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Packet Simulation using MR – A Review

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Abstract - *The value of traditional learning approaches in system modeling has been challenged with regards to students' understanding, learning performance and mastering of modeling techniques. The use of multimodal learning environments can be used in networking to enhance critical thinking, improve problem-solving activities, support system thinking and promote learning. The use of interactive visualization through multi-dimensional graphics and simulation could provide an opportunity to present key learning content for students using multiple representations. Multiple representations support a variety of learning activities and can provide unique benefits when students are learning new concepts or complex ideas. To provide a more interactive user experience, we are attempting to apply mixed reality to the concept of packet simulation in networking. Through this paper we propose the design for a system that simulates transfer of packets between networking devices with the help of Microsoft Hololens. Image recognition with Vuforia and Hololens is a significant method that will be used in the system. We aim towards creating an application that allows students better understand the concept of packet transfer in networking.*

Key Words: **Multimodal learning, Microsoft Hololens, Mixed Reality, Networking, Vuforia, Markers**

1. INTRODUCTION

Terms like Augment Reality (AR), Virtual Reality (VR) and Mixed Reality (MR) are being used interchangeably and often incorrectly. Determining the difference between these concepts can be challenging. In this section, we will be briefly covering these concepts. In AR, a virtual object is complimented to our real world. Here, we do not lose sight of the real world, but instead add something to it. The basic idea is to augment / overlay digital content onto our real space.

In the case of VR, the real world is replaced by virtual objects and scenarios. It completely replaces what we have come to consider normal reality. Since a person is completely immersed in the virtual environment, he has no awareness about his/her surroundings.

MR is an amalgamation of physical objects and virtual objects/components that are overlaid onto the physical world. These virtual objects can be interacted with. Rather than being superimposed on top of normal reality, as is done with augmented reality, MR experience blends the two realities together to create a new mixed reality. Microsoft's HoloLens is the first Mixed Reality device. Using Hololens, we can create holograms which are nothing but digital objects formed from light and sound that give an illusion of real objects. Gaze, gesture and voice commands can be used to interact with the holograms.

Unity is a complete 3D engine supporting C# scripting, 3D and 2D graphics, physics, sound and animation. Unity is the preferred software platform for developing Windows Mixed Reality experiences. The app development happens within Unity. Another objective of this thesis is to show how to fit the library under Unity 3D development tool, analyzing Vuforia's main functionalities: detection and tracking.

2. LITERATURE SURVEY

[1] As stated in this paper, Computer Networking course commonly taught in mixed mode involving lecture and practical session whereas beside face-to-face theory session, students need to experience hands-on activities in order to appreciate the technology and contents. Nevertheless, the abstraction in Computer Networking course such as the complexity in TCP/IP network layering, the connection and configuration of client and server's framework, differences in static and dynamic IP address configuration had imposed a great challenge for students to understand and grab the main concept of computer networking technology. As such, an approach of using computer network simulation and visualization tool in teaching and learning Computer Networking course is seen beneficial for educators and students. In this research, computer network simulation software of CISCO Packet Tracer was utilized in Computer Networking (MTN3023) course. Students (N=55) were exposed to CISCO Packet Tracer on which they developed Wide Area Network (WAN) that consists of configuration activities of Personal Computer (PC), Servers and Switches according to CISCO standard. Subsequently, student's feedback and their insight on the effectiveness of CISCO packet Tracer in learning computer networking were probed using questionnaire.

[2] In this paper, they have planned to use AR to leverage the increased computing power of smart-phones to build a system that displays 3D objects using a printed image without using any complicated equipment. The purpose of this system is to accelerate learning and understanding of concepts such as structures or mechanisms. Instead of reading long manuals, the user can watch and interact with a 3D video manual through AR. The average person learns better by observing and listening something than by simply

reading something. We will be using this specific property of the human mind to accelerate learning.

In this research [3], Unity 3D game engine is used on Vuforia platform. Vuforia platform make it possible to write a single native application that runs on almost all smartphones and tablets. To test the concept, 8 pieces of virtual 3D puzzle modules were created using 8 markers. Each virtual module was assigned with physical properties such dimensions, shapes and positions. When assemble the puzzle, each piece of the marker must be able to move around so that the virtual modules can fit to each other. By lifting and rotating the markers, the virtual module will snap with the other proper virtual part, forming virtual 3D puzzle. The virtual module will not penetrate each other because they have their own territory due to their dimensions. With this experiment, users will have a realistic feeling on assembling the virtual model. The concept can be implemented for experiments that are dangerous or expensive to setup.

In this [4] paper, a mobile system is presented that enhances mixed reality experiences and games with force feedback by means of electrical muscle stimulation (EMS). The benefit of their approach is that it adds physical forces while keeping the users' hands free to interact unencumbered—not only with virtual objects, but also with physical objects, such as props and appliances. They demonstrate how this supports three classes of applications along the mixed-reality continuum: (1) entirely virtual objects, such as furniture with EMS friction when pushed or an EMS-based catapult game. (2) Virtual objects augmented via passive props with EMS constraints, such as a light control panel made tangible by means of a physical cup or a balance-the-marble game with an actuated tray. (3) Augmented appliances with virtual behaviors, such as a physical thermostat dial with EMS detents or an escape-room that repurposes lamps as levers with detents. It also presented a user-study in which participants rated the EMS-feedback as significantly more realistic than a no-EMS baseline.

Virtual Reality [5] can transform teaching and be embedded within education as a regular teaching tool. Higher education institutions and professional development courses, throughout the world, are beginning to encompass Virtual Reality content within their curriculum and training practices via a variety of methods. Embedding Virtual Reality resources into higher education can benefit academics and teachers as well as their students. Students are able to immerse themselves into a virtual environment that provides an alternative platform to deliver the information they need, and also enables them to interact with the content.

This paper [6] presents insights from the implementation of a mixed reality intervention using 3d printed physical objects and a mobile augmented reality application in an ICT networking classroom. The intervention aims to assist student understanding of complex theoretical multi-step problems without a corresponding real world physical analog model. This is important because these concepts are difficult to conceptualize without a corresponding mental model. The simulation works by using physical models to represent networking equipment and allows learners to build a network that can then be simulated using a mobile app to observe underlying packet traversal and routing theory between the different devices as data travels from the source to the destination.

In this paper [7], a survey of different mobile and wireless technologies was provided and also how they have impact AR, place them into different categories so that it becomes easier to understand the state of art and to help identify new directions of research. Recent advances in hardware and software for mobile computing have enabled a new breed of mobile augmented reality (AR) systems and applications. A new breed of computing called 'augmented ubiquitous computing' has resulted from the convergence of wearable computing, wireless networking, and mobile AR interfaces.

3. MOTIVATION

While knowledge has become more easily available for people, the current approach to education has two significant problems:

1. It is based on the traditional format – Fact Retention. Teaching methods are focused on providing facts, however having access to and consuming a lot of information is not learning.
2. A lot of people have difficulties comprehending information.

Using MR, students can be provided with easy demonstrations of crucial concepts through interactive experiences.

Cisco packet tracer is a course which attempts at a methodology to encourage mixed mode of learning i.e hands on work with theory sessions. So, this basic idea of making the concepts of networking easier is what our project is trying to achieve.

4. SOFTWARE AND HARDWARE REQUIREMENTS

Software Requirements –

1. Mixed Reality Toolkit
2. Unity 3D
3. Visual Studio Community
4. Vuforia

Hardware Requirements –

1. Microsoft Hololens
2. PC/Laptop

If a Mixed Reality device is not available, the Hololens emulator or the Windows MR simulator can be used.

5. PROPOSED METHODOLOGY

5.1. Input and Output:

- **Input**

1. Gesture
2. Gaze
3. Voice
4. Vuforia markers
5. Text input

Using the above mode of inputs, the student will be able to collaborate with the mixed reality application, and perform various interactions according to his/her requirement. Vuforia markers specifically will help bring the three-dimensional assets like routers into the mixed reality environment, and the rest of the input modes can be used by the student according to his/her convenience. Gaze will be used to set the student's eyes on a particular hologram and Gestures like air tap, pinch can be used for selection and manipulation. Figure 1 depicts the input methods.

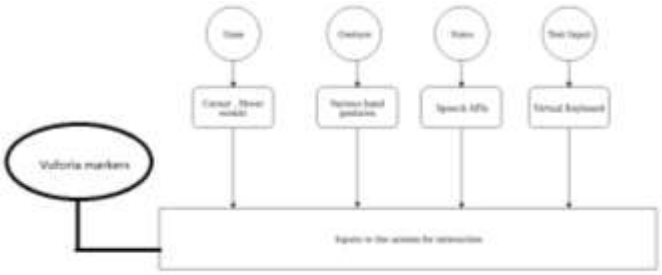

Fig. 1 Input methods

- **Output**

Simulation of transfer of data packets within the network is shown through figure 2.

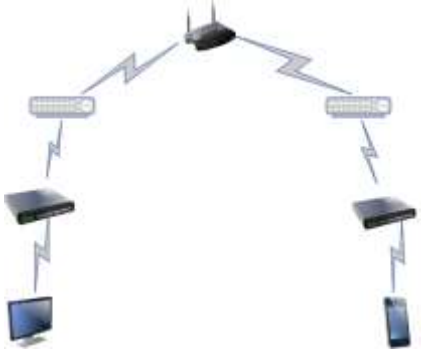

Fig. 2 Output

5.2. Basic Unity Application development:

Creating any unity application requires certain significant settings that need to be made. Post making these settings, application development can be started. Fig-3 shows the basic steps that need to be followed for developing an application using unity.

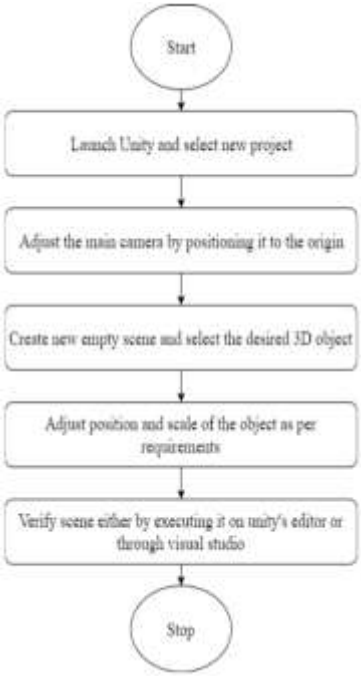

Fig. 3 Event Handling Flowchart

5.3. Packet Transfer

Once the image targets have been recognized and appropriate 3D assets have been superimposed, select the source and destination devices, between which packet transfer needs to be simulated. Fig-4 is an input output state diagram which shows all the steps involved in the application design process.

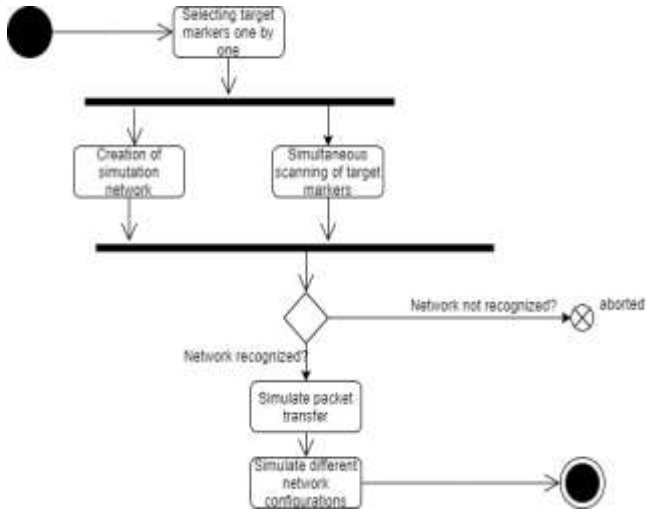

Fig. 4 I/O State Diagram

6. CONCLUSION

Our software will include 3d printed networking components (Vuforia markers) that will be scanned by the energy-efficient depth camera of Hololens with a 120x120 angle of view using the Vuforia plug-in. Using 3d printed components, the application will identify each component and use them to construct a custom network based on the placement of the markers. Once the network is visualized on the Hololens the students can then simulate the packet transfer. Students can also rearrange the 3D objects to make different networks to understand packet simulation. Our system makes use of 3D assets identification, simulation and visualization with the collaboration with Vuforia plugin to help the student understand packet transfer between various networking devices. 3D models of network equipment will be placed in a field and then the mixed reality app can be used to observe packet traversal and routing between the different devices as data travels from the source to the destination.

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