

HARDNET VR- EXPERIENCE HARDWARE AND NETWORKING FROM THE INSIDE

Dr Brindha S¹, Ms. Priya D², Mr. Akash S³, Mr. Akhil R⁴, Mr. Krishan A S⁵, Mr. Sujeet P⁶

¹Head of the Department, Computer Networking, PSG Polytechnic College, Coimbatore

²Lecturer, Computer Networking, PSG Polytechnic College, Coimbatore

^{3,4,5,6} Students, Computer Networking, PSG Polytechnic College, Coimbatore

Abstract - HARDNET VR is a Virtual Reality application developed to provide immersive training in computer hardware and networking. The system consists of two modules: a PC Building Simulator, which allows users to assemble and disassemble components such as CPU, GPU, RAM, motherboard, and storage devices, and a Networking Devices Viewer, which enables interactive exploration of routers, switches, and hubs. By simulating real-world tasks using VR headsets and hand tracking, the system provides guided instructions, real-time feedback, and a safe, cost-effective learning environment. This platform improves user engagement, enhances knowledge retention, and makes hardware and networking education more interactive and accessible for students and learners.

Key Words: Virtual Reality, Hardware Training, Networking Devices, VR Simulation, Interactive Learning

1. INTRODUCTION

In the modern era of digital transformation, Virtual Reality (VR) is revolutionizing the way humans learn, interact, and experience information. VR technology allows users to immerse themselves in a simulated 3D environment that replicates real-world scenarios or creates entirely new worlds that are otherwise impossible to experience physically. Unlike conventional learning methods such as textbooks, lectures, or even 2D simulations VR enables learners to engage with complex systems in a highly interactive, safe, and repeatable manner. This technology has found applications across numerous fields, including healthcare (surgical simulations), architecture (virtual walkthroughs), automotive design, entertainment, and education. Educational institutions in particular are increasingly adopting VR to enhance student engagement, improve retention of knowledge, and offer practical exposure to otherwise expensive, dangerous, or inaccessible environments.

When it comes to computer hardware and networking education, one of the major challenges

students face is the lack of adequate hands-on experience. Physical laboratories often require significant investment in components such as motherboards, processors, network switches, and routers. These labs also involve regular maintenance costs and the risk of accidental damage due to improper handling by beginners. These barriers prevent many students from truly understanding how hardware components fit together or how networking devices function internally.

The VR PC BUILDING SIMULATOR Project is an innovative solution that addresses these challenges by providing a virtual hardware and networking laboratory. The system includes two modules: the PC Building Simulator for assembling and disassembling computer components such as CPU, GPU, RAM, and storage devices, and the Networking Devices Viewer for exploring routers, switches, and hubs. Built using Unity, Blender, and Oculus SDK, it creates an immersive environment without the risk of physical damage or additional cost.

2. RELATED WORK

Virtual Reality (VR) has been widely studied as an emerging tool for education and training. Researchers have highlighted its ability to create immersive environments where learners can interact with concepts in ways not possible through traditional methods.

Rianti et al. (2020) studied the impact of Virtual Reality on engineering education and concluded that VR applications significantly improve spatial visualization skills, technical understanding, and learner engagement. Their work highlighted that immersive environments are especially useful in subjects where real-world practice is limited by cost or safety issues.

Freina and Ott (2015) carried out a survey on immersive learning in STEM fields and reported that VR tools increase motivation, concentration, and knowledge retention among students. They noted that the interactive nature of VR helps learners connect theoretical concepts with practical applications more effectively than traditional methods.

The development of "PC Building Simulator" (2018) demonstrated how virtual environments can be used for hardware education. The simulator allowed users to

assemble and disassemble computer parts such as CPUs, GPUs, RAM, and storage devices in a virtual setting, showing that VR can be a cost-effective alternative to physical hardware labs.

Pinho et al. (2019) explored the use of VR in networking education, where students could virtually inspect routers, switches, and hubs. Their study indicated that VR-based visualization provides deeper insights into internal structures compared to diagrams and static illustrations.

From these research efforts, it is clear that VR plays an important role in bridging the gap between theory and practice. The proposed system builds upon these works by combining PC assembly and networking device visualization into a single platform, creating a reusable, safe, and interactive educational tool.

System Architecture

The workflow diagram below illustrates the architecture and working flow of the system. Fig.1 represents how user actions are processed by the VR application and transformed into immersive visual feedback. The system is built in a layered structure, consisting of three core layers: User Interaction, Simulation Engine, and Visualization & Rendering.

User Inputs

The workflow begins when the user interacts with the system using a VR headset and motion controllers. These inputs include actions such as grabbing, rotating, placing, or disassembling virtual components in the PC Building Simulator, as well as exploring and inspecting devices in the Networking Devices Viewer. These gestures are tracked using the Oculus headset or any compatible VR hardware.

User Interaction Layer

This layer captures user inputs and translates them into virtual actions. It handles gesture recognition (e.g., pick, place, rotate) and allows users to manipulate objects in the 3D space. It also provides visual cues such as highlights or arrows to assist users in assembling PC components or exploring networking devices.

Simulation Engine Layer

The simulation engine acts as the logic center of the system. It verifies whether components are correctly assembled or placed in the PC Building Simulator, such as checking CPU orientation or RAM insertion. In the Networking Devices Viewer, it manages interactions like opening devices and viewing internal structures. If errors occur, it generates real-time feedback such as "Incorrect Placement" or "Rotate 180°."

Visualization & Rendering Layer

This layer is responsible for rendering high-quality 3D visuals. It uses models created in Blender and manages textures, lighting, shadows, and animations. It also supports features such as exploded view & cross-sectional visualization, allowing users to clearly understand both hardware assembly and internal structures of networking devices.

Visual Output

Finally, the processed simulation is displayed as visual output inside the VR headset.

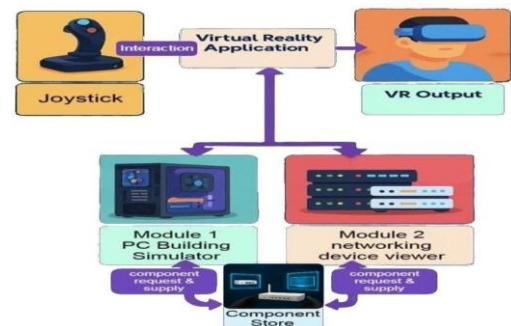


Fig 1: Block Diagram

3. METHODOLOGY

This module outlines the step-by-step process used to develop the VR PC assembly system. It begins with setting up the required hardware and software environment, followed by creating the Unity project and organizing assets. The process continues with enabling VR functionality, designing the player rig and interactive environment, prototyping grabbable components, and implementing snap sockets with part compatibility logic. Finally, a simple world-space user interface is integrated for feedback, and the system is tested within the Unity Editor. Together, these steps demonstrate the development of an interactive VR system that validates component placement and provides real-time feedback.

Pre-requisites : Before starting the project, ensure a VR-ready system and compatible headset are available. Install Unity Hub with Unity 2022/2023 LTS along with required modules. Visual Studio is used for scripting, while Blender and Git can be used optionally. Proper VR runtime configuration is also required. A stable internet connection is recommended for downloading packages and updates. Basic knowledge of Unity and C# scripting will be helpful for development.

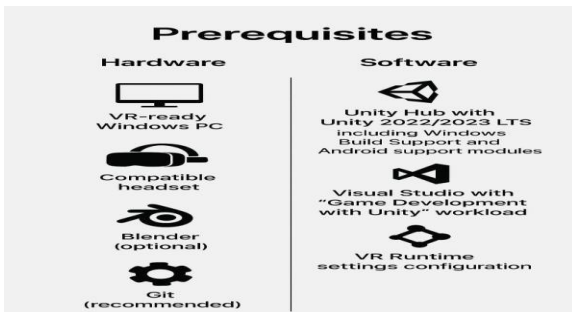


Fig 2: Prerequisites

Create the Project : Begin by opening Unity Hub and creating a new 3D project using the URP template. Name the project VR_PC_Builder and create it. This will serve as the foundation for your VR PC assembly environment. The next step is to organize the project files for clarity and maintainability.

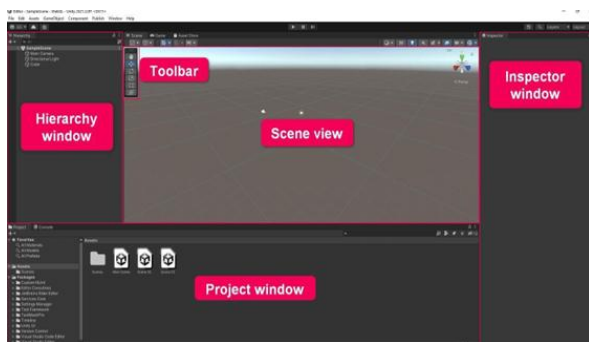


Fig 3: Unity window

Enable VR (XR): To enable VR, necessary Unity packages must be installed and configured. This includes XR Plugin Management and the XR Interaction Toolkit. In the project settings, switch the active input handling to the new input system. OpenXR should be enabled for the target platform.

Add a VR Rig and Basic Environment: The VR environment begins with a player rig as shown in fig.3, which represents the user within the scene. A floor should be added for the player to stand on, along with basic elements like a table to hold parts. This initial setup allows for early testing and ensures that the VR camera and tracking are functioning correctly.

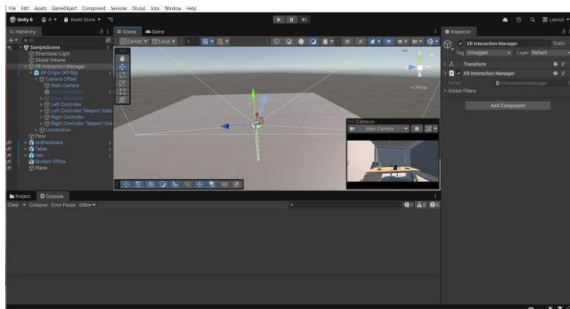


Fig 4: Vr-rig

4. SYSTEM MODULE DESCRIPTION

The VR system consists of several integrated modules that work together to create an interactive and educational virtual environment for learning computer hardware and networking concepts. The system includes a PC Assembly Simulator where users can interact with 3D components such as the motherboard, CPU, RAM, GPU, and power supply. Each component is designed with realistic dimensions and textures, allowing learners to understand the structure and placement of actual hardware. Users can pick, rotate, and position parts correctly using VR controllers, making the learning experience practical and immersive. The system also provides on-screen guidance and visual cues to help users follow the correct assembly process without the risk of damaging physical components.



Fig 5: Vr-rig

In addition to PC assembly, the system includes a Networking Devices Viewer that enables users to explore the internal structure of routers, switches, hubs, and other networking devices. Users can view internal circuits, ports, chipsets, and layouts that are usually not accessible in real devices. The system also provides smooth interaction through VR-based controls, object manipulation, and a user-friendly interface for easy navigation between modules and instructions



Fig 6: Networking Device Environment

All 3D assets used in the system are optimized to ensure smooth performance. Models created in Blender are exported with reduced complexity and efficient textures for stable rendering. The virtual lab is designed

with proper lighting and spatial arrangement to create a realistic and distraction-free environment. Together, these modules form a complete VR-based learning system that enhances understanding, improves engagement, and provides a safe and repeatable platform for practicing hardware and networking concepts. The system is scalable, allowing future expansion with additional hardware modules and networking scenarios. It also supports interactive learning by enabling users to experiment and learn through hands-on virtual experience.

5. RESULT

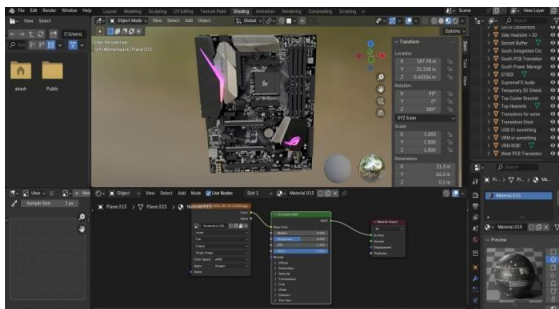


Fig.7: 3D Model in Blender



Fig.8: 3D Ram Model

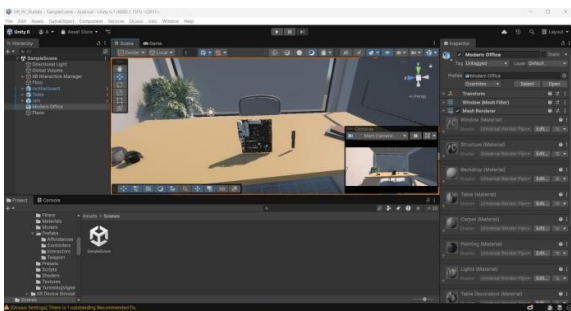


Fig.9: Visualization and Rendering

6. CONCLUSION

The VR project successfully demonstrates how Virtual Reality can be used as an effective learning platform for teaching computer hardware assembly and networking concepts. By combining the PC Building Simulator and Networking Devices Viewer modules with interactive 3D models, VR controls, and an immersive environment, the system

allows students to assemble components and explore networking devices without the need for physical equipment. This reduces the risk of damaging real components, provides unlimited practice opportunities, and improves conceptual understanding through visual and hands-on engagement. The development process also provided valuable experience in Unity development, 3D modeling, asset optimization, and VR interaction design, enhancing technical knowledge and practical skills.

Overall, the system achieves its goal of providing a realistic and user-friendly virtual lab experience. Students who tested the application found it more engaging and easier to understand compared to traditional learning methods. Although the current version is fully functional, the system can be further enhanced with features such as collaboration, AI-based guidance, advanced networking simulations, and haptic feedback. With continuous improvements, VR can become a scalable and modern solution for teaching hardware and networking in educational institutions.

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REFERENCES

- [1] R. Gupta, S. Menon, and A. Kumar, "Virtual Reality-Based Computer Hardware Training System," *International Journal of Advanced Computer Science and Applications (IJACSA)*, vol. 13, no. 5, pp. 221–229, 2022.
- [2] H. Patel and N. Shah, "3D Simulation and VR Interaction Techniques for Technical Education," *International Journal of Engineering Research & Technology*, vol. 11, no. 2, pp. 45–51, 2023.
- [3] L. Johnson and M. R. Torres, "Immersive VR Environments for Teaching Networking Concepts," *International Journal of Computer Applications*, vol. 184, no. 16, pp. 32–38, 2022.