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A Review of Real-time Military Training Simulator Based on Improving War Scenario Using AI Tools

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ABSTRACT

Enhancing military training technology is crucial for improving combat readiness and decision- making. This paper introduces a review real-time military training simulator built on AI Technology models to make war scenarios more realistic and adaptive. Current simulators often struggle to respond effectively to real-time changes, creating a gap that this research aims to address. The objective of this study is to develop a simulator using AI Technology to create highly responsive and lifelike training experiences. The methodology involves designing and implementing the AI-based simulator and evaluating its performance in dynamic training settings. Results demonstrate that integrating AI Technologies enables more fluid and interactive simulations, allowing trainees to engage in responsive training that mimics real- time combat situations. This leads to improved decision-making, strategic thinking, and adaptability under pressure. In conclusion, using AI Technologies in military training simulators bridges the gap in current training technology by creating more adaptive and realistic scenarios. This leads to better-prepared military personnel ready for real-world challenges.

1. Introduction

Modern warfare has become increasingly complex, demanding constant advancements in military training methods to prepare personnel for rapidly changing and unpredictable combat situations. This paper proposes a new methodology that integrates big data with Live, Virtual, and Constructive (LVC) simulations. By considering a wide range of factors, this approach enhances the accuracy of WCE analysis, supporting weapon development, operational planning, and training. It aims to address current limitations and set the stage for future research in this field [1]. The POSNA Leadership Program helps pediatric orthopedic surgery leaders develop essential skills for guiding their teams effectively [2]. This chapter explains that winning in operations depends on balancing time, space, and force based on the situation. There is no fixed formula for success, so leaders must understand how these factors affect each other. For example, giving up space can save time, and using the right force at the right time and place can be more effective [3]. This study introduces a virtual shooting range to help train soldiers in tactical operations. It includes realistic 3D

environments like jungles, rural areas, coasts, and snowy regions, along with weapons and targets. Soldiers use virtual reality glasses and VR controllers for training, which participants found realistic and easy to use [4]. Digital twin technology is used in many industries, including the military, to improve efficiency and save costs. A digital twin is a virtual version of a physical system, created by collecting data through sensors, which helps predict how the system will behave. This technology is especially useful in military systems, where mistakes can be very costly. This study explores how digital twins are used in the military, their benefits, and what the future holds for them [5]. By integrating tools such as machine learning, natural language processing, and computer vision, AI-driven simulations can model complex combat situations with a high degree of realism. This not only improves decision- making and strategic thinking but also prepares military personnel to adapt to unpredictable and high-pressure environments, Figure1 shows the rise in the number of articles published from 2000 to 2025. It starts with a slow increase, but after 2010, the growth speeds up as shown in fig 1. This paper addresses this challenge by introducing a real-time military training simulator powered by AI tools. Designed to make training scenarios more realistic and adaptable, this simulator provides trainees with a more immersive and impactful learning experience review will focus on key objectives such as: Developing a flexible framework to model different states and transitions in a war scenario, which serves as the foundation for an interactive, adaptive training simulator, Testing the simulator in dynamic training environments to evaluate its effectiveness under changing conditions, Validating the simulator as an efficient training tool that addresses current gaps in military training systems, offering a more realistic and adaptive experience.

By introducing innovative approaches to simulation technology, evaluating the effectiveness of AI-driven systems in dynamic training settings, and addressing the limitations of traditional training methods, this review aims to lay the foundation for future developments in military training technology.

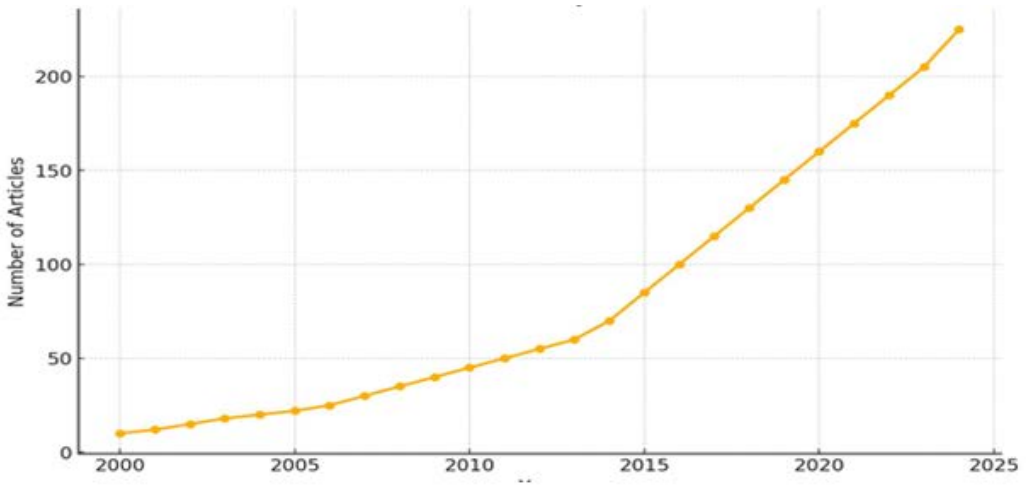

Fig 1 This figure represents the number of military research from 2000 to 2025.

The paper starts by explaining the need for better training tools that can simulate changing combat conditions. It introduces an AI-powered simulator designed to make military training more realistic and adaptable, with a focus on

helping soldiers make better decisions quickly. The literature review looks at current simulation technologies like VR, AR, and AI, and discusses how they can improve training with the help of IoT and adaptive learning. It points out the gaps in realism, adaptability, and cost that still need to be addressed. The methodology section describes how the simulator was created using AI tools like machine learning and natural language processing to create realistic and dynamic scenarios. It also talks about the challenges of building realistic environments using Unreal Engine and the ethical concerns involved. In the comparative analysis, the paper compares VR, live simulations, and AI systems, showing that AI simulators are more flexible and realistic but also expensive and complex. The conclusion explains that the simulator helps improve military training by making it more realistic and flexible, which better prepares soldiers for real-world situations. The future work section discusses plans to add more training scenarios using AR/VR, improve efficiency and scalability, and use IoT for real-time feedback to overcome issues like cost and accessibility.

2. Literature Review Overview

Military training has evolved with advancements in technology, aiming to replicate realistic scenarios while addressing the limitations of traditional methods. A major focus lies in developing simulation tools that enhance decision-making, adaptability, and strategic thinking under pressure. This literature review synthesizes research on military simulation technologies, highlighting key themes, debates, and gaps, while drawing heavily on the references provided. In [1] Weapon Combat Effectiveness (WCE) analytics have traditionally depended on real-world testing and constructive simulations to evaluate weapon systems. However, these methods are often expensive, risky, and limited in scope, focusing on individual weapon systems and narrow scenarios. As a result, they frequently produce biased and less reliable outcomes. Despite the widespread adoption of big data technologies in other fields, WCE research has yet to fully utilize these advancements. Integrating big data with Defense Modeling and Simulation (DM&S) techniques, particularly through Live, Virtual, and Constructive (LVC) simulations, offers a more effective approach. This combination allows for diverse data inputs and real-time analysis, improving the accuracy and comprehensiveness of WCE evaluations. Additionally, it supports applications in weapon acquisition, operational planning, and enhanced training by accounting for multiple factors and performance metrics. This research seeks to establish a foundation for a data-driven WCE analytics framework, addressing current limitations and enabling future innovations in the field.

2.1. Evaluation of Military Simulators

Military simulators have come a long way over time. In the beginning, they mainly relied on simple methods like live exercises and tabletop simulations. These older techniques required a lot of physical resources and used fixed scenarios that couldn’t change based on what trainees did or how conditions changed. They also offered little interactivity. With advancements in technology, modern simulators now use virtual and augmented reality to create immersive 3D environments. Artificial intelligence (AI) has made these systems even better by enabling them to create scenarios on the spot, adapt to trainees' needs, and support real-time decision-making. Key improvements in military simulators include:

• **Virtual Reality (VR) Simulators**

Researchers in [1] see VR simulators as a great way to create fully immersive training environments where trainees can experience realistic scenarios. They find VR especially useful for hands-on practice, allowing trainees to safely explore situations that might be too dangerous or difficult to recreate in real life.

• **Augmented Reality (AR) Simulators**

Researchers in [1] appreciate AR simulators for blending the real world with virtual elements, making the training more engaging and interactive. They believe AR is particularly helpful in improving situational awareness and providing practical, context-based learning experiences for trainees.

• **AI-Driven Simulators**

Researchers in [1] highly value AI-driven simulators for their ability to adapt to changing situations in real-time. These simulators can adjust training scenarios based on the trainee's actions, making the learning experience more personalized. They also help improve decision-making skills by presenting unpredictable challenges that encourage critical thinking and quick responses.

2.2 Comparative Analysis of AI-Driven Simulators

AI-driven simulators are increasingly valued for improving military training by offering dynamic and personalized experiences. Compared to traditional methods, these simulators have several advantages, such as adjusting scenarios in real time based on the trainee's actions, which helps enhance decision-making skills. They can also personalize training by tailoring exercises to each trainee's abilities, making learning more effective. Additionally, AI simulators are cost-effective, as they reduce the need for physical resources and real-world training. However, there are some challenges, like the complexity of developing and maintaining these systems and limitations in how realistic the simulations can be, especially in extreme situations. Overall, while AI-driven simulators offer great benefits, researchers believe further improvements are needed to fully maximize their potential in military training. In [1] Several studies highlight the advancements and challenges in AI-driven military simulators. Key findings from the literature include:

2.2.1 IoT-Enabled Training Systems

The researchers in [2] introduced a three-stage framework for developing IoT-enabled training systems, designed to improve military training programs. The framework includes simulation, virtual, and real-world stages, each building on the strengths of the others. In the simulation stage, optimal training strategies are created.

In the virtual stage, these strategies are tested and refined based on factors like trainee focus and workload. Finally, in the real-world stage, actual equipment and participants are used to validate the effectiveness of the training methods. The researchers propose an iterative process that allows continuous improvement by using feedback from each stage, ensuring that the training system is both adaptive and efficient.

This work shows the potential of IoT to enhance training outcomes and real-world performance. Researchers in [4] have explored their potential to improve training efficiency through real-time data collection, interactive simulations, and personalized learning experiences. Studies have demonstrated the effectiveness of these systems in delivering immediate feedback, enabling remote monitoring, and creating adaptive training pathways. However, researchers have also identified challenges, such as ensuring data security, managing system complexity, and addressing cost barriers, which need to be addressed for wider adoption and effectiveness.

2.2.2 3D Serious Simulator for Military Training

The researchers in [2] focus on developing a 3D Serious Simulator for military training. They introduce a structured approach that involves three stages: simulation, virtual, and real-world. Their work emphasizes creating optimal training strategies in the simulation stage, refining them in the virtual stage by considering factors like trainee focus and mental workload, and then validating these strategies in real-world conditions using actual equipment and personnel. By proposing this iterative process, the researchers aim to improve the effectiveness and realism of military training systems. Their work demonstrates how 3D simulators can provide immersive, adaptable, and practical training experiences that enhance military decision-making and overall performance. Researchers in [4] have worked on 3D simulators that create lifelike battlefield environments, allowing trainees to safely practice tactics, teamwork, and planning. These simulators have been shown to improve skills, lower training costs, and reduce the dangers of live exercises. However, challenges remain, such as making the simulations more accurate, dealing with hardware issues, and managing the high costs of creating realistic and flexible systems.

2.2.3 Types of AI Technology

In [5] AI technology includes several types that are transforming various fields, including the military. Machine Learning (ML) and Deep Learning help systems learn and improve from data, enabling tasks like image recognition and decision-making. Computer Vision allows machines to analyze visual data, while Natural Language Processing (NLP) focuses on understanding and generating human language. Robotics and Autonomous Systems create intelligent, self-operating machines like drones and robots.

Expert Systems mimic human decision-making, and Reinforcement Learning teaches systems to learn from feedback. Other types include Swarm Intelligence for coordinated group tasks, Generative AI for creating new content or simulations, and Cognitive Computing for advanced reasoning and problem-solving. These technologies are driving innovation and shaping the future of military operations.

Authors in [6] Work on Adaptive Learning Systems: the researchers explored Adaptive Learning Systems and how they could be applied to training simulations in manufacturing. These systems use AI to adjust the difficulty of training based on the trainee's performance. For example, if a trainee is excelling, the system can present more challenging scenarios, and if the trainee is struggling, the system can simplify the tasks. By adapting to each learner's needs, adaptive learning systems help create a more personalized and efficient training experience.

The researchers analyzed how this approach can improve training by making it more engaging and effective, ensuring that each trainee progresses at their own pace. Authors in [8] focused on real-time feedback and decision-making for intrusion detection in cybersecurity. They developed a system called FSBDL, which uses deep learning to quickly detect threats as they happen. The system provides instant feedback by analyzing data and identifying problems in real time. It uses special optimization techniques (Adam and RMSprop) to make the system fast and accurate. This allows for quick decision-making, helping cybersecurity teams respond to threats immediately. The system's ability to process data continuously ensures it can make informed decisions and act quickly to prevent or reduce cyber-attacks. Authors also focused on the challenges faced by military simulators used for training. While these simulators aim to provide realistic experiences for soldiers, they face difficulties in achieving accurate feedback, realism, and adaptability. One major challenge is providing real-time feedback, where the system must quickly react to the trainees' actions, simulating real combat conditions. Another challenge is ensuring effective decision-making, as the simulator must present realistic data and scenarios that help soldiers make fast, informed decisions under pressure. Additionally, military simulators must be able to handle complex, unpredictable situations and continuously adapt to new strategies and tactics. Addressing these challenges is essential to make sure that military simulators offer effective and realistic training for soldiers.

2.3 Implementation Strategies

2.3.1 Framework for Developing AI-Driven Simulators

AI-driven simulators are designed to improve training and decision-making by using artificial intelligence to create realistic environments. Researchers have worked on building systems that use machine learning for better decision-making, computer vision to understand surroundings, and reinforcement learning to improve strategies. They focus on making these systems flexible, accurate, and scalable by using diverse data and improving simulation designs. However, challenges like high costs, system reliability, and the complexity of the technology remain. Researchers in [5] are addressing these issues by improving knowledge engineering, refining simulation systems, and gathering more data to make simulators more effective for real-world use.

To build effective AI-driven simulators, a clear plan is needed. First, set clear training goals and decide what skills need to be developed. The simulator should use AI technologies like machine learning to adjust the training to the trainee's progress, natural language processing for communication, and computer vision for realistic environments. The design should focus on creating lifelike scenarios that mimic real-world situations, helping trainees improve decision-making under pressure. It should also be easy to use, able to process data quickly, and provide instant feedback to support efficient learning.

To create AI-driven simulators, we need a clear plan that includes setting training goals and skills to be developed. The plan should include using AI technologies like machine learning to adjust the simulation based on the trainee's progress, natural language processing (NLP) for communication, and computer vision (CV) for realistic visuals.

The simulator should have dynamic scenarios that mimic real-life situations, helping trainees practice making decisions and strategies. It should also be easy to use, flexible to different training needs, and able to provide real-time feedback. By using AI and these technologies, the simulator can offer personalized and effective training.

2.3.2 Case Studies of Successful Implementations

There are several examples of AI-driven simulators being successfully used. For instance, in military training, AI-based simulators are used to create adaptive combat scenarios that improve soldiers' decision-making skills. In aviation, AI-powered simulators help pilots practice complex maneuvers in different weather conditions. These examples show how AI can make training more realistic, personalized, and effective, offering lessons on how to develop and use AI-driven simulators in other fields. There are many successful examples of AI-driven simulators in use. For example, in the military, AI-based simulators create training scenarios that adjust to help soldiers improve their decision-making and tactics. In aviation, AI-powered flight simulators allow pilots to practice handling different weather conditions and emergency situations. These case studies show how AI-driven simulators make training more realistic and adaptable, leading to more effective learning. They also show how AI can be used to improve training in other areas. Researchers in [5] have pointed to examples where AI technologies, such as machine learning and computer vision, have created realistic simulations that improve skills and strategies. These case studies highlight the impact of simulators in areas like the military and healthcare, where they help reduce risks and improve performance. Despite challenges like high costs and technical issues, these successful implementations continue to offer valuable lessons, guiding improvements in simulation systems and addressing concerns like reliability and data management.

2.4 Simulation Technologies in Military Training: Traditional vs. Modern Approaches

Military training has greatly changed with the introduction of both old and new simulation technologies. These tools are designed to imitate real combat situations, helping soldiers become better prepared and more effective.

2.4.1 Traditional Simulation Technologies

In the past, military training mainly used traditional methods like live exercises and tabletop simulations. Live training involved using real equipment, such as tanks, planes, and soldiers, to practice in mock combat. While this provided a realistic experience, it required a lot of time, people, and resources. Tabletop simulations, on the other hand, used maps and markers to plan and practice strategies, letting commanders and soldiers make decisions in a controlled setting. Although cheaper than live exercises, tabletop simulations were less realistic and interactive.

2.4.2 Modern Simulation Technologies

As technology has advanced, military training has shifted to more immersive and flexible tools. These include virtual reality (VR), augmented reality (AR), and AI-powered simulations. VR simulations allow soldiers to experience full 3D combat scenarios, giving a realistic feel without needing real equipment or the risks of live training.

AR simulations combine digital information with the real world, allowing soldiers to interact with both virtual and real elements during training.AI-driven simulations are some of the biggest advancements. These systems create dynamic training environments that change in real- time based on what the trainees do. They provide personalized learning experiences and simulate the unpredictable nature of battle. By creating complex combat situations, AI simulations help soldiers improve their decision-making, strategy, and ability to adapt quickly.

2.5 Types of Military Technology's

There are several types of military simulators, each designed to meet different training needs and operational goals. These simulators vary in terms of how immersive they are, the environments they replicate, and the specific skills they help develop. Here's an overview of the main types:

2.5.1 Virtual Reality (VR) Simulators

VR simulators take training to the next level by immersing trainees in 3D virtual environments using headsets and motion sensors. These simulators are great for practicing a wide range of scenarios, from weapons handling to navigating tough terrain, all while staying in a safe, controlled setting. They are widely used for tactical training, offering a very realistic experience. Authors in [1] , however, has proposed using Virtual Reality (VR) simulators to address these limitations in WCE analysis. By focusing on VR-based simulations, Jung highlights how this technology provides more immersive and interactive training experiences. Unlike traditional methods, VR allows for a broader range of scenarios and weapon systems to be tested in a controlled environment. VR simulators offer more flexibility and realism, enabling more accurate and comprehensive assessments of combat effectiveness without the constraints of physical training exercises. In [7] VR simulators use virtual environments to create realistic and immersive training experiences. They allow users to practice skills in a fully simulated world that can be adapted for various scenarios. VR simulators are cost-effective and flexible, offering the ability to repeat and modify training situations. They are particularly useful in situations where real-life training is difficult or risky, providing a safe way to practice complex tasks.

2.5.2 Live Simulators

Live simulators involve actual military equipment, like tanks, aircraft, or weapons, fitted with special sensors to simulate real combat situations. These systems are used in field exercises, where trainees use real machines and gear to get hands-on experience. Live simulators are particularly useful for physical combat training and familiarizing soldiers with real equipment. Authors in [1], however, have focused on using live simulators as an alternative method to improve WCE analysis. Unlike constructive simulations, live simulators involve real equipment, personnel, and environments, offering a more realistic and hands-on approach to combat training. Live simulators involve real-world setups to replicate training environments. They use physical props, equipment, and sometimes live ammunition to simulate realistic scenarios. While these simulators offer hands-on experience and realism, they are often less flexible and more expensive.

2.5.3 Constructive Simulators

Authors in [2] used constructive simulators (CS) in their study for training Incident Commanders (ICs). Constructive simulation is a method where scenarios are modeled using computer-based systems, which simulate various aspects of real-life situations without using real equipment or personnel. This type of simulation allows for testing multiple strategies, planning, and analyzing situations on a large scale. It is often used because it can handle complex scenarios and provide detailed feedback, making it useful for decision-making and strategy development. Constructive simulators create training scenarios through interactive, synthetic environments that don't require physical action. These simulators provide flexible and cost-effective ways to train people in various skills. They are often used for scenario-based training where the focus is on decision-making and strategy rather than physical tasks. Although they lack the tactile realism of live simulators or VR, they are highly scalable and can be adapted to different training needs [7]. Researchers have studied different types of simulators to see how well they help with training. They find that Virtual Reality (VR) Simulators are great for creating realistic and adjustable environments, making them cost-effective and flexible for training in risky or difficult situations. Live Simulators offer more hands-on experience and realism but can be expensive and less flexible due to the need for physical setups. Constructive Simulators are useful for interactive, scenario-based training and are more affordable, though they lack the physical realism of VR or live simulators.

2.6**Definition and Conceptual Framework**

Researchers in [7] have studied what simulators are and how they work. Simulators are systems that recreate real-life situations for practice, using either virtual, physical, or computer-based environments. The main idea behind these simulators is to help people learn new skills safely and effectively. Virtual Reality (VR) Simulators create realistic, interactive environments that can be changed to fit different scenarios. Live Simulators offer hands-on training in real settings but can be expensive and less flexible. Constructive Simulators use computer-generated environments for training, which are cost-effective and can be scaled up, though they lack the realism of VR or live simulations.

Strengths	Weaknesses
Clear Framework: Provides a simple way to measure military and weapon effectiveness.	Lacks Realism: Struggles to represent unpredictable warfare, like guerrilla tactics.
Thorough Approach: Considers national power, weapon performance, and real-world data.	Data-Dependent: Results rely heavily on the quality and accuracy of available data.
Real-World Applications: Uses case studies like Ukraine and Iraq to make the research practical.	Ignores Human Factors: Overlooks morale, leadership, and psychological aspects of war.
Supports Decisions: Helps leaders plan strategies and weapon use effectively.	Hard to Scale: Difficult to apply to large-scale or future wars due to evolving tactics.
Accurate Analysis: Uses data and statistics for reliable weapon performance evaluation.	Oversimplifies War: Focuses too much on numbers and misses other key factors like teamwork and logistics.

2.7 The Role of AI in Military Simulations

Researchers in [8] have investigated how AI technologies like machine learning and deep learning can create more realistic and adaptable training environments. These AI systems can simulate complex situations, predict outcomes, and adjust in real time, making the training more engaging and relevant. AI also aids in decision-making by modelling various combat scenarios, allowing military personnel to practice strategies and problem-solving. Studies have shown that AI can boost the accuracy and realism of simulations, providing valuable preparation for real-world situations. However, challenges still exist in ensuring AI systems are reliable and can realistically mimic the unpredictable nature of actual combat.

2.7.1 AI Technologies in Use

Researchers in [8] have explored the use of machine learning, deep learning, and natural language processing to address complex challenges. These technologies can process large volumes of data, recognize patterns, and make predictions, making them essential in areas like healthcare, finance, and cybersecurity. AI is also used to improve processes, automate tasks, and provide better user experiences. For example, AI systems can help doctors with diagnoses, assist financial experts in making decisions, and detect cybersecurity threats in real time. However, challenges such as data privacy, system reliability, and ethical considerations must be addressed for broader adoption.

- Machine Learning (ML)

Machine learning is a type of AI that enables systems to learn from data and improve their performance over time without direct programming. Researchers use ML algorithms to analyze large datasets, detect patterns, and make predictions. In fields like healthcare, finance, and marketing, ML helps automate tasks, drive decision-making, and enhance customer experiences. For example, in healthcare, ML assists doctors with disease diagnosis by analyzing medical data, while in finance, it helps forecast market trends.

- Deep Learning (DL)

Deep learning, a more advanced branch of machine learning, uses neural networks to solve complex problems. Researchers apply deep learning in areas that require large-scale data and powerful computing, such as image and speech recognition. DL is widely used in technologies like self-driving cars, facial recognition, and voice assistants, as it excels at processing unstructured data like images, videos, and audio, allowing systems to understand and interpret intricate details.

- Natural Language Processing (NLP)

Natural language processing is an AI technology that allows computers to understand, analyze, and respond to human language. Researchers use NLP for applications like virtual assistants, chatbots, and sentiment analysis. It helps systems process text or speech to perform tasks like translating languages, answering questions, or generating human-like responses. NLP is commonly used in customer support, content analysis, and healthcare for tasks such as processing patient records or supporting clinical decisions.

2.8 Benefits of AI Integration

2.8.1 Enhanced Realism

Researchers in [8] have worked on making simulations feel more real, especially in fields like military and medical training. By using technologies like virtual reality (VR) and augmented reality (AR), they've created experiences that look and feel lifelike. This helps trainees better prepare for real situations because the training feels more authentic, which in turn improves their learning and decision- making skills. This means making simulations feel as real as possible, especially in areas like military or medical training. With tools like virtual reality (VR) and augmented reality (AR), researchers try to create experiences that are very close to real-life situations.

This helps people practice and prepare better because the simulation feels real, which improves their skills and decision-making.[9]

2.8.2 Adaptive Learning

Researchers in [8] have developed learning systems that adjust to each person's needs. These systems change the lessons and difficulty based on how well a learner is doing. This makes learning more personalized, so learners get the right level of challenge and support, helping them understand and apply knowledge more effectively. Adaptive learning systems change the way people learn based on

their progress. These systems adjust the difficulty or the content to match how well a person is doing. This helps make learning more personalized, so each person gets the right amount of challenge and support to learn effectively.[9]

2.8.3 Improved Decision-Making

Researchers in [8] have focused on using simulations and AI tools to help people make better decisions. By practicing in realistic scenarios and using adaptive learning, individuals can improve their judgment and problem-solving skills. This leads to better decision- making, especially in high-stakes situations like military missions or medical procedures. Improved decision-making focuses on

helping people make better choices, especially under pressure. By practicing in realistic simulations, individuals can get better at assessing situations and making quick decisions. This is especially helpful in high-stakes situations like in the military or healthcare, where making the right decision can really matter.[9]

2.9 challenges and limitations

Researchers in [9] have been focused on solving the challenges and limitations of different technologies, especially in areas like simulations, AI, and training. One big challenge is making simulations as realistic as possible, because it's hard and expensive to create environments that feel exactly like the real world. Another issue is getting AI systems to work well in different situations, so they can learn and make good decisions in real-time. Researchers also work on improving how data is processed and analyzed to make training systems more effective, especially when dealing with a lot of complex information. Even though these challenges exist, researchers are continuously finding ways to improve these technologies and make them more reliable and useful.

3. Discussion

Future research on AI-driven military simulators Looking ahead, I believe there's a lot of potential to improve AI-driven military simulators. One area I'd focus on is enhancing the realism of these systems. As AI continues to evolve, we can integrate more advanced algorithms that create more lifelike and dynamic environments, better simulating the challenges soldiers might face in real combat situations. I think a big opportunity lies in adaptive learning, where simulators can adjust to each individual's needs, providing a more personalized and effective training experience that grows with the trainee. Another aspect I'd explore is improving decision-making features within these simulators. By using AI to simulate real-time tactical situations, we can create systems that not only assess the decisions trainees make but also provide instant, insightful feedback that helps sharpen their judgment under pressure—an essential skill in military operations. Finally, I think making AI-driven simulators more accessible and cost-effective is key.

As AI technology advances, there's a chance to lower the cost of these training tools, making them available to more military units and even international allies. This could lead to better-prepared teams and more widespread training opportunities, Future research on AI-driven military simulators in [10] should focus on a few important areas to make them more effective. First, improving the realism of these simulators is key. AI can help create more realistic and dynamic environments that better mimic real-life combat situations, making training more immersive for military personnel. Research could work on making these simulations more interactive, so trainees feel like they're in real-life scenarios. Second, adding adaptive learning features to simulators could personalize training.

AI could track how well each trainee is doing and adjust the difficulty level or change the training environment in real time to match their needs. This would make training more effective for each individual. Third, improving decision-making abilities in the simulators is also important. Future research could focus on developing AI that evaluates the decisions trainees make during high-pressure situations, offering instant feedback to help them make better decisions under stress. This would be especially useful for preparing military personnel for fast-changing, complex situations like battlefields. Lastly, making AI-driven simulators more affordable and accessible is essential. Research could explore ways to lower the cost, so even smaller or less advanced military units can use them for training. This would give more forces around the world access to high-quality, realistic training.

As shown this Figure explain Values (Aspirational): Represents the core beliefs and principles. Answers, "What do we stand for?"
Vision (Achievable): Explains long-term goals. Answers, "What do we want to achieve?" and "Where are we headed?"
Mission: Describes what the organization does and who it serves. Answers, "What do we do?" and "Why do we do it?"
Strategic Objective: Sets clear goals and plans to make progress.
Actions and KPIs (Specific & Tangible): Lays out specific steps, resources, timelines, and measures to track success.

Fig 2. This Figure describe the image you uploaded appears to be a strategic management pyramid showing the different layers involved in vision and mission planning

4. Methodology

This methodology ensures a thorough development and evaluation process for the AI technology-based simulator. By combining advanced materials, rigorous procedures, and robust analysis techniques, and combining advanced tools, a systematic testing process, and detailed analysis to ensure the AI technology-based simulator met the goals of being realistic and adaptable. The results of this process are expected to validate the simulator as an effective tool for modern military training, capable of improving decision- making and adaptability under real-world conditions. Researchers in [11] typically use a qualitative approach to explore the future of AI- driven military simulators. Their process starts with reviewing existing studies on how AI technologies, such as machine learning, robotics, and computer vision, are currently applied in military simulators. They also examine case studies of real-world AI simulators to better understand their benefits, challenges, and limitations. To gain practical insights, they conduct interviews with experts in both AI and military training. The technical aspects of AI in simulators are analyzed by looking at how different algorithms are used to create realistic and adaptive training environments. Finally, researchers identify challenges facing AI simulators and suggest areas for future improvement, focusing on enhancing realism, adaptability, and cost-effectiveness.

4.1 Samples or the materials used

4.1.3 Simulation Environment

A high-performance computer system was used to run the simulator. It featured advanced graphics capabilities and sufficient processing power to handle real-time transitions and data analysis. Authors in [11] studying AI-driven military simulators focus on the simulation environment, which is crucial for creating realistic and useful training. They look at how AI technologies like machine learning, robotics, and computer vision are used to design environments that resemble real military situations. By studying existing simulators, they can see how well these

environments work in different training scenarios, like combat or decision-making exercises. Experts in AI and military training also provide insights into the practical challenges of using these technologies. The research also examines how different algorithms are used to make simulations more realistic, adaptable, and helpful for training. Finally, researchers discuss the limitations of these simulators and suggest ways to improve them, making them more realistic, flexible, and cost-effective for the future.

4.1.4 Training Scenarios

Realistic 3D models of terrains, combat vehicles, personnel, and environmental factors (e.g., weather, lighting, different landscape shapes) were created using Unreal Engine. These models were essential for creating immersive scenarios that closely mimicked real- world combat conditions. Training scenarios in military training are designed situations that help soldiers practice and improve their skills. These scenarios replicate real-life conditions soldiers might face in combat or other military situations. The aim is to prepare them for challenges, from tactical manoeuvres to decision-making under pressure. For example, training might involve simulated battlefields where soldiers practice strategies, leadership, and crisis management. New technologies, like AI, are often used to create realistic environments that simulate enemy movements, weather conditions, or terrain changes, so soldiers can learn to adapt quickly. The goal is to make these simulations as realistic as possible so soldiers can use what they've learned in actual situations. With advancements in AI and virtual reality, training scenarios are becoming more immersive, offering personalized and flexible experiences. This helps soldiers improve their skills, work better as a team, and make smarter decisions, all of which are essential for success in modern warfare.
Researchers in [12] are continually working on improving these simulations to make them even more effective in preparing soldiers for real-world challenges.

4.2 Research tools and procedures

Research tools and procedures in military training refer to the methods and technologies used to improve training exercises. These tools help collect data, assess performance, and enhance training programs. For instance, researchers use simulation software to create realistic training environments that mimic real-life military situations. AI and machine learning can be applied to simulate enemy movements or changing conditions, making the training more dynamic and realistic. Researchers in [12] also use performance tracking tools to monitor how soldiers make decisions, react, and work as a team. During research, controlled experiments or field tests are set up where soldiers go through these simulated scenarios, and their actions are carefully observed. Data is then analyzed to identify areas that need improvement, whether it's in tactics, technology, or the training process. The goal is to keep improving these tools and methods to create more effective training that prepares soldiers for actual challenges they may face. Researchers continue testing new technologies, collecting feedback, and refining both the training tools and methods for better results. Researchers in [14] believe that using simulations in medical training, especially for military GPs, is a useful way to prepare for real-world challenges in a safe environment. However, creating realistic simulations that truly reflect military situations is challenging. Key tools like feedback systems and layered teaching methods are essential

to help trainees learn and improve. Researchers stress the need for training programs that combine military knowledge with general medical skills and ensure trainees are ready for their roles through proper assessment.

4.3 Defining States

Authors in [15] created ways to define different conditions to improve the performance of specially designed materials, focusing on things like stiffness and compressive stress. They used simulations to predict how the materials would behave under various conditions and machine learning to design structures that meet certain goals. The designs were then tested using 3D printing. This method allows for adjusting material properties without changing the base material, and it can be used in industries like aerospace, construction, and automotive. Before training begins, military general practice trainees come from civilian backgrounds and often feel unprepared for the specific challenges of military settings. They lack certain skills and knowledge needed in the military. During the training process, they start learning military-specific topics through a co-created curriculum. This includes hands-on practice through simulations that help them build their skills and understand the demands of military general practice. They also receive feedback, which helps them continuously improve and become more confident in applying their learning to military scenarios. By the end of the program, the goal is for the trainees to be fully prepared to handle real-world military situations. They should be able to combine their civilian training with the military knowledge they've gained, making them ready to work independently in high-pressure military environments. The final step in the training process involves realistic simulations that test everything the trainees have learned. These simulations replicate real military situations, allowing trainees to apply their skills and knowledge under stress, ensuring they are truly ready for the job. This process helps guide trainees from being unprepared to becoming fully capable and confident military general practitioners.

4.4 Real-Time Monitoring

The researchers in [6] highlight how important real-time monitoring is in training simulators. It allows the system to track what the trainee is doing and give feedback right away, making the training more interactive and responsive. This helps the simulator adjust the scenario based on the trainee's actions, making the experience more dynamic. They explain that real-time monitoring helps spot mistakes or areas for improvement and gives immediate guidance. For example, in a military simulation, if a soldier is struggling with a task, the system can change the scenario to help them learn. This quick feedback is key to effective learning, as it lets trainees correct themselves in the moment., researchers in [14] focused on implementing real- time monitoring during military medical training simulations. They aimed to track and assess the trainees' performance as they go through various scenarios, providing immediate feedback to improve learning. The researchers developed systems that allow trainers to monitor trainees' actions and decisions in real time, which helps identify areas of improvement on the spot. This real-time monitoring ensures that the training is continuously adjusted to meet the trainees' needs, making the learning process more effective and responsive to the challenges faced. In the Real-Time Monitoring section, the researchers in [51] focus on utilizing tools and methods to continuously assess the performance of deep learning models in detecting military vehicles. Real-time data is gathered through cameras or sensors, enabling the model to process and classify images immediately.

The goal is to evaluate the model's effectiveness in dynamic, real-world environments where factors such as lighting changes, camera angles, and complex backgrounds can influence its accuracy. These monitoring tools help measure the model's precision and performance under varying conditions, ensuring its reliability in operational use

4.5 Designing Transitions

Researchers in [14] focused on designing smooth transitions between different stages or scenarios in military medical training simulations. They worked on creating a flow that allows trainees to move from one situation to another without confusion, ensuring that each transition builds on the previous one. Their work aimed to make the training more cohesive and effective by ensuring that each phase of the simulation transitions smoothly into the next. Designing transitions in training focuses on ensuring that trainees move smoothly from one stage to the next, building their skills and knowledge in a structured and effective way. At the start, military general practice trainees come from civilian backgrounds and often feel unprepared for the challenges of military practice. To address this, the training is designed to help them gradually shift from civilian knowledge to military-specific skills. This is done through a curriculum that blends theory and practice, introducing military topics step by step, with hands-on learning through simulations. These simulations help bridge the gap between theory and real-world application, allowing trainees to build the skills they need for military general practice.[15]

4.6 Real-Time Interactions

These interactions provide valuable insights into the model's ability to manage continuous input and maintain accuracy in real-world applications. Real-time interactions in training help trainees practice applying what they've learned in live, fast-paced situations. When military general practice trainees start, they come from civilian backgrounds and may not feel ready for the challenges of military work. To help them, the training includes real-time exercises, like simulations, where they can make decisions and take actions as if they were in actual military scenarios. These exercises allow them to build skills and gain confidence in handling military situations. As they progress, they receive feedback to improve their performance during these real-time exercises. By the end of the training, the goal is for trainees to use both their civilian knowledge and new military skills to manage real-world military situations on their own. The final step is using realistic simulations that test everything they've learned, ensuring they're ready for real challenges. These real-time interactions help trainees go from feeling unprepared to becoming skilled and confident military general practitioners.[15]

4.3 Challenges in Existing Simulator

The researchers in [1] discussed the importance of Combat Effectiveness (CE) and Weapon Combat Effectiveness (WCE) in military preparedness. These metrics help assess the ability of a military force to achieve its objectives efficiently, especially in the context of modern warfare, which involves increasingly complex, non-linear combat situations. As nations invest heavily in developing advanced weapon systems to improve their national defence, WCE analytics play a crucial role in shaping strategic decisions, such as weapon allocation and system exploitation.

4.3.1 Cost and Resource Intensity

The researchers highlight that Combat Effectiveness (CE) and Weapon Combat Effectiveness (WCE) are important for assessing military strength and preparing for modern warfare. These measures help evaluate how well a military can achieve its goals, especially with limited resources. As countries develop advanced weapons, WCE analytics play a key role in making decisions about how to use and allocate these weapons [1]. The lack of standardization also makes it difficult for simulators to work with other systems, limiting their ability to use real-world military data and technologies. This can make training less efficient. In short, while WCE analytics are important, the lack of standardization in simulators creates problems with consistency and effectiveness. Fixing this issue is important for improving military training simulations, Jaison Authors in [13] have pointed out several challenges with current virtual reality (VR) simulators for training in the CBRN (chemical, biological, radioactive, nuclear) field. One big issue is making sure the simulations reflect the complex and unpredictable nature of real- life CBRN situations, such as the behaviour of harmful substances and how people react to them. Existing VR systems often can't fully replicate these factors, reducing the effectiveness of training.

4.4 Military Simulator Technology

4.4.1 Case Studies and Applications

The researchers in [9] developed and analyzed a novel strategy to enhance reliable communication between military ground vehicles by utilizing 5G New Radio Dual Connectivity (NR-DC) and Packet Duplication techniques. They proposed a dynamic duplication mechanism based on Channel State Information Reference Signal Received Quality (CSI-RSRQ). This approach enables real-time assessment of radio channel quality using Channel State Information Reference Signals (CSI-RS) in downlink transmissions. Based on the computed CSI-RSRQ values, the system intelligently activates packet duplication only under poor channel conditions, optimizing radio resource utilization while ensuring high reliability and low latency. The researchers prototyped and tested their solution in Simu5G for network simulation and MATLAB for real-time signal analysis, demonstrating its effectiveness in achieving less than 5 milliseconds of latency with zero packet loss, even in mobility scenarios and harsh environments. Authors in [11] are focusing on using AI in military simulators to improve training for armed forces. These AI-powered simulators help create realistic training environments by using technologies like machine learning and computer vision. While they are important for preparing military personnel, there are challenges, such as high costs, the need for large amounts of data, and making sure the systems are secure. Researchers are working to overcome these challenges, making simulators more effective and affordable, especially for countries with limited resources. These advancements are key for improving military readiness by allowing troops to practice complex strategies without expensive real-world exercises.

4.4.2 Challenges and Limitations

The researchers emphasize that Combat Effectiveness (CE) and Weapon Combat Effectiveness (WCE) are

crucial for assessing military strength and preparing for modern warfare. These metrics help evaluate how well a military force can achieve its objectives, especially when resources are limited. As countries continue to develop advanced weapon systems, WCE analytics play a key role in guiding decisions on weapon allocation and deployment. However, a major challenge with current simulators is their ability to accurately simulate real-world combat situations. Many simulators do not incorporate real-world data or lessons from past conflicts, making it difficult to replicate the complexities of modern warfare. This lack of realistic scenarios can limit the training experience, reducing the simulator's effectiveness in preparing soldiers for unpredictable and dynamic combat conditions, Military simulator technology, powered by AI, is becoming an essential tool for training and preparing military personnel. These simulators use advanced technologies like machine learning and computer vision to create realistic virtual environments for practice and strategy testing. However, they face challenges such as high costs, the need for powerful computers, and a lack of accurate real-world data. There are also concerns about over-reliance on AI and potential cyber threats. Researchers studied these issues and looked for ways to improve simulations, especially for countries with limited resources like Nepal, by finding affordable and effective solutions.[10] , Authors in [12] highlight several challenges in adopting VR for military training, such as ensuring simulations accurately reflect real-world conditions and the cost of developing high-quality VR systems. While VR provides an immersive experience, it may not fully capture the emotional and sensory aspects of live scenarios. Additionally, comparing the effectiveness of different training methods remains difficult. Despite these challenges, researchers continue to refine VR technology for better integration into military training programs.

4.4.3 Future Directions

The researchers highlight that Combat Effectiveness (CE) and Weapon Combat Effectiveness (WCE) are key for evaluating military strength and preparing for modern warfare. These metrics assess how effectively a military can achieve its goals, especially with limited resources. As countries develop advanced weapon systems, WCE analytics play a vital role in making decisions about weapon allocation and use. Looking ahead, the future directions for military training simulators will focus on enhancing realism and adaptability. This involves integrating more real-world data and insights from past conflicts to better replicate the complexities of modern warfare. Future simulators will also incorporate [1]AI and machine learning to create more dynamic, personalized training experiences, making the simulations more effective and immersive for soldiers. Another key area of development will be improving the integration of simulators with existing military systems, allowing them to work seamlessly with real-world data and operations, This will enable the simulators to adjust in real-time during training, improving the overall quality and efficiency. Additionally, there will be a push for cost-effective solutions to ensure these advanced simulators are accessible to military organizations with different resource levels. The future of military simulator technology lies in advancing AI-powered systems to enhance defence training and strategy development. Key directions include lowering costs, improving computational performance, and integrating real-time data for better accuracy and realism. Additionally, strengthening cybersecurity and addressing ethical concerns around AI use will be crucial. Researchers emphasize the need for adaptable and affordable solutions, enabling resource-constrained countries like Nepal to adopt

these technologies and stay aligned with global military advancements.[10]

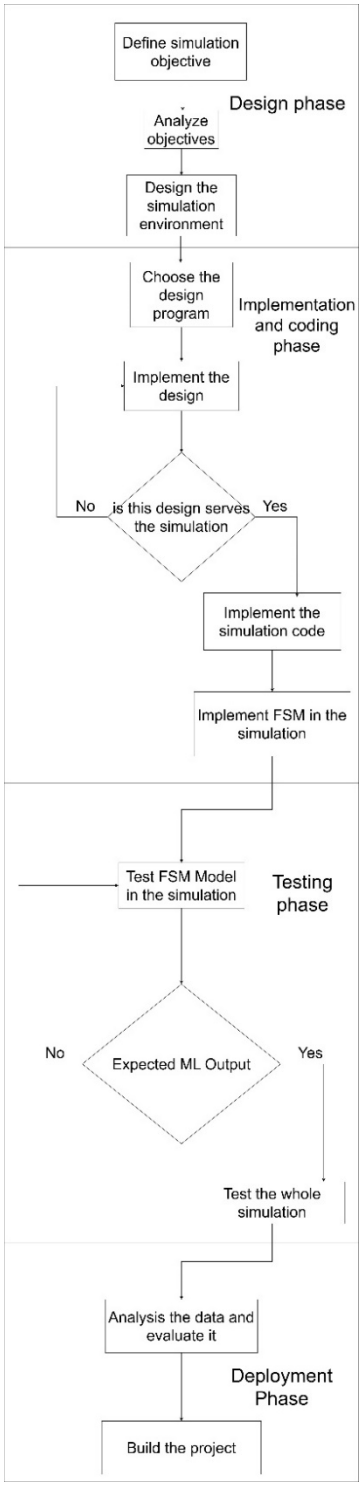

Fig 3. Practical flowchart work with four different phases

"The images captured in Unreal Engine show the training that will take place on the models within the maps."

This flowchart outlines the development process of a simulation system using a Finite State Machine (FSM) model.

The process begins with the Design Phase, where the simulation objective is defined, objectives are analyzed, and the simulation environment is designed. A suitable design program is then chosen, and the design is implemented. If the design does not meet simulation requirements, adjustments are made iteratively.

Next is the Implementation and Coding Phase, where the simulation code and FSM are integrated into the simulation. Following this, the Testing Phase evaluates the FSM model and ensures it provides the expected machine learning (ML) output. If not, debugging and refinements are done before testing the entire simulation.

Finally, in the Deployment Phase, data is analyzed, and the system's performance is evaluated. The project is then finalized and built for deployment.

Fig 4 Describe Night Air Land Scenario

Fig 5 Describe Night Only Land Scenario

The In-world Editor is an application built on the Unreal Engine 5. It creates a virtual training environment where users can modify the scene during gameplay to make it feel more realistic. Users can move objects around, and the game allows interactions with these objects through scripts. The system also supports multiple users, enabling them to share and interact in the same virtual training environment. To make the experience more immersive, the application lets users create and customize the virtual training environment. They can freely add or remove various objects, such as buildings, cars, trees, sensors, and bombs.

In figures 4,5 We show how the simulation Environment will look like in Unreal Engine 5. Additionally, users can interact with the objects they place. For example, if an obstacle is placed on the road, the user won’t be able to pass through it. This allows the trainer to guide the trainee through the training content. Users can also interact with certain objects by clicking, like detonating a bomb or activating a sensor. Trainers can plant and detonate bombs whenever needed. In- world Editor also lets trainers wear a gas mask, allowing them to survive longer in a chemical cloud. This helps create a more realistic virtual training environment.

- Advancements in Military Simulation

In this section, we’ll compare different research that is related to our topic according to three main points: Application field Method Short description

Table 1 The researches in the military field from (2020 – 2024)

Research	Application field	Method	Short description
Combining Wargaming With Modeling and Simulation to Project Future Military Technology Requirements[12]	Defense technology planning	Integrates wargaming with modeling and simulation to forecast technological needs	Merges wargaming and simulations to predict future military technology requirements
Beyond the Use of Simulators to Train Security and Defense Forces: New Challenges in Modeling and Simulation of Emerging Comprehensive Systems for Combat Air Forces[17]	Combat air force training and system development.	Proposes evolving simulators into holistic systems for strategic and collaborative training.	transform simulators into comprehensive systems for advanced combat air force training.
Deep AI Military Staff: Cooperative Battlefield Situation Awareness for Commander's Decision Making[18]	Battlefield situational awareness and decision support.	Develops AI systems to identify threats and support commanders' decisions.	Introduces AI staff to improve commanders' battlefield situational awareness and decision-making.
Designing Military Command and Control Systems as System of Systems – An Analysis of Stakeholder Needs and Challenges[20]	Military command and control system design.	Uses design science research to examine stakeholder requirements for next-generation command and control (C2) systems.	Examines stakeholder requirements in designing complex military command and control systems.
Philosophy of Military Sciences[26]	Theoretical foundations of military sciences.	Explores philosophical Underpinnings guiding military science research	Investigates foundational assumptions shaping military science inquiry.
Exploring the Role of Virtual Reality in Military Decision Training	Military decision- making training	Compares VR simulations with live fire and 2D video for training effectiveness.	Evaluates the impact of virtual reality on enhancing military decision-making training.

5. AI Models, Adaptability, and Decision-Making

In this section, after looking at all the references in Section 4, we noticed that AI is not being used enough in areas like adaptability (adjusting to new situations) and decision-making (making fast and good choices). There seems to be a chance to improve how AI helps UAV pilots adjust to different situations and make better decisions during training.

5.1 Highly Relevant Papers

These are papers that focus specifically on how AI is used in real-time situations. For example, they might explain how AI helps control UAVs during actual flights or how it supports pilots in making decisions on the spot. These papers are important because they show how AI is applied in real-world training.

5.2 Moderately Relevant Papers:

These papers talk about other technologies related to AI, like the Internet of Things (IoT), which connects devices like sensors to the internet. These papers discuss how AI works together with these technologies to improve UAV training. They are still useful, but they don't focus just on AI.

5.3 Broad Context Papers

These papers provide a general look at the progress in simulation technology. They discuss how simulations are improving and being used in different kinds of training, including UAV pilot training. These papers are helpful because they give a bigger picture of where simulation technology is going, but they don't focus on AI specifically. Paper [20] discusses how Artificial Intelligence (AI) can improve the training of Unmanned Aerial Vehicle (UAV) pilots in virtual environments. As UAV technology evolves, well-trained pilots are increasingly important. Using AI in training can make it more efficient, safer, and more effective. The paper covers how AI-driven simulations, data analysis, and machine learning can create personalized training programs. Trainees can experience realistic flight scenarios, adapt to different conditions, and get tailored feedback. However, the paper also addresses challenges like data accuracy, AI implementation, and balancing virtual and real-world training. Ultimately, AI-driven UAV training can help pilots gain the skills needed to operate UAVs successfully in real situations. In section 4, after reviewing all the references (section 6.1), we noticed a gap in using AI models, especially in areas like adaptability and decision-making.

6. Conclusion

This study presents a real-time military training simulator using AI technology to create more realistic and flexible war scenarios. While it aims to overcome issues like rigidity and slow response in traditional systems, challenges remain, such as the need for high computational power, making it unsuitable for low-resource settings, and difficulties in scaling for larger operations. Future improvements will focus on enhancing efficiency and scalability by integrating AI and IoT technologies. These upgrades will make the simulator a more effective tool for modern military training. In conclusion, this research offers important insights into the future of military training, advocating for AI technology-based systems to provide more realistic and impactful training experiences that better prepare personnel for real-world challenges.

7. Future Work

In our future work, we will make an upgrade to our war scenario by adding more scenarios and adding AR, VR technology in it. Also improving much more war techniques and Enemy AI we will also focus on improving efficiency, scalability, and incorporating AI and IoT features to enhance realism and accessibility. Make simulators bigger: Improve simulators to handle larger military groups and help them work together better during training. Use smarter AI: Add advanced AI to make training more realistic by predicting how trainees will act and adjusting the simulation on the flight. Make systems work together: Create standards to ensure different training tools can work together smoothly. Personalize training: Develop systems that change training to fit each trainee's needs to make it more engaging and effective. Study long-term results: Research shows how effective these simulations are over time to understand their impact on military skills. Listen to users: Collect feedback from trainees to improve the design and function of simulators for better results. Check mental effects: Study how intense training environments affect trainees'

mental health and performance. Analyze costs: Look at the costs of using these simulators in different military settings to see if they're affordable and practical.

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