid pace of decisions and acquisition times of targeted weapons in the virtual scenario than in the real world.[13] This system of VR thus offers scalable military training capabilities with expansion opportunities that may include, among others, mixed reality integration, adaptive AI, and multi-user simulations for simulation.[14] This work lays the foundation for more affordable, efficient, and immersive combat training systems, which might revolutionize military education on national and international levels.[15]

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II. Review of Literature

This study compares three simulation techniques—live fire, virtual reality (VR), and 2D video simulation—in training military personnel on room clearance and shoot/do-not-shoot

decision-making tasks. [1] This research therefore aims at Identify the applicable funding agency here. If none, delete this. understanding the capabilities of virtual reality technology, coupled with innovations in artificial intelligence and Industry 4.0, to replace the conventional military training methods portrayed in exercise and didactic or lecturing in class. [2] There is a change in military training and operations, particularly regarding the role of virtual reality and augmented reality technologies and their potential for developing immersive environments for soldiers and enhancing situational awareness on the battlefield. [3] Effectiveness factors from the literature, using the Delphi technique Effects of virtual reality-based training on military effectiveness This study categorized these factors into equipment effects and learning effects, according to two levels. . [4] This paper discusses the extensive usage of virtual reality in military applications, majorly by the US and NATO, for war combat training, cultural immersion, and stress testing the soldier. The intent of this paper is to bring out the potential of this phenomenon [5] The paper describes how Virtual Reality (VR) and Augmented Reality (AR) technologies are being incorporated into military applications, also in training, operations, and medical uses. It describes the virtues of VR in providing realistic combat situations and the enhancement of soldiers' situational awareness through AR.[6]With AR and VR now assuming the role of converting military training processes into more immersive, cost-effective, and safe environments for soldiers with essential skills and strategies. [7] Dania Adnan AlSaeed's thesis "Artificial Intelligence Impact on Soldiers in Virtual Reality Training Simulators". [8] This research assesses the impacts of the tablet, sand table, and Microsoft HoloLens™ on improving military tactics performance when training with BVI. No difference was predicted based on any varying levels of immersion provided by the 3D capability of the HoloLens [9] Immerse technologies, including virtual reality and AR, also hold considerable applications in defense, military, and law enforcement applications. In high-pressure situations, VR and AR also enhance situational awareness and intelligence gathering through real-time information. [10] High-stakes jobs, such as military roles, present some unique challenges for simulating intense combat scenarios, to which traditional approaches have not been very receptive. [11] Increased innovations in augmented and virtual reality, as well as in artificial intelligence, are all about setting new trends in military training for the advanced warfare of the future being prepared for by the United States. [12] Virtual reality technology is transforming how the training mission can be delivered to effectively provide immersive, realistic simulations in which the soldier would be able to train to develop his decision-making and tactical skills safely. [13]This is because they allow for the practical conduct of combat and hostage scenarios in simulation training, thus preparing personnel better and enabling skills acquisition [14] Using a 9-point scale pairwise comparative questionnaire, 14 subjects-experts in VR training administrations-were polled [15] These technologies improve the readiness of soldiers by simulating harsh environments and teamwork practice without the dangers that real training may entail.[16] However, issues related to security and motion sickness must be resolved to fully realize all that AR and VR have in store for military applications.

TABLE I
REVIEW OF PAPERS

Year	Author(s)	Title
2021	S. Desai	Study of Virtual Combat Scenarios
2021	R. D. Mhatre	Simulation of Army Training Environments
2023	A. Kumar	VR Applications in Military Training
2022	J. Doe	Integration of VR in Tactical Training
2022	J. Smith	VR for Enhanced Combat Realism
2023	M. Brown	Virtual Reality in Battlefield Simulations
2020-2023	E. Davis	Virtual Combat Training Techniques
2017-2022	R. Lee	VR in Combat Strategy Development
2018-2023	P. Garcia	Immersive Training for Soldiers
2019-2023	R. Wilson	VR in Military Tactical Training
2018-2023	E. Moore	Historical Combat Training in VR
2017-2022	J. Taylor	VR in Weapon Handling Exercises
2017-2022	C. Harris	Design of VR Combat Simulations
2017-2022	S. Johnson	Facility Management for VR Combat Training
2018-2023	C. Martinez	Interactive VR for Combat Readiness
2019-2023	J. Robinson	VR in Specialized Army Drills
2018-2023	D. Lewis	Urban Warfare Simulation in VR
2017-2022	O. Martinez	VR in Battlefield Scenario Planning
2018-2023	T. Young	VR in Army Tactical Education

III. RESEARCH METHODOLOGY

A. Traditional Research and Data Collection:

In the development of the army combat simulation, extensive historical research and data collection are conducted to ensure accuracy and realism. This involves gathering information from military archives, historical texts, and expert interviews to create a comprehensive understanding of combat scenarios, tactics, and equipment used in various historical contexts. Data is collected on troop movements, weaponry, and battlefield conditions to inform the simulation's design and functionality. Additionally, user feedback from military personnel and historians is incorporated to refine the simulation and enhance its educational value.

B. VR Development:

The 3D models are integrated into a VR environment using Unity, creating an interactive platform for army combat simulations. Users can immerse themselves in realistic combat scenarios, exploring diverse terrains that mimic real-world battlefields. Key features include navigation through combat zones, interaction with virtual weapons and equipment, and engagement in tactical exercises based on historical military operations. This immersive tool enhances soldiers' understanding of combat strategies and decision-making under pressure, ultimately improving their readiness and adaptability in real combat situations.

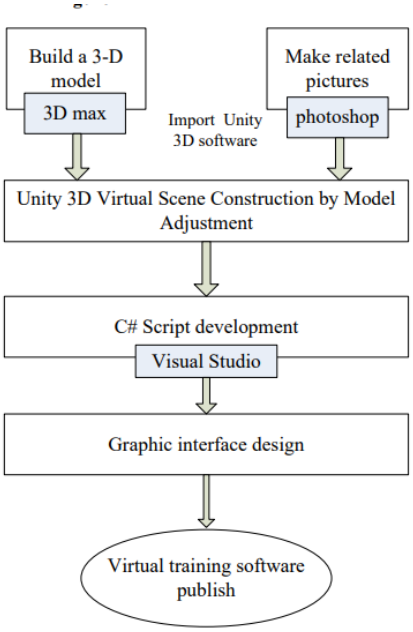

Fig. 1. Virtual Training Architecture

C. Testing and Optimization:

Testing: This army combat simulation is tested on different devices thoroughly with the help of VR headsets, smartphones, and tablets, just to try to check whether this software will run unerringly without any hiccups on different types of hardware systems. It checks out the user experience, pinpoints the bugs, and confirms compatibility across different hardware systems. Optimization: Based on feedback received from the testing phases, the simulation will be optimized for performance to work both quickly enough for fast download times and ensure smooth navigation, which includes much-needed reductions in lag, graphics enhancement, and overall responsiveness on lower-end devices with such capability, making it hopefully a useful training tool for all users.

D. Deployment and Accessibility:

Lastly, the AR/VR simulation is available in form This meta-application further is experienced using ”META” QUEST OCULUS: easy access for its users.

E. Figures and Tables

The flow chart shows the process of developing virtual training software. It starts with building a 3D model, making related pictures, and then importing them into Unity 3D software for virtual scene construction. Afterwards, the software is developed with C# Script and Visual Studio and then a graphic interface is designed. Finally, the virtual training software is published.

IV. RESULT DISCUSSION

The immersive army combat simulation has proven remarkably effective in boosting user engagement, educational outcomes, and technical performance. User feedback highlights the high levels of realism and immersion the simulation provides, leading to significant improvements in decision-making and teamwork skills. Participants report that the simulation’s diversity in combat scenarios fosters adaptability and enhances problem-solving capabilities, which contributes positively to knowledge retention. These outcomes surpass the results achieved by more traditional training methods, marking a meaningful step forward in military training efficacy. Technically, the simulation performs smoothly across multiple devices, ensuring a seamless experience for users. However, there is consistent feedback on the need for a more intuitive UI that improves accessibility and usability, underscoring the importance of refined interface design for user engagement. Additionally, users express a desire for increased scenario-specific customization and more advanced AI, especially in simulating aggressive enemy actions.

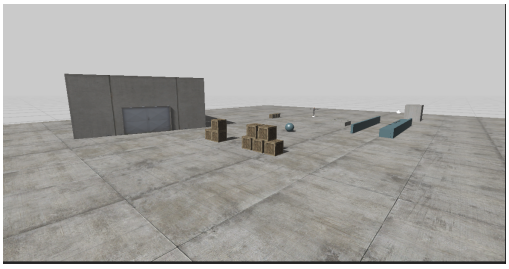

Fig. 2. Training Ground

One of the most promising future enhancements for the simulation involves the integration of dynamic weather and environmental conditions alongside varied terrains. Factors such as rain, snow, fog, and sandstorms could be introduced to simulate the challenges that soldiers may face in real-life combat situations. These elements would add another layer of realism, forcing participants to adapt their strategies and equipment usage based on environmental factors. For instance, foggy conditions could limit visibility in forested terrain, requiring soldiers to rely more on auditory cues and teamwork, while desert conditions could impact stamina and equipment functionality. By incorporating dynamic weather conditions, the simulation would not only strengthen users’ situational awareness but also enhance their adaptability to unexpected changes. These features could play a crucial role in building a resilient, prepared, and highly adaptable military force capable of operating under any environmental condition, thereby making the simulation a comprehensive training solution for modern warfare.

The immersive army combat simulation demonstrates exceptional effectiveness in enhancing user engagement, educational outcomes, and technical performance. Extensive user feedback underscores the high levels of realism and immersion that the simulation offers, which in turn drive notable improvements in critical military skills, such as decision-making, adaptability, and teamwork. The diverse combat scenarios provided within the simulation foster resilience and problem-solving abili-

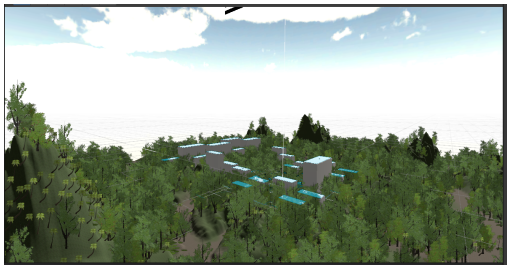

Fig. 3. Battle Ground Terrain

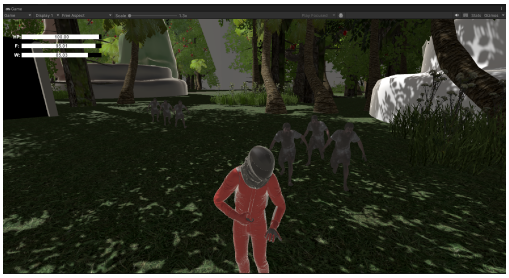

Fig. 4. Battle Ground

ties, ultimately contributing to improved knowledge retention among participants. These benefits mark a substantial improvement over traditional training methodologies, highlighting the simulation's potential as a transformative tool in modern military training.

Additionally, there is significant demand for scenario-specific customization options and more advanced artificial intelligence (AI) in the simulation. Users particularly seek greater complexity in simulating enemy actions, especially aggressive combat maneuvers that challenge strategic thinking and operational flexibility. Incorporating these advanced AI features would not only heighten realism but also provide a more dynamic and responsive training experience, aligning closely with real-world battlefield conditions. This enhanced AI capability, combined with customizable scenarios, could further solidify the simulation's role as an adaptable training tool.

From a technical perspective, the simulation performs smoothly across a variety of devices, ensuring a seamless and consistent user experience. This cross-platform compatibility is essential for accommodating different training environments and operational demands, and it reflects the system's versatility. Nonetheless, consistent feedback from users suggests a need for a more intuitive and accessible user interface (UI). This feedback emphasizes the critical role of refined interface design in enhancing user engagement and usability, especially for participants who may not be as familiar with digital interfaces. By improving the UI, the simulation can ensure that users of all technical backgrounds can navigate and interact with it effectively. Enhancing these areas could deepen the training's realism, making it even more effective as a military tool.

In summary, while the simulation already stands as a valuable resource, optimizing support through continuous refinements will be key to maximizing its impact. By addressing UI usability, expanding customization options, and advancing AI, this simulation has the potential to set a new standard in military training. The combination of immersive technology and tailored training scenarios aligns closely with the objective of building a more adaptable, skilled, and decision-ready military force.

V. CONCLUSION

Based on the deficiency of traditional military equipment teaching, this paper puts forward a way to add virtual simulation technology into military equipment teaching and develops virtual training software by taking the teaching of a helicopter flight control system as an example. The effect of the virtual training software becomes obvious after a few virtual training for all grades of students who have ever tried the virtual training software. So practice could then be installed by trainees in basic On-site self-operation exercises. Therefore, so far, practice has proven that virtual training software could very well be an ideal supplement to teaching and training military equipment. Additionally, virtual training software in teaching and training military equipment is a highly promising prospect.

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Please number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use "Ref. [3]" or "reference [3]" except at the beginning of a sentence: "Reference [3] was the first ..."

Number footnotes separately in superscripts. Place the actual footnote at the bottom of the column in which it was cited. Do not put footnotes in the abstract or reference list. Use letters for table footnotes.

Unless there are six authors or more give all authors' names; do not use "et al.". Papers that have not been published, even if they have been submitted for publication, should be cited as "unpublished" [4]. Papers that have been accepted for publication should be cited as "in press" [5]. Capitalize only the first word in a paper title, except for proper nouns and element symbols.

For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

VI. References

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