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DESIGN, IMPLEMENTATION AND PRELIMINARY TESTING OF A VIRTUAL REALITY SYSTEM USED TO TRAIN MILITARY PERSONNEL ON A SIMULATED BATTLEFIELD

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Abstract: *In this article, we present the design, implementation, and testing of a virtual reality-based training solution for military personnel. The aim of using virtual reality instead of traditional training processes is to simulate battlefield conditions as realistically as possible and to save financial resources that could be directed to other educational processes. The system was implemented using the Virtual Battlespace 4 (VBS4) virtual simulation software application, interconnected with Virtual Reality Headset and Controllers, to provide an enhanced simulation training experience. A wireless network has also been set up and tested for increased flexibility and quick setup during multiplayer simulation.*

Keywords: virtual battlespace, wireless network, virtual reality, multiplayer training

1. Introduction

In the last few years, there has been a dramatic increase in the use of virtual reality technology. This technology has developed tremendously and is now considered to have the greatest growth potential, given the increasing demand for VR-based products with advanced hardware.

Virtual reality has expanded its applicability in a wide range of fields, from gaming, entertainment, marketing, to education and training, medicine, architecture, etc. The military environment is also an area where virtual reality will play an important role, especially in the context of the increasingly rapid development of the technology.

Robotics, nanotechnology, biotechnology are some of the capabilities that the military brings with technological progress. Another recent military technology with serious potential to spread is the computerised use of systems (users can operate/modify simulated systems and see the resulting effects in real time) [1].

Virtual reality is a concept that describes the interaction between humans and a simulated environment, implemented using computer technology containing computer graphics and artificial intelligence [2].

In order to render the complex virtual space as realistically as possible, two main components are required: algorithms to produce photorealistic images specific to the virtual area and equipment to display the resulting images. Of course, increasingly powerful graphics processing units and high processing speeds are needed to render the virtual environment in real time [3].

Directions for the development and use of

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VR technology have existed for many years in the military, so that all defense departments have projects to simulate aircraft, submarines, tanks, helicopters [4]. Not only simulators have been targeted in military training activity, but also simulations based on educational games, such as Virtual Battlespace. In the "Nicolae Balcescu" Land Forces Academy of Sibiu, students use virtual and augmented reality technologies in the training process. With VBS-3 and VBS-4 applications, students have access to immersive experiences that capture their interest, encourage their creativity and offer them the opportunity to create their own scenarios and turn them into VR applications [5]. These applications allow the simulation of any planned tactical scenario, giving students the possibility to select from databases a variety of military equipment, weapon systems or combat vehicles. With the advent of the VBS-4 version, instant troop deployment is possible in any location or terrain in the world, with terrestrial-wide rendering for tactical practice, experimentation and mission rehearsal.

VR technology brings many advantages to the training of military personnel, such as: scenarios and missions considered dangerous can be safely simulated without risk; missions can be rehearsed whenever necessary; the cost of equipment and training is reduced [6].

Cost and time savings, the ability to conduct training remotely, motor skills practice, simplification of complex situations and creative experiences make virtual reality training an increasingly suitable tool to replace traditional training processes, even for the military [7].

2. Materials and Methods

The following hardware and software resources were used to achieve the objectives of this work:

- VBS4 software application.

VBS4 provides a comprehensive virtual training environment with full terrain rendering for tactical training, experimentation and mission rehearsal. Another important feature is that it includes a new intuitive editor that allows users to import, create and modify terrain [8]. The interface supports collaboration and allows instructors without special training to edit terrain and create new missions quickly and easily.

- HP Reverb G2 Virtual Reality Headset.

They can deliver realistic images, immersive soundscapes, tracking and enhanced performance. Internal cameras and position detection sensors can track real-time arm movement directly in virtual reality without additional peripherals, and thanks to the interpupillary distance adjustment (IPD) function, it is possible to adjust the lens width for a perfect fit.

- HP Reverb G2 Controller.

HP Reverb G2 controllers are shipped with the HP Reverb G2 VR headset and connect via Bluetooth. They offer six degrees of freedom and have a very ergonomic design. They will be used by military personnel to coordinate their own movements with those of their avatar for a more realistic experience.

- Desktop Workstation for setting up and running the VBS 4 server.

The workstation was installed in the training room to be used by the coach to create the tactical scenario to be simulated, but also to view, edit and record in real time the military actions performed by the players.

- HP Z VR Backpack Workstations.

It is ideal for immersive trainer experiences, walkthrough simulations, product development and more. In our case, we used this equipment to provide increased mobility for the military during virtual training without the need for external wired connections.

- Wireless router for VBS 4 multiplayer training.

To ensure training of several soldiers at the same time, using the multiplayer capabilities of the software and to ensure maximum flexibility during training

without the need for wired connections, a wireless network was chosen.

This wireless network was set up using a Wi-Fi 5 compliant router using the IEEE 802.11ac standard to provide a throughput of at least 1 gigabit per second (1 Gbit/s) for multiple stations. Also, in choosing the router, it was taken into account that it must have 4x4 Multi-User MIMO capabilities (offering four spatial streams). This feature provides the ability to transmit to multiple clients simultaneously (in our case, a maximum of 4) instead of just one, and to transfer data to a client on the network using multiple data streams simultaneously and thus increase throughput. With this option, a wireless router can transmit data to multiple users at the same time on a single wireless radio channel or with a single user using multiple data streams on the same channel.

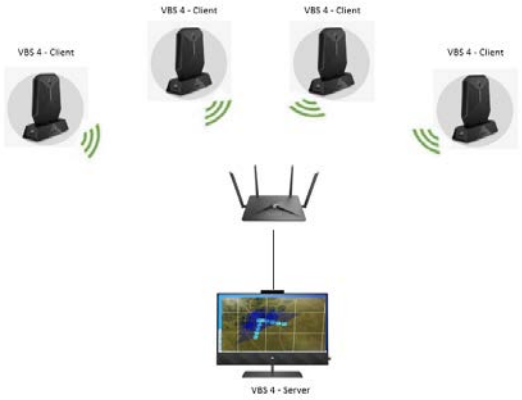


Figure 1: Wireless network topology
Source: Author

In order to use virtual reality headsets and controllers, Windows Mixed Reality had to be installed on all client workstations that will be connected to these devices. After installation, it will display a live feed of the view from the headset and you will be able to see the status of the headset and controllers.

The next step is to install and launch the VBS4 application. Using the application - VBS Launcher, which creates a suite of additional parameters and source code, allows users to easily connect their virtual reality headsets and controllers.

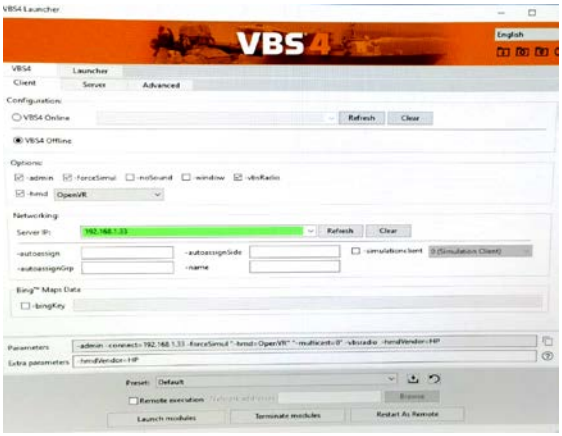


Figure 2: VBS Launcher Interface
Source: Author

VBS4 is a virtual, constructive, full-land simulation that enables multiplayer scenarios for combined arms training. Bohemia Interactive Simulations (BISim) military trainers can typically train between 100 and 200 players in networked virtual exercises using this software.

To set up a multiplayer scenario we need to choose the type of player (depending on the scenario being played) or set up a new one and it needs to be set as playable to be controlled by the player.

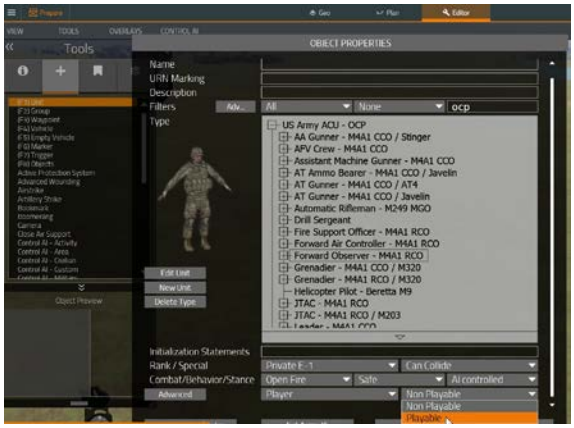


Figure 3: Interface used for setting playable units
Source: Author

Once all the entities in the scenario (units, vehicles, artillery strikes, etc.) have been established, one important thing is to establish the briefing. From the briefing edit tab we can add details about the plan, import images (maps) for better understanding and add objectives for the mission.

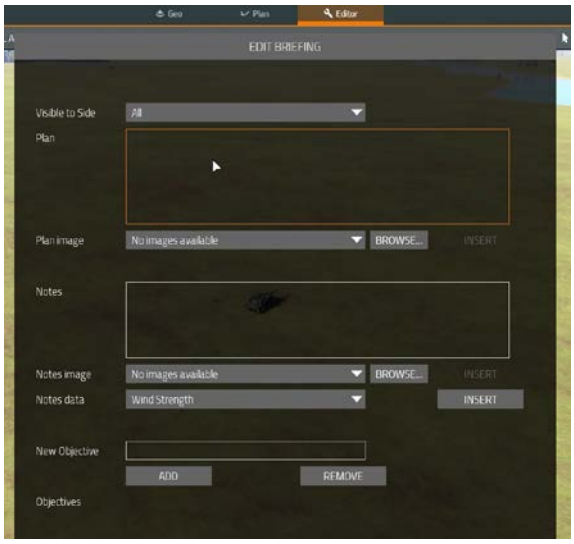


Figure 4: Interface for editing briefing information
Source: Author

In the next step, the trainer runs the scenario and waits for the players to choose their role in the scenario, then executes the mission. All players who have chosen a role will be introduced to the mission and will have to go through the briefing.

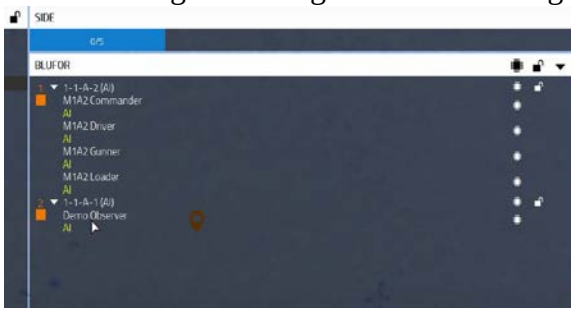


Figure 5: Interface for player selection
Source: Author

The system that was tested is intended for individual training and small team training (maximum 4 players), but with a significantly enhanced simulation experience thanks to the integration of headsets and virtual reality controls.

3. Results and Discussions

The testing and validation of the proposed system for implementation in mission training was carried out in the following three phases.

Phase 1: testing the traffic speed and adjusting the router parameters for optimal network operation. In the network configuration, a wireless network was tested in both the 2.4 GHz and 5 GHz bands in different bandwidths. Clearly, the highest throughput was achieved on the 5 GHz frequency on a channel with a bandwidth of 80 MHz. On the other hand, the use of these parameters significantly reduces the link distance. To keep these configurations allowing us to bring the throughput to the maximum possible, we chose to connect the instructor's workstation via FTP cable to the router to allow a longer distance between the router and the VBS server, and the router was installed as close as possible to the training area.

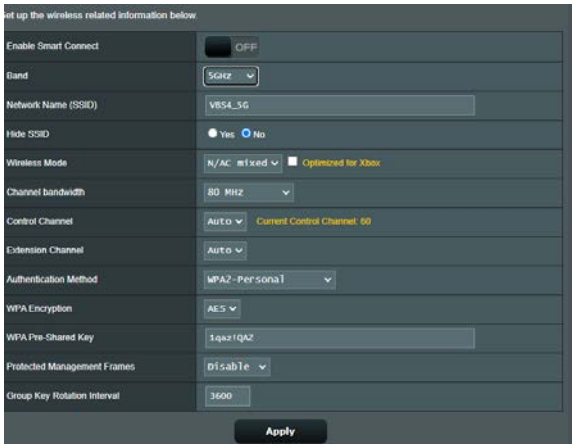


Figure 6: Wireless router configuration
Source: Author

All computers were configured to automatically receive IP addresses from the DHCP server enabled on the wireless router, and the computer configured on the server was set to receive the same IP address whenever it connects to the network based on the MAC address. This configuration was chosen because the VBS clients need the IP address of the server to connect to it and we want to remain the same.



Figure 7: Manual IP assignment based on MAC address
Source: Author

Phase 2: set up and test compatibility between the HP Reverb G2 virtual reality headset, controllers and VBS4 simulation software. The first step in making the interconnection was to test and adjust the headset parameters and controls in the Windows Mixed Reality application. The next step was to configure the necessary settings in the VBS launcher to work with these devices. After launching the application, we tested how the controls work during gameplay and the quality of the image viewed with the headset.



Figure 8: Control and image testing in VBS4
Source: Author

The test results showed good handling of the weapons with the controls, as well as quite good quality of the 3D image projected by the headset.



Figure 9: Graphical view during testing
Source: Author

Using these devices makes the gaming experience much closer to reality and the quality of training much better.
Phase 3: create, implement and test a team-based multiplayer tactical scenario where soldiers use headsets and controllers to accomplish their mission. In the final phase of the system implementation, a scenario was created that included four soldiers who completed their mission using the proposed simulation system.



Figure 10: Testing the system in a four-player simulation
Source: Author

After the mission, the soldiers said they were satisfied with the way the system worked and wanted to use it in as many training activities as possible.

4. Conclusions

The system is functional and can be used by the military in the training process. In order for this type of exercise to be as accurate as possible, a training period should be considered for the military to learn how to use the equipment so that it does not

negatively influence the training process.

The main contribution of this paper is a comprehensive study analysis of the unique challenges and potential solutions for VR networks connected via wireless for military training. This work represents a preliminary stage and a source of research into optimizing solutions for virtual reality using wireless networks. The initial implementation, reduced to the integration of 4 users in the game, may create high latencies with the introduction of more players. However, with the implementation of WiFi 6 technology in communications, virtual reality training will be able to be developed, thanks to gigabit speeds, ultra-fast response times and the use of new MIMO technologies.

Acknowledgment

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