

Major Project Report on
Augmented Reality for Computer Networking

Submitted in partial fulfillment for the degree of Bachelor of Technology
in
Information Technology

Submitted by

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Certificate

This is to certify that Pratishtha Tamore, Kajal Tiwari, Sritika Manjrekar doing the Major Project Phase II-A on the topic “Augmented Reality for Computer Networking” satisfactorily in partial fulfillment for the Bachelor’s Degree in Information Technology under the guidance of Mrs. Prachi Dhanawat during the year 2023-24 as prescribed by Shreemati Nathibai Damodar Thackersey Women’s University.

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I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

In recent years, there has been an increasing interest in applying Augmented Reality (AR) to create a unique study of computer networking. This paper reports a review of literature on augmented reality in computer networking considering the factors include the uses, features, and effectiveness of augmented reality in computer networking. Furthermore, the report discusses trends and the vision towards the future and opportunities for further research in augmented reality for computer networking. The purpose of this research is to develop augmented reality learning and build application that makes it easier for students to understand the computer networks.

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Chapter 1

Introduction

Augmented reality (AR) is the integration of digital information with the user's environment in real time. Unlike virtual reality (VR), which creates a totally artificial environment, AR users experience a real-world environment with generated perceptual information overlaid on top of it. Augmented reality is used to either visually change natural environments in some way or to provide additional information to users. The primary benefit of AR is that it manages to blend digital and three-dimensional (3D) components with an individual's perception of the real world. AR has a variety of uses, from helping in decision-making to entertainment. AR delivers visual elements, sound and other sensory information to the user through a device like a smartphone or glasses. This information is overlaid onto the device to create an interwoven experience where digital information alters the user's perception of the real world. The overlaid information can be added to an environment or mask part of the natural environment. Augmented reality can be delivered in a variety of formats, including within smartphones, tablets and glasses. AR delivered through contact lenses is also being developed. The technology requires hardware components, such as a processor, sensors, a display and input devices. Augmented Reality (AR) is a groundbreaking technology that has

transformed the way we perceive and interact with our physical surroundings. In an era where the digital and physical realms increasingly intertwine, AR has emerged as a powerful tool that extends our reality by overlaying digital elements onto the real world. This capability has ushered in a new era of immersive experiences, revolutionizing various industries and captivating the imagination of technologists, developers, and users alike. AR seamlessly merges the tangible world with virtual information, creating a dynamic and interactive amalgamation. Whether experienced through smartphones, tablets, smart glasses, or specialized headsets, AR enriches our sensory perception by introducing visual, auditory, or haptic elements into our environment. This technology has far-reaching implications, from enhancing entertainment and gaming to improving education, training, and productivity across numerous sectors.

1.1 Problem Statement

To empower learners with the knowledge and skills essential for confidently navigating the increasingly interconnected world with enthusiasm and self-assurance. Specific computer network concepts pose significant challenges for students due to their inherently abstract nature are Subnetting and IP Addressing, Network Protocols, Routing Algorithms, Packet Switching and Routing Tables, Network Security, Network Topology, Wireless Networking in Augmented Reality,

1.2 Objectives of the Study

The objective of this study is to investigate the potential of Augmented Reality (AR) technology as an innovative and effective tool for enhancing the learning experience in the field of computer networks. The primary goals of this research are as follows:

- Assess the impact of Augmented Reality (AR) on computer network learning outcomes.
- Explore how AR enhances student engagement, motivation, and interest in the subject.
- Analyze AR's role in developing problem-solving skills among students.
- Evaluate the user experience and usability of AR tools in network education.
- Identify challenges and provide integration recommendations for AR in education.

By achieving these objectives, this study aims to provide valuable insights into the potential of Augmented Reality to transform computer network education, making it more engaging, effective, and aligned with the demands of the digital age. Ultimately, the findings from this research may guide educators and institutions in adopting AR as a tool to enhance the learning experience in the field of computer networks.

Chapter 2

Review of Literature

2.1 Overview of Previous Research

1. "Augmented Reality for Mobile-Based Computer Network Learning Interactions": This research paper explores the use of Augmented Reality (AR) markers, typically images of network hardware, to trigger the integration of 2D or 3D digital objects into the real world. AR distinguishes itself from Virtual Reality (VR) by blending virtual elements seamlessly with the physical environment. The study focuses on marker recognition for rendering 3D computer network hardware objects in AR applications. If a marker is recognized, it is used as a trigger to render and replicate digital objects, particularly those related to 3D Computer Network Hardware. The core aim is to investigate the effectiveness of markers in enabling the augmentation of the physical environment with digital elements.

2. "Development of interactive learning media in computer network using augmented reality technology" :-

Augmented Reality (AR) is a technology that combines two-dimensional or three-dimensional virtual objects into a real three-dimensional environment

and then projects these virtual objects in real time. This research discusses the development of learning media Augmented reality of computer network installation. The purpose of this research is to develop augmented reality learning media and build media that makes it easier for students to understand the process of installing computer networks that becomes an alternative as a learning media. The method used is Research and Development (R&D). The purpose of AR is to interact with users with virtual and real environments in real-time. Users will feel the virtual world in real life. AR can add digital content in the form of 2D and 3D animation into the real world. The ability of a device to perform tracking is divided into 2, namely marker tracking and markerless tracking. In marker tracking, there is an object/image that has been set to be the exit position of the 3D object. The object's/images used are known as trackables. In markerless tracking the system has been programmed to detect several colors or objects with a predetermined shape. AR includes semi-immersive/mix reality levels.

3. "Development and Evaluation of Augmented Reality Learning Content for Pneumatic Flow: Case Study on Brake Operating Unit of Railway Vehicle" (8 May 2023):

AR content was designed to train maintenance staff on the pneumatic flow of railway vehicle BOU using SLMVC and CEPC algorithms. An experiment showed a reduction in performance and frustration scores, an increase in

correct answers, and a decrease in perceived workload. The AR content is practical, convenient, and not limited by time and space, making it a valuable tool for maintenance education in railway operating organizations.

4. "Merge Cube as a New Teaching Tool for Augmented Reality" (02 August 2023): This research project aims to create an open-source Unity 3D environment for Android devices, intended for hospitalized children. The project will focus on solar systems, world monuments, and marine animals, with two entertainment parts. The use of mobile devices for teaching, or m-learning, is also discussed, along with examples of augmented reality applications in the automotive and medical industries. The Merge Cube software is also mentioned as a tool for creating holograms. The disadvantage of some educational apps is that they only provide partial functionality for free and require a license. Finally, the Explorer app is highlighted as a comprehensive educational resource with animated scenes, with a sample of the solar system development. This document outlines the principles of augmented reality, including 2D and 3D object tracking, face and body tracking, plane detection, and cloud recognition. It also describes an object viewer that allows for detailed viewing and manipulation of objects in a database, such as dinosaurs, ancient artifacts, and computer parts. The Hologlobe application allows users to examine satellite images of Earth in

detail, including scientific data on precipitation, clouds, temperatures, glaciers, and fires. CoSpaces is a web-based application for creating virtual worlds and augmented reality objects, and there are several tools available for creating applications for the Merge Cube, including Merge Edu, CoSpaces, Unity, and Unreal Engine. The author is currently working on another educational app for Merge Cube with new functionality in physics, mathematics, and natural sciences.

5. "Enhancing Biomedical Education with Real-Time Object Identification through Augmented Reality" (Xi'an, China, 07 September 2023):

A mobile AR platform has been developed to train STEM majors in identifying and using laboratory instruments. The platform uses computer vision and AR technologies and includes features such as a knowledge test, guided navigation, and the ability to build a library of instruments through AR. The platform was built using Unity 3D Game engine and ARkit-XR plugin, and future research will expand the platform to include chemistry and physics labs with additional functionalities to improve the learning environment.

6. Fighting Pandemics With Augmented Reality and Smart Sensing-Based Social Distancing" (14 December 2022):

DistAR is an Android-based AR application that uses smart sensing to promote

social distancing. It estimates distances using ARCore's depth API and displays visualizations to help users navigate safely. The app collects real-time sensor data and sends it to a storage server over LoRaWAN, which is accessed via a RESTful API. Future directions include developing cross-platform AR applications and improving user experience and acceptance.

7. "Evaluation of an Augmented Reality for Historical Context Experiences of 3DRestored Court Paintings" (25 April 2023):

The study addresses the challenge of interpreting traditional Korean court paintings that depict royal events, which require historical context for accurate understanding. Existing methods using digital technologies fall short in enabling interaction and explaining historical context. To tackle this, the study proposes an augmented reality (AR) system that provides 3D virtual restorations of vital information from the paintings, allowing visitors to intuitively grasp the missing historical narratives. The AR system also facilitates interactive experiences of royal events and is designed based on experiential learning theory and digital storytelling. User studies show that this approach offers a more immersive and accurate understanding of court paintings and historical events, making it a valuable tool for museum visitors without prior historical knowledge.

8. "Augmented Reality Implementation for Device Recognition Learning Computer Network" (21 December 2022):

Augmented reality incorporates two-dimensional or three-dimensional virtual

objects into a virtual reality environment, projecting these virtual objects in real time. This research aimed to increase the knowledge and skills of Hidayah Vocational High School students' understanding of the various types of network devices with an augmented reality application and developed tutorial videos on steps for creating a new atmosphere. This research model used the waterfall method. The android app that was developed went through product feasibility test stages carried out by lecturers and teachers and was declared fit for use. Then the product was tested on SMK Hidayah class XI students and declared "good." Based on the data above, it can be concluded that the android-based application in the form of a 3D Visualization Design of a Computer Network can be used to understand computer introduction material.

Chapter 3

Existing System

AR can add digital content in the form of 2D and 3D animation into the real world. The ability of a device to perform tracking is divided into 2, namely marker tracking and markerless tracking. In marker tracking, there is an object/image that has been set to be the exit position of the 3D object. The object's/images used are known as trackables. In markerless tracking the system has been programmed to detect several colors or objects with a predetermined shape. AR includes semi-immersive/mixed reality levels seen in Figure 1.

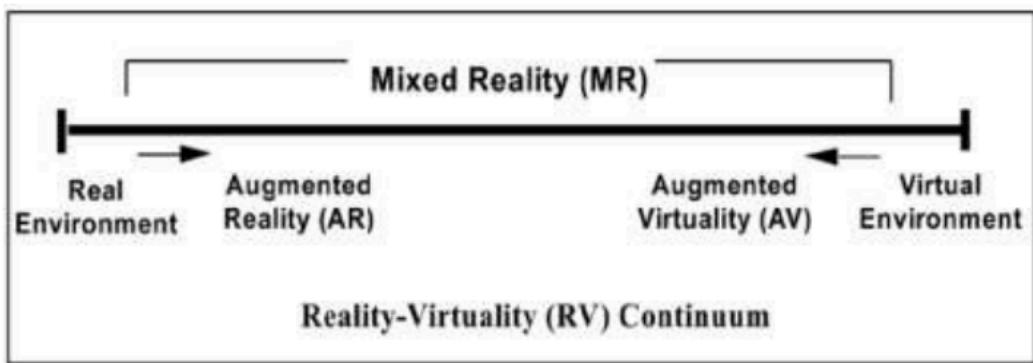


Figure 1. Mixed Reality

3.1 Proposed System

1. System Overview:

Our proposed system is an Augmented Reality (AR) network learning platform designed to enhance the education and understanding of networking concepts for students. It leverages AR technology to create an immersive and interactive learning experience. The system incorporates 3D Network Models, Visualized Network Traffic, Gamified Learning, Real-World Network Scenarios, and Resource Libraries to provide a comprehensive learning environment.

2. 3D Network Models:

Objective: Build 3D models of network components to facilitate hands-on exploration and interaction.

- Create realistic 3D models of routers, switches, servers, and endpoints.
- Enhanced Understanding: 3D models aid comprehension and provide a realistic representation of network components.
- Clear Descriptions: Provides precise information, making learning accessible to diverse student needs.
- Visual Learning: Appeals to different learning styles and fosters independent exploration.

3. Visualized Network Traffic:

Objective: Use AR to visualize network traffic in real-time for a deeper understanding of network concepts.

- Develop AR simulations to display network traffic flows, packets, and data transfer processes.
- Enable students to observe and analyze network traffic patterns and protocols.
- Provide interactive tools for students to trace the path of packets and understand routing and switching

Chapter 4

Workflow of Proposed Model

4.1 Flow chart

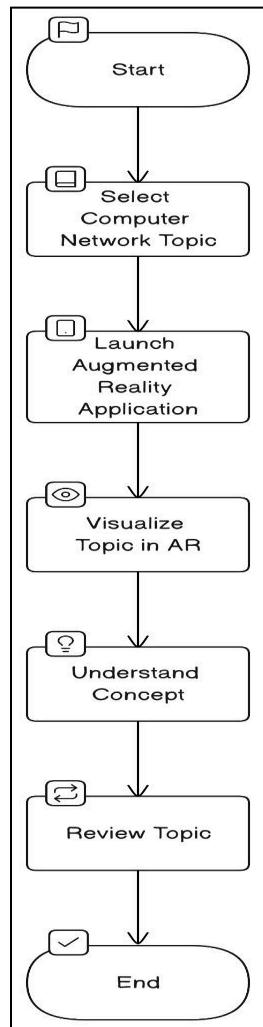


Figure 5.1

4.2 Sequence diagram

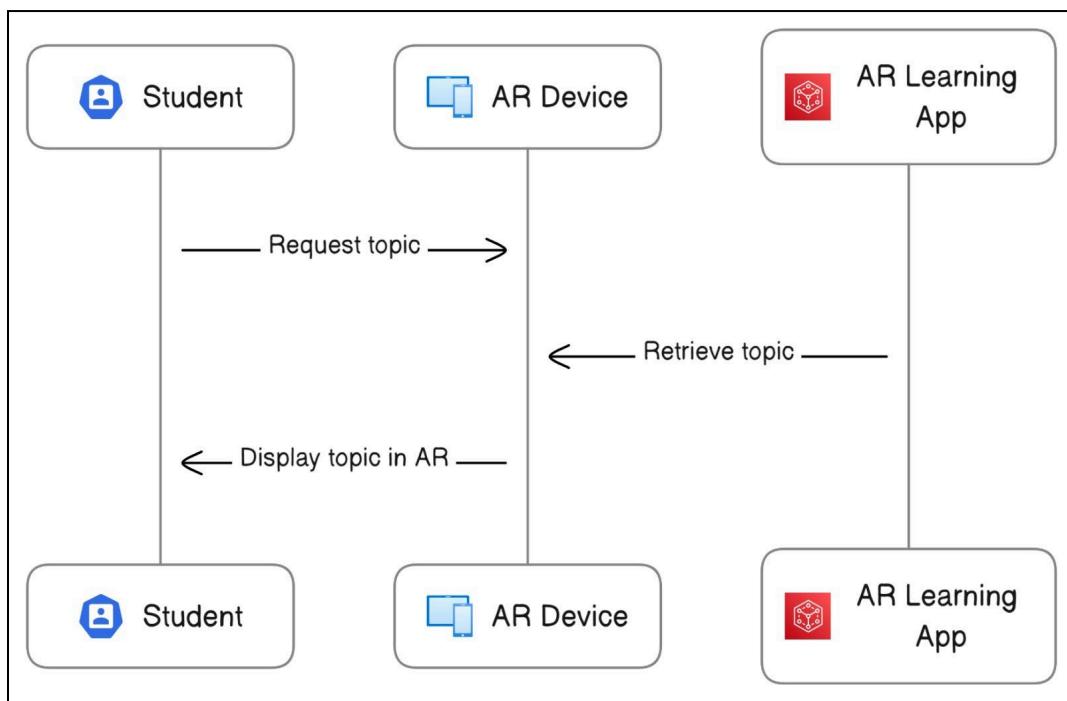


Fig 5.2 sequence diagram

5.3 Architecture of Augmented Reality

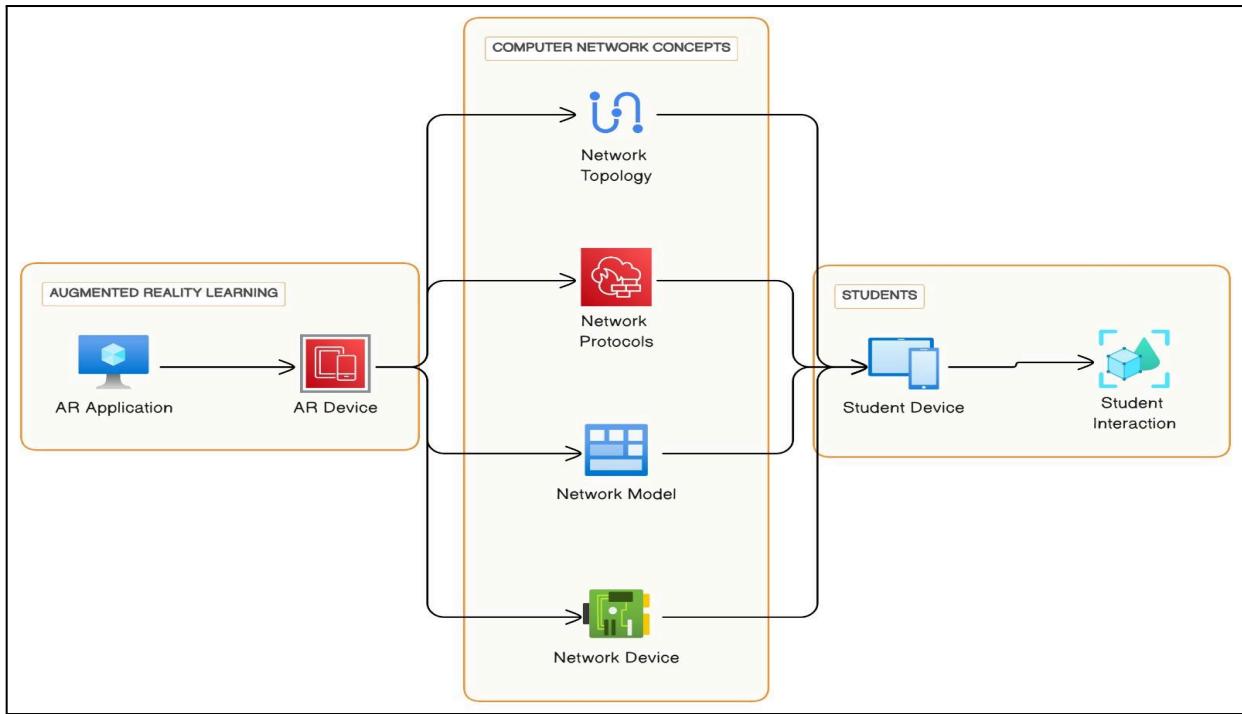


Figure 5.3:- Architecture of Augmented Reality

Chapter 6

Software Used

- Windows 10 (Operating System)
- Visual Studio Code (IDE)
- HTML
- CSS
- JavaScript
- Model-Viewer
- Bootstrap

External files:

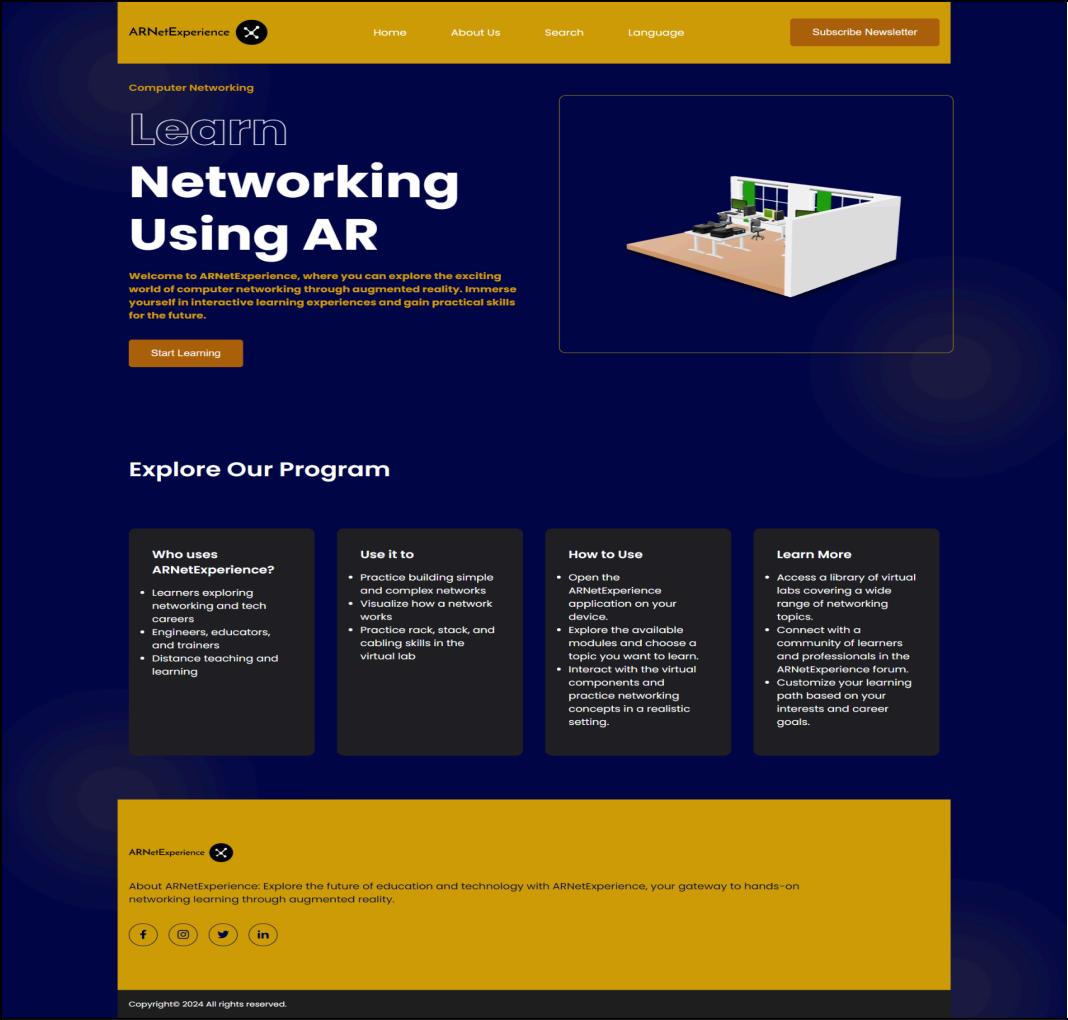
- GLB

Documentation :-

- Latex(Overleaf)

Chapter 7

Implementation



The screenshot shows the homepage of ARNetExperience. At the top, there's a navigation bar with links for Home, About Us, Search, Language, and a prominent orange 'Subscribe Newsletter' button. Below the navigation, the title 'Computer Networking' is displayed, followed by a large, bold heading: 'Learn Networking Using AR'. A sub-headline below the main title reads: 'Welcome to ARNetExperience, where you can explore the exciting world of computer networking through augmented reality. Immerse yourself in interactive learning experiences and gain practical skills for the future.' To the right of the text is a 3D rendering of a virtual networking lab setup with desks, chairs, and computer equipment. Below the main title, there's a section titled 'Explore Our Program' containing four dark grey boxes with white text: 'Who uses ARNetExperience?', 'Use it to', 'How to Use', and 'Learn More'. Each box lists specific features or benefits. At the bottom of the page is a yellow footer bar with social media icons for Facebook, Instagram, Twitter, and LinkedIn, along with a copyright notice: 'Copyright © 2024 All rights reserved.'

Figure 7.1:- ARNetExperience Home Page

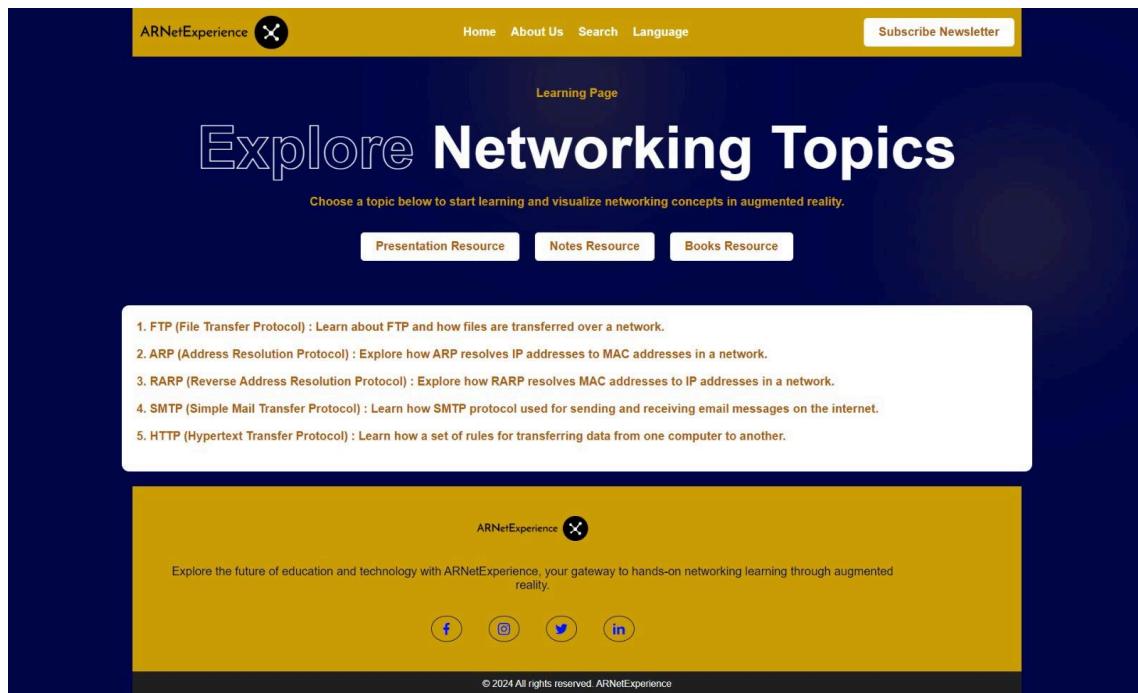


Figure 7.2:- ARNetExperience Learning Page

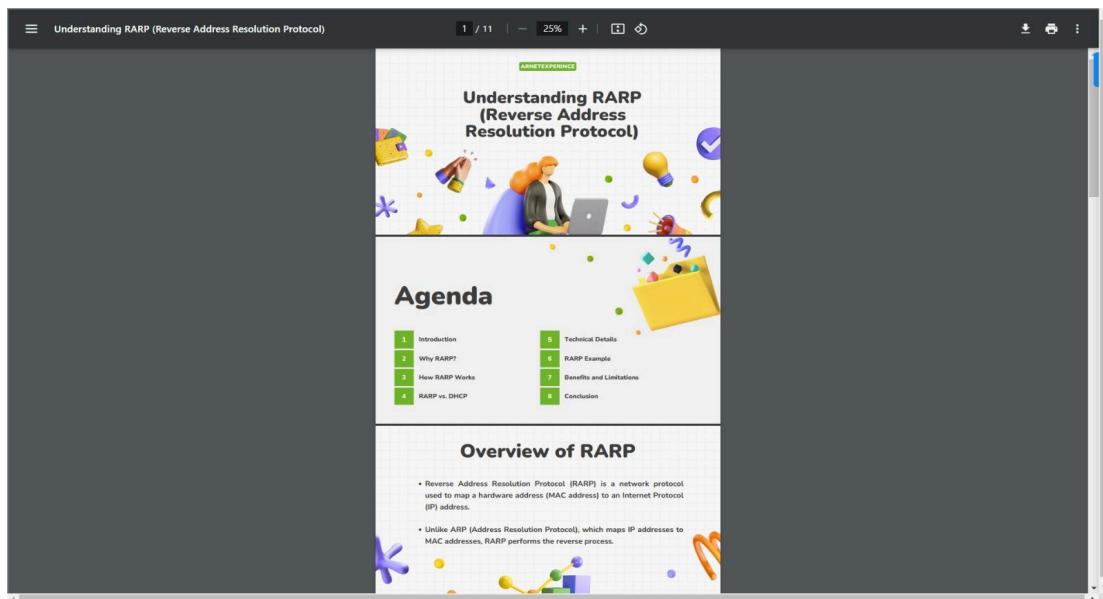


Figure 7.3:- ARNetExperience Presentation Resource Page

The screenshot shows a web browser window with multiple tabs open. The active tab displays a document titled "Computer Network Notes". The content includes sections on Introduction, Features, Architecture, and Components, each with a numbered list of points. The "Features" section lists 5 points: 1. Resource Sharing, 2. Communication, 3. Reliability, 4. Scalability, and 5. Cost Efficiency. The "Architecture" section describes the Client-Server Model and Peer-to-Peer Model. The "Components" section lists Nodes, Links, and Switches/Routers.

Computer Network Notes

Introduction:
A computer network is a set of interconnected computers that communicate with each other to share resources and information. This collaboration allows users to access data, applications, and services remotely. Networks can be local, connecting devices within a limited geographical area, or global, connecting devices worldwide.

Features:

1. Resource Sharing: Networks enable the sharing of resources such as files, printers, and internet connections among connected devices.
2. Communication: Facilitates communication between users through various means like emails, instant messaging, and video conferencing.
3. Reliability: Networks enhance reliability by providing alternate paths for data in case of failure, ensuring continuous connectivity.
4. Scalability: Networks can be easily scaled to accommodate a growing number of devices or users.
5. Cost Efficiency: Shared resources and centralized management contribute to cost efficiency in terms of hardware, software, and maintenance.

Architecture:
Computer network architecture refers to the design or structure that determines how computers in a network are organized and how tasks are allocated among them.

1. Client-Server Model: In this architecture, one or more computers (servers) provide services to other computers (clients) in the network. Common in web and database applications.
2. Peer-to-Peer Model: In this decentralized model, all computers have equal status, and each can act as both a client and a server. Common in small networks for file sharing.

Components:

1. Nodes: Devices like computers, printers, and servers that are part of the network.
2. Links: Physical or wireless connections that allow data to flow between nodes.
3. Switches and Routers: Devices that manage and direct data traffic within a network.

Figure 7.4:- ARNetExperience Notes Resource Page

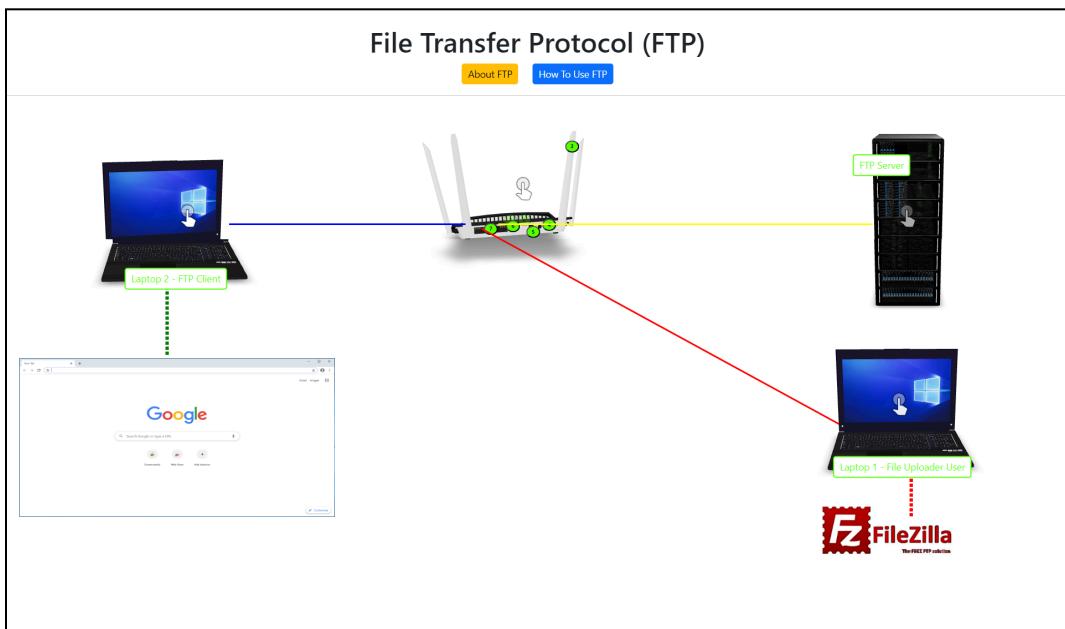


Figure 7.5:- File Transfer Protocol(FTP) Page

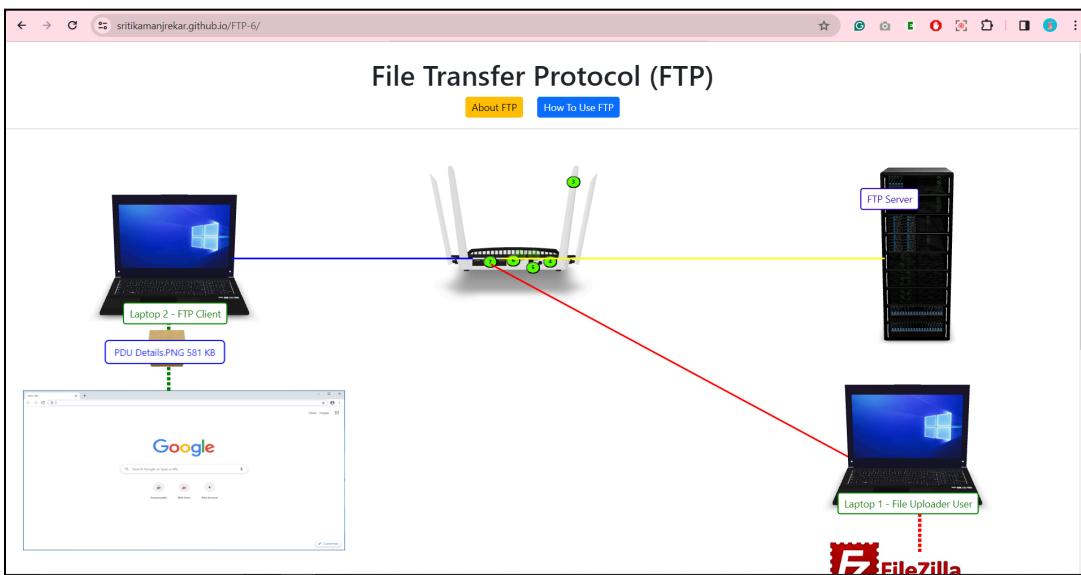


Figure 7.6:-FTP Simulation I

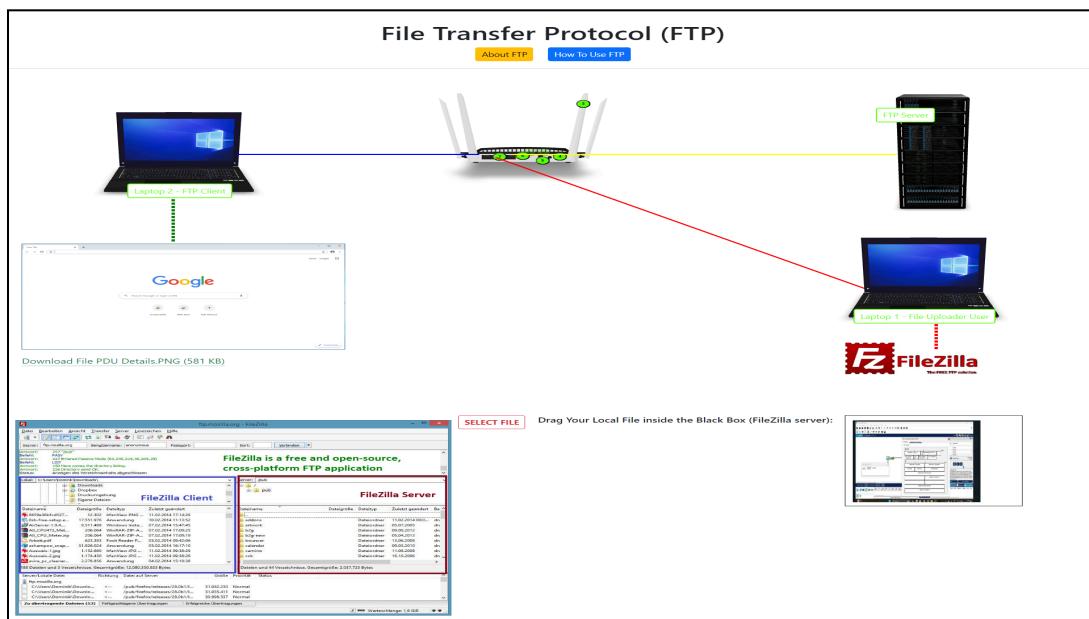


Figure 7.7:- FTP Simulation II

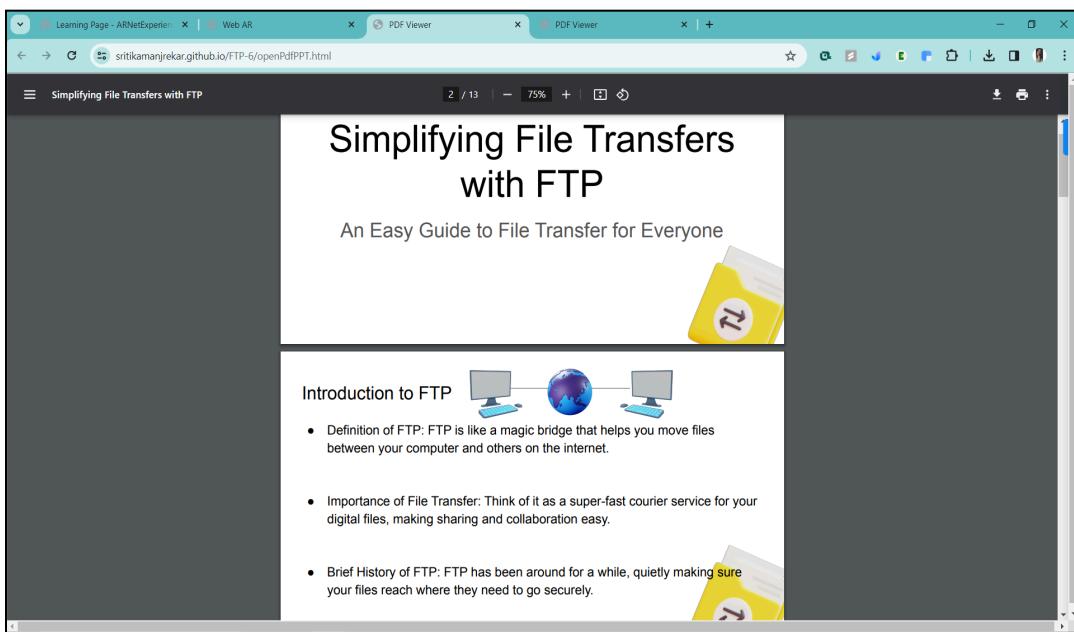


Figure 7.8:- About FTP Page

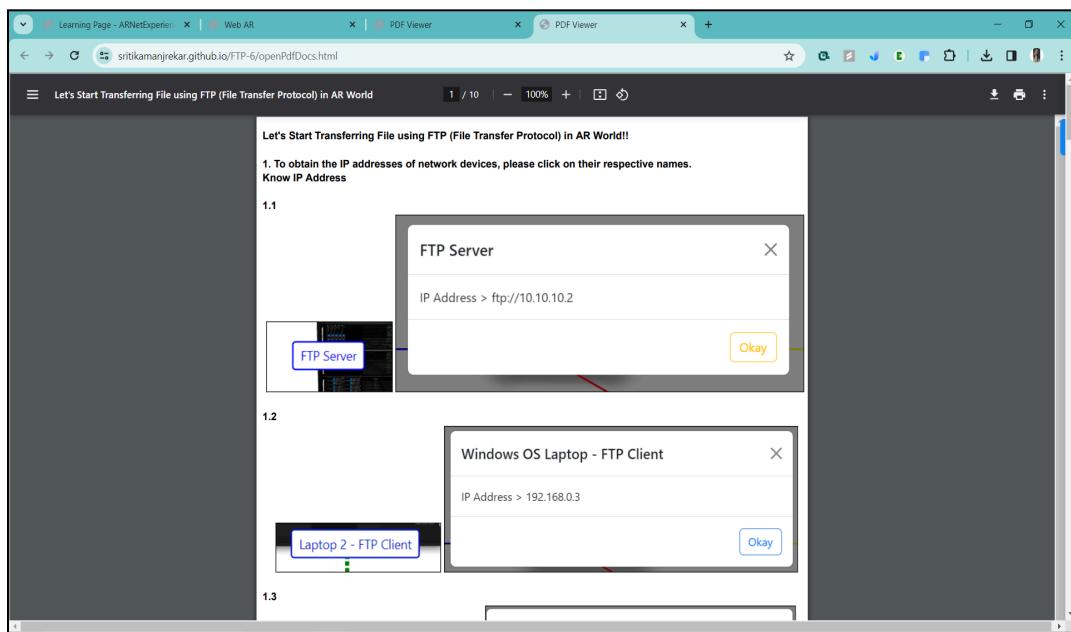


Figure 7.9:- How To Use FTP Page

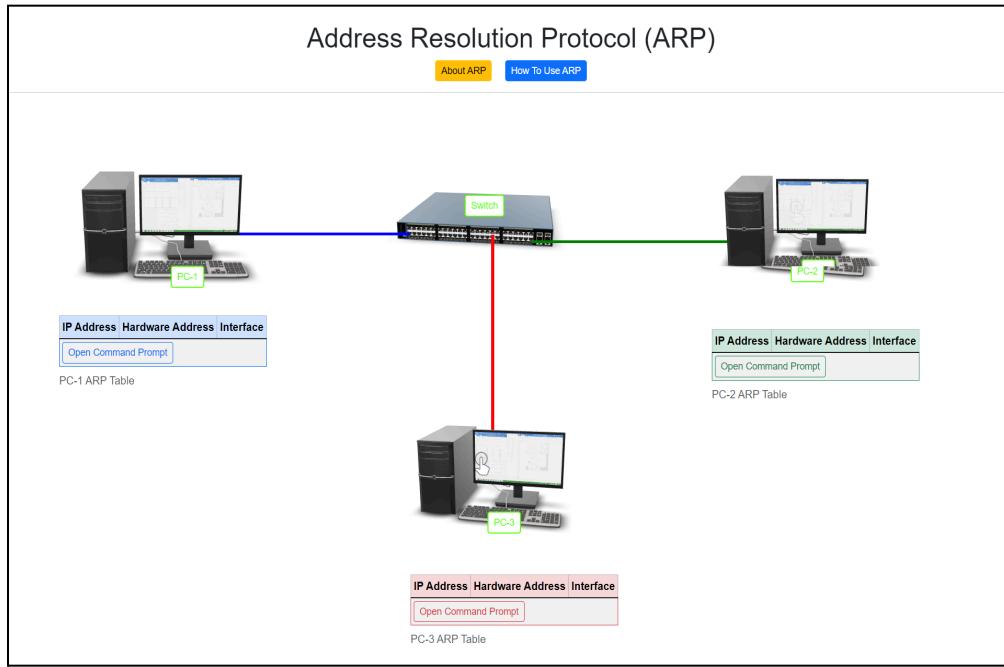


Figure 7.10:-Address Resolution Protocol (ARP) Page

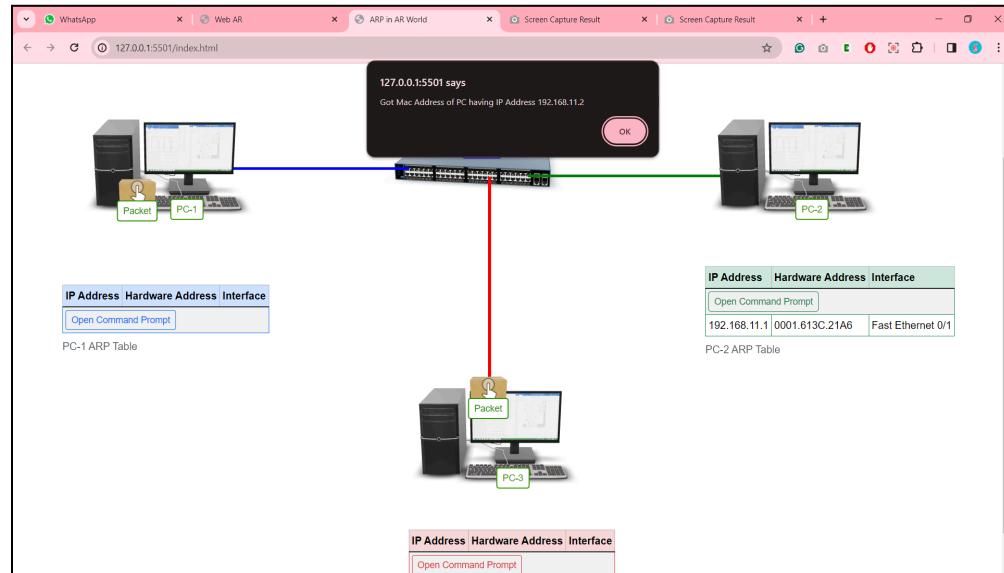


Figure 7.11:- ARP Simulation I

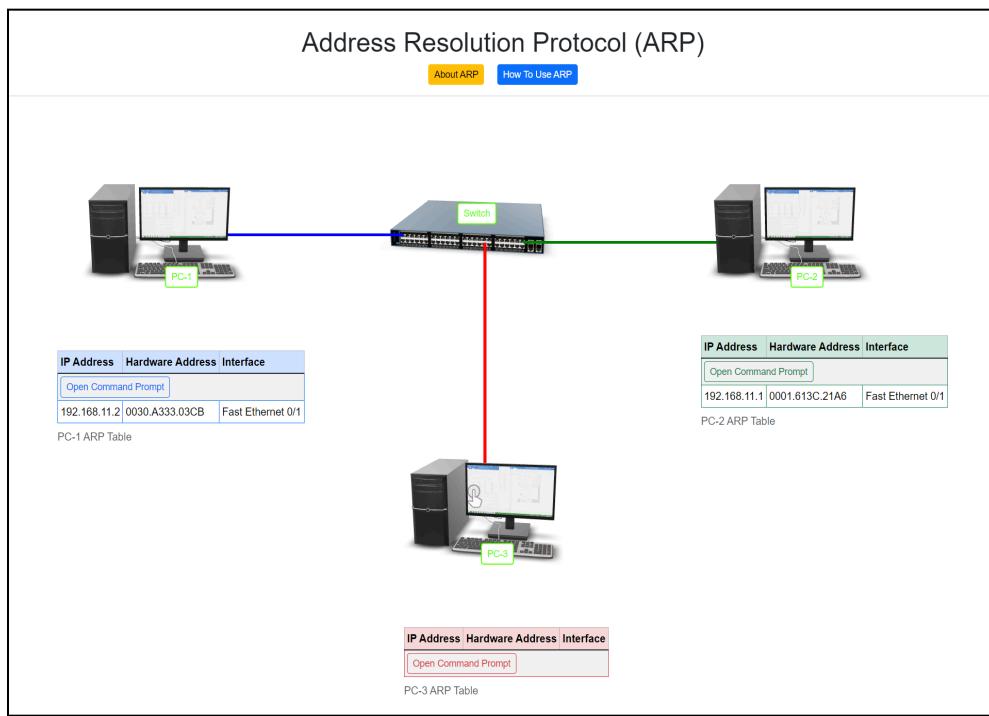


Figure 7.12:-ARP Simulation II

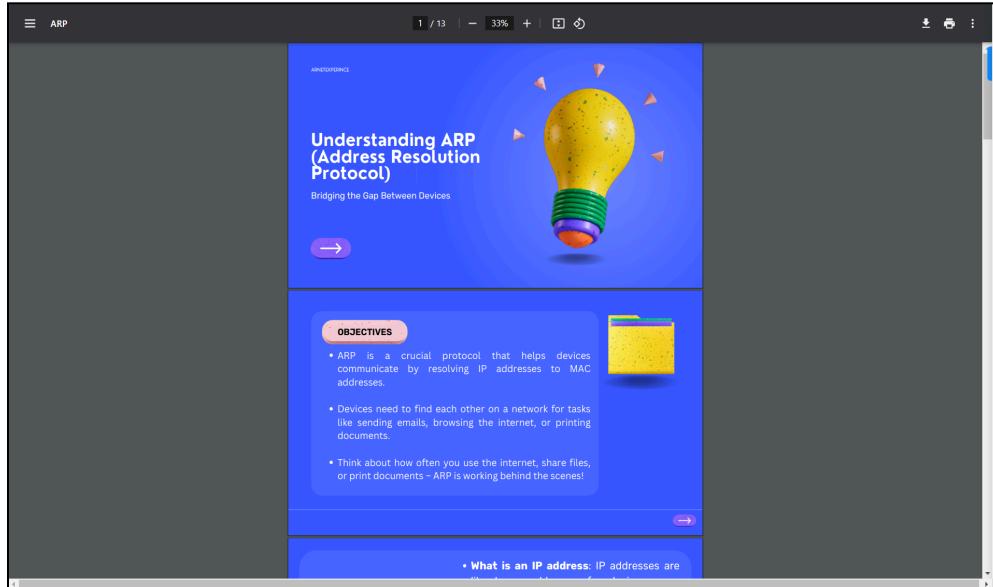


Figure 7.13:- About ARP Page

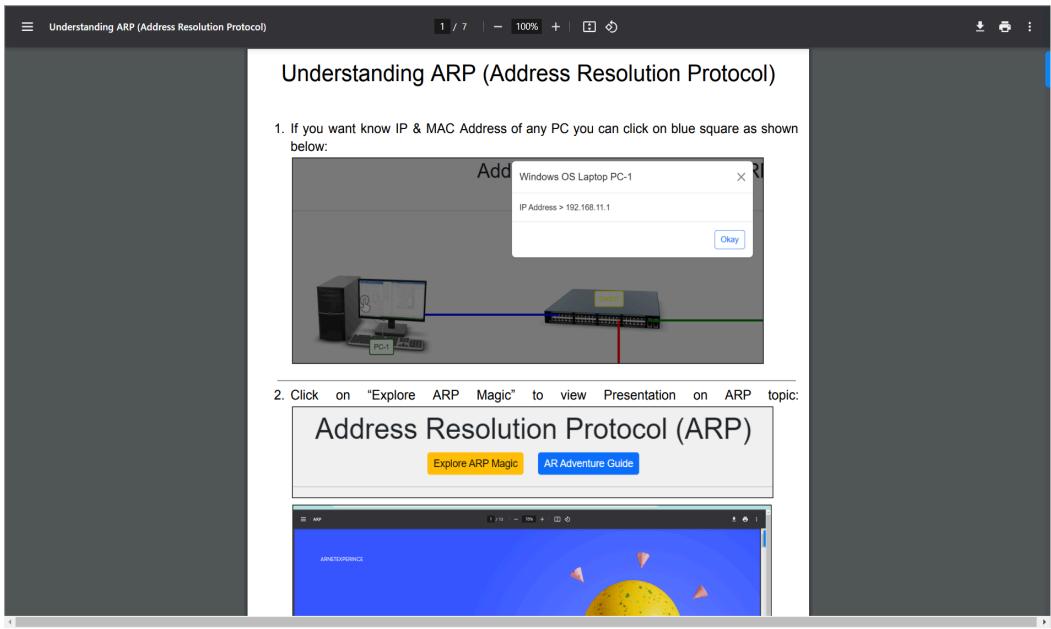


Figure 7.14:- How To Use ARP Page

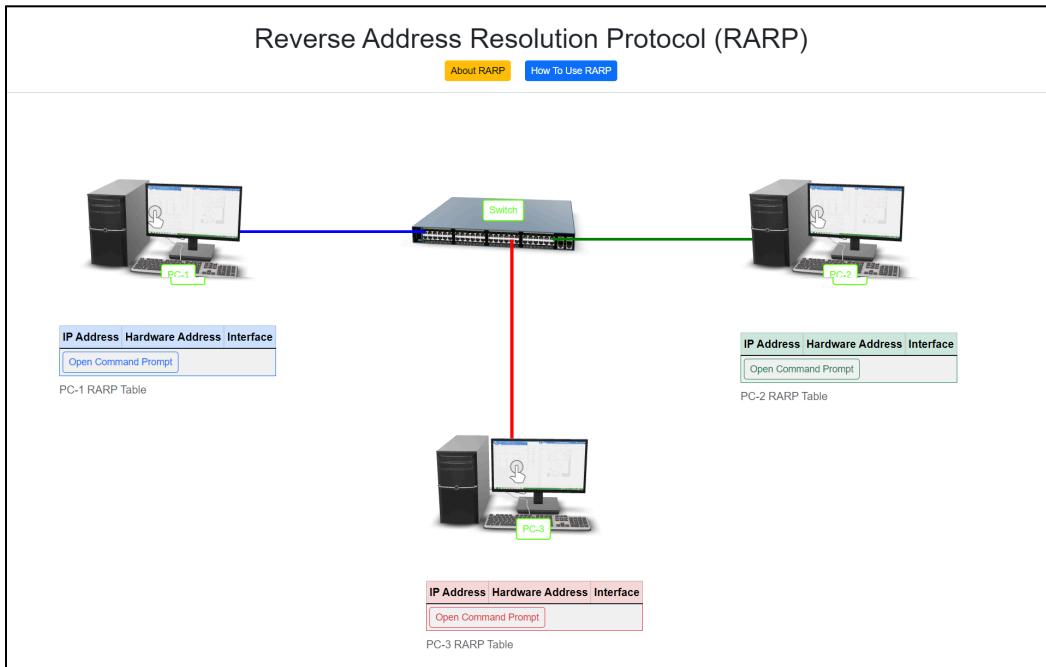


Figure 7.15:- Reverse Address Resolution Protocol (RARP) Page

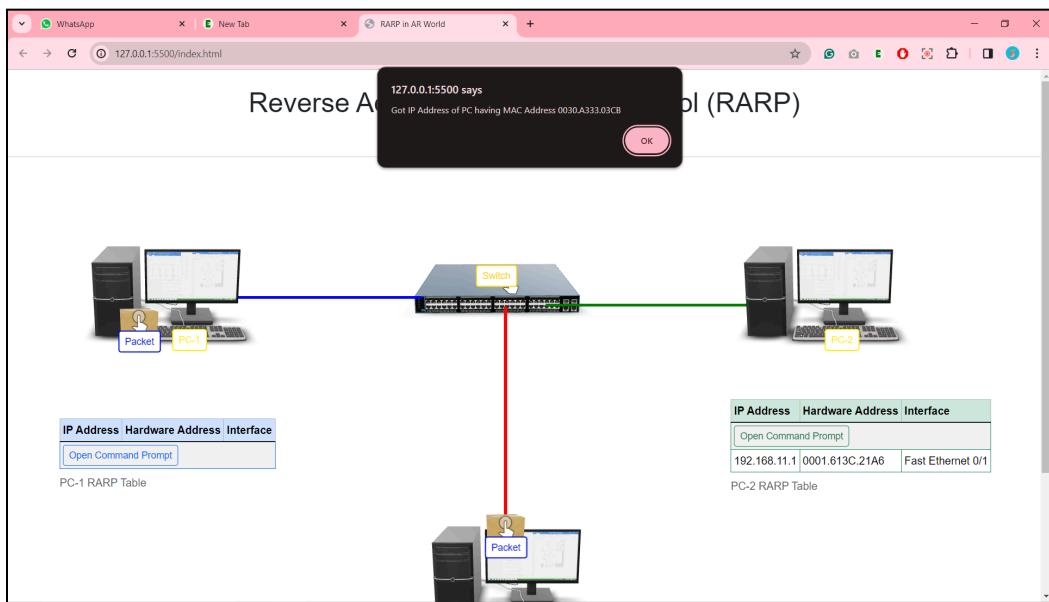


Figure 7.16:- RARP Simulation I

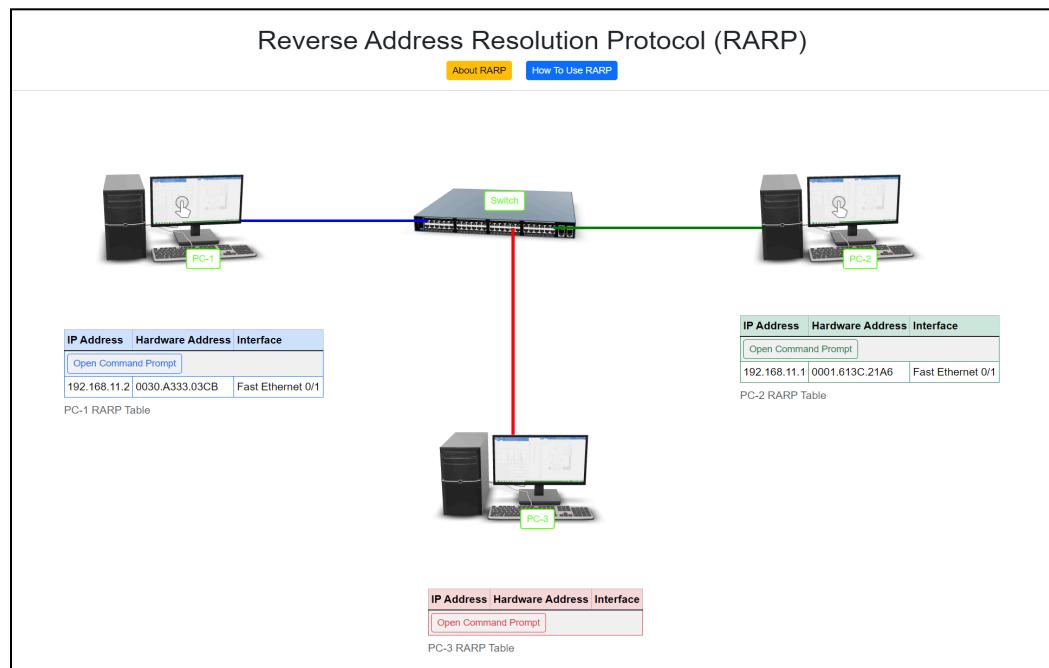


Figure 7.17:- RARP Simulation II

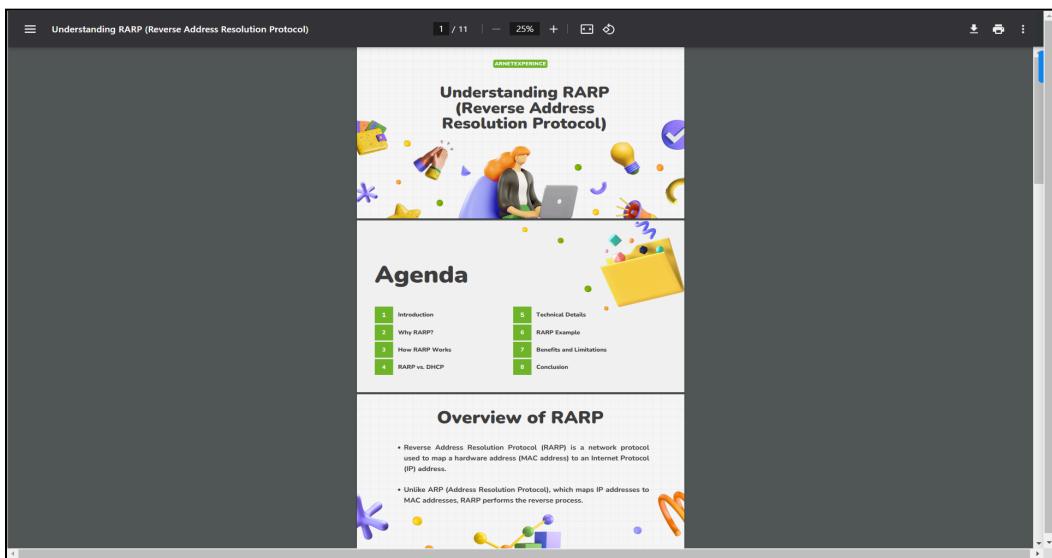


Figure 7.18:- About RARP Page

Chapter 8

Conclusion and Future scope

This application is a developed media to assist students in understanding basic computer networking lessons, with features including, providing learning content such as viewing computer network devices directly through a combination of the real and virtual worlds using Augmented Reality. Computer Networks, Augmented Reality which displays network devices along with concise information. The future scope for augmented reality is limitless. In the future, the primary aim of gamified learning will be to bolster engagement by introducing dynamic gamification elements. This entails the integration of quizzes, challenges, and rewards within the learning process, fostering a sense of competition among students to actively participate and enhance their understanding. Furthermore, a robust progress-tracking system will be in place to monitor individual achievements, providing students with the motivation to consistently strive for improvement in their educational journey. In the future, the resource library's objective is to offer an expansive collection of augmented reality-enhanced learning materials, including textbooks, tutorials, videos, and reference materials, while efficiently categorizing these resources based on various networking topics and skill levels. This approach ensures that students can readily access materials tailored to their specific learning needs and preferences, fostering a highly personalized and immersive educational experience in the realm of computer networking.

References

1. "Augmented Reality for Mobile-Based Computer Network Learning Interactions"
2. Development of interactive learning media in computer network using augmented reality technology
3. "Development and Evaluation of Augmented Reality Learning Content for Pneumatic Flow: Case Study on Brake Operating Unit of Railway Vehicle" (8 May 2023)
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6. "Fighting Pandemics With Augmented Reality and Smart Sensing-Based Social Distancing" (14 December 2022):
7. "Evaluation of an Augmented Reality for Historical Context Experiences of 3D Restored Court Paintings" (25 April 2023)
8. Augmented Reality Implementation for Device Recognition Learning Computer Network

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