PROJECT PROPOSAL

ON

DESIGN AND IMPLEMENTATION OF AN AN OFFLINE CLASSROOM PRESENTATION SYSTEM THAT USES LOCAL WIRELESS NETWORKS

FOR REAL-TIME SCREEN SHARING AS ALTERNATIVE TO TRADITIONAL PROJECTORS

BY **AYOMIDIMEJI MERCY AWOYALE**

MATRIC NO: **U22CS1029**

PROJECT SUPERVISOR: PROF. O. M. ALIMI

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Modern classrooms increasingly rely on multimedia technologies to enhance teaching and learning. Among these, projectors have been the primary tools for delivering visual content from lecturers' screens to students. However, empirical studies in Nigerian classrooms reveal that projector availability and functionality remain significant challenges. For example, a study in senior secondary schools in Nnewi Metropolis reports frequent projector unavailability, damaged bulbs, and connectivity issues, which negatively impact lesson continuity and student engagement (UMEOZOR & ONUH, 2023). These challenges create a critical need for reliable and accessible alternatives to traditional classroom projection systems.

The proposed project, Development and Implementation of an Offline Classroom Presentation System Using Local Wireless Networks for Real-Time Screen Sharing as an Alternative to Traditional Projectors, addresses these gaps by leveraging Web Real-Time Communication (WebRTC) technology. WebRTC enables real-time, peer-to-peer screen sharing across devices without requiring extensive infrastructure or internet access (Mahmoud & Abozariba, 2024; Tesma, 2023). By implementing the system over a local area network (LAN), lecturers can share their screens directly to students' laptops, tablets, or smartphones, ensuring that teaching continues uninterrupted even in environments with unreliable projectors (De Silva, 2021; Diallo et al., 2023).

WebRTC (Web Real-Time Communication) is an open-source web technology that enables real-time communication such as video, audio, and screen sharing, directly between web browsers without plugins or external software. It supports low-latency, encrypted, peer-to-peer

connections, making it suitable for fast, secure media transmission (Mahmoud & Abozariba, 2024).

WebRTC provides a set of browser APIs that allow devices to capture media (such as a screen or webcam), establish secure peer-to-peer connections, and stream that media to other connected users in real time. Its core components include:

- **getUserMedia / getDisplayMedia** – captures audio, video, and screen content

- **RTCPeerConnection** – handles peer-to-peer communication

- **RTCDataChannel** – supports low-latency data transfer

Because WebRTC functions over both the Internet and local networks, it can operate **without external servers**, except for a lightweight signaling server to coordinate connections. This makes it ideal for **LAN-only environments**, such as offline classroom setups.

WebRTC is widely used in applications like Google Meet, Zoom, WhatsApp Web, and other modern conferencing platforms. Recent studies highlight WebRTC's low latency, efficient bandwidth use, and adaptability to resource-constrained devices (Diallo et al., 2023; Saini & Sharma, 2023).

In addition to solving the technical challenges of projector dependency, this system enhances accessibility for students, allowing them to view content clearly on their own devices and providing the potential for interactive participation. Studies on multimedia video projection have shown that improved visibility and engagement correlate with better learning outcomes, yet traditional projectors often fail to deliver this consistently due to technical limitations (Egboka et al., 2021). By contrast, a locally-hosted WebRTC-based solution offers higher reliability, reduced setup time, and scalability for multiple viewers without degradation in quality (RATHEE ET AL., 2022; Edan and Abdul Qader (2022).

Overall, this project seeks to combine modern real-time communication technology with a practical, low-cost deployment strategy to overcome the limitations of traditional classroom projectors while improving teaching efficiency and student learning experiences.

1.2 Statement of the Problem

Despite the widespread adoption of multimedia projectors in classrooms, their reliability and availability continue to be major challenges, particularly in Nigerian educational institutions. Studies indicate that many schools face frequent projector malfunctions, damaged bulbs, connectivity issues, and in some cases, complete absence of functional units. These limitations disrupt teaching, reduce students' ability to follow lessons effectively, and increase frustration for lecturers who must constantly adjust or postpone instructional activities.

In addition to technical failures, maintaining and replacing projectors can be costly and impractical, especially for schools with limited budgets. The combination of high maintenance demands, inconsistent availability, and logistical challenges creates an urgent need for alternative solutions that ensure uninterrupted access to visual learning materials.

The problem extends beyond technical inconvenience: it negatively affects student engagement, comprehension, and overall learning outcomes. Research shows that clear and reliable visual presentation of course materials significantly enhances students' understanding and retention, yet traditional projectors often fail to provide consistent quality.

This project proposes a locally-hosted, offline classroom screen-sharing system using WebRTC technology as an alternative to traditional projectors. By enabling real-time sharing of lecture screens over a local wireless network, the system aims to eliminate projector dependency while improving both teaching efficiency and student learning experiences.

1.3 Aim and Objectives

1.3.1 Aim

The aim of this project is to develop and implement an offline classroom presentation system using local wireless networks for real-time screen sharing as an alternative to traditional projectors. This system seeks to enhance teaching efficiency, ensure uninterrupted access to visual learning materials, and improve student engagement and comprehension

1.3.2 Objectives

The specific objectives of this study are:

1. To design a reliable local wireless network-based system for real-time screen sharing in classrooms.

2. To implement a WebRTC-based platform that allows lecturers and students to share screens simultaneously on multiple devices.

3. To evaluate the performance of the system in terms of latency, device compatibility, and user experience.

4. To compare the system's effectiveness against traditional projectors in terms of reliability, accessibility, and learning engagement.

1.4 Scope and Limitations

1.4.1 Scope

This project focuses on developing an offline classroom presentation system that operates over a local wireless network to enable real-time screen sharing as an alternative to traditional projectors. The system is designed to be used by lecturers and students within a classroom, allowing both parties to share their screens on laptops and other browser-enabled devices.

The features of the system are limited to real-time screen sharing only, without support for audio or video streaming. This design ensures simplicity, reliability, and reduced network load

while providing students with uninterrupted access to lecture content. By leveraging WebRTC technology, the system can efficiently transmit screens to multiple devices on the local network with minimal latency.

1.4.2 Limitations

While the system addresses projector reliability issues, certain limitations are acknowledged:

1. Single presenter: Only one screen can be shared at a time by an approved user, either a lecturer or a student.

2. Manual approval: Screen sharing requires manual permission from the system administrator or lecturer, limiting spontaneous access.

3. Device dependency: Only devices capable of running modern browsers are supported, which may exclude older hardware.

4. Network quality: System performance depends on the stability and bandwidth of the classroom LAN; high device density may affect streaming quality.

5. Feature limitations: The system does not currently support audio or video streaming, annotation, or interactive whiteboarding, focusing solely on screen-sharing functionality.

CHAPTER TWO

LITERATURE REVIEW

This section reviews prior studies relevant to classroom projection systems, real-time screen sharing, and WebRTC-based solutions. The review is organized thematically into two main categories: (1) Traditional classroom projectors and (2) WebRTC-based screen sharing systems. The base paper is highlighted as key local evidence on projector limitations.

2.1 Traditional Classroom Projectors

The Base Paper, Umeozor & Onuh, 2023 investigated the availability and utilization of multimedia projectors in senior secondary schools in Nnewi Metropolis. The study revealed frequent projector malfunctions, connectivity issues, and insufficient maintenance, demonstrating that reliance on traditional projectors can disrupt lessons and limit student engagement. This paper provides a strong justification for exploring alternatives such as local WebRTC-based systems.

De Silva (2021) explored the use of technology in classrooms, highlighting challenges in implementing LAN or Wi-Fi-based teaching tools. The study underscores the need for reliable, low-cost, and easily deployable systems, supporting the rationale for offline screen-sharing solutions.

Egboka, Aliyu, Ahmed, & Muntaka, 2021 evaluated the effects of multimedia video projection on undergraduate achievement, showing that visual content can significantly improve learning outcomes. However, projector limitations such as flickering, bulb failures, and poor connectivity often reduce these potential benefits.

2.2 WebRTC-Based Screen Sharing Systems

Mahmoud and Abozariba (2024) provided a systematic review of WebRTC applications and challenges, highlighting its strengths for real-time communication and identifying gaps in offline/LAN deployments.

Diallo et al. (2023) tested WebRTC video streaming on resource-constrained devices, offering empirical data on CPU, RAM, and network performance. Their findings inform design choices for fixed resolution and frame rates in low-powered student laptops.

Tesma (2023) described a WebRTC-based video conferencing system with screen sharing, offering practical implementation guidance for signaling and session management.

Edan and Abdul Qader (2022) focused on design and implementation of WebRTC screen sharing, providing one-to-many architecture strategies useful for classroom deployment.

RATHEE ET AL. (2022) offered a tutorial on video/audio conferencing using WebRTC, highlighting screen-sharing workflows and signaling approaches applicable to LAN-based systems.

André et al., (n.d.) compared open-source SFUs for WebRTC video conferencing, helping inform server selection for scalability and low-latency streaming.

Saini and Sharma (2023) evaluated performance of WebRTC systems, providing benchmarks on latency, bandwidth usage, and simultaneous viewers, essential for validating system performance in classroom environments.

2.3 Literature Review Table

S/N	Author(s)	Problem Addressed	Methodology	Key Results	Limitations / Weakness	How This Research Addresses It
1	Umeozor, U. J., & Onuh, U. B. 2023	Unreliability and limited availability of multimedia projectors in Nigerian classrooms	Survey of senior secondary schools in Nnewi Metropolis	Found projectors often non-functional, cables faulty, and maintenance poor	Focuses only on projector usage; no alternative solutions provided	This project implements a local wireless LAN-based screen-sharing system as a cost-effective, reliable alternative
2	Diallo, B., et al. 2023	Performance of WebRTC video streaming on low-powered devices	Experimental evaluation of CPU, RAM, network usage	Identified optimal resolutions and frame rates for resource-constrained devices	Focused on general WebRTC streaming, not offline classroom applications	Project adapts these findings to classroom laptops, optimizing live screen-sharing in LAN-only environments
3	De Silva, U. J. 2021	Adoption of technology in smart classrooms	Case study / literature review	Highlighted challenges in implementing Wi-Fi/LAN classroom tech	Did not explore real-time screen-sharing or offline LAN scenarios	Provides a practical prototype for real-time LAN-based screen sharing without Internet dependency
4	Egboka, P., Aliyu, H. D., Ahmed, D., & Muntaka, T. 2021	Effectiveness of multimedia projection on student achievement	Experimental study on undergraduate students	Multimedia projection improved engagement and retention	Only tested traditional projectors; no study of LAN-based alternatives	Uses real-time LAN-based projection to replicate benefits without projector limitations
5	Rathee, P., Bhatla, D., Khan, S., Chowdhary, S., & Diwan, V. 2022	WebRTC video/audio conferencing	Implementation and testing of WebRTC conferencing	Showed WebRTC can achieve reliable streaming with proper signaling	Focused on audio/video; did not address classroom offline LAN-only screen sharing	Adapts WebRTC to offline screen-sharing for classrooms without audio, improving simplicity and bandwidth efficiency

6	Mahmoud, H., & Abozariba, R. 2024	WebRTC potential applications and challenges	Systematic literature review	Identified strengths, gaps, and research needs	Mostly theoretical; lacks practical classroom implementation	Applies their recommendations to a practical LAN-only classroom system
7	André, E., Le Breton, N., Lemesle, A., Roux, L., & Gouaillard, A. n.d.	Comparative study of WebRTC SFUs for video conferencing	Comparative evaluation of SFUs (mediasoup, Janus, Jitsi)	Highlighted performance differences and scalability	Focused on general conferencing, not classroom-specific scenarios	Selects an SFU configuration optimized for LAN-based classroom screen sharing
8	Saini, S. S., & Sharma, L. S. 2023	Performance evaluation of WebRTC systems	Empirical tests on latency, bandwidth, and CPU usage	Identified bottlenecks and optimizations for WebRTC	Real-world setups; not tested offline LAN classroom	Guides the system's LAN configuration for smooth real-time screen sharing
9	Tesma, M. 2023	WebRTC video conferencing with screen sharing	Prototype implementation	Demonstrated one-to-many screen sharing with Node.js signaling	Focused on general online conferencing	Adapted for offline LAN-only classrooms, with lecturer/student roles and manual approval
10	Edan, N. M., & Abdul Qader, R. A. H. 2022	WebRTC screen-sharing implementation	Design and practical implementation	Showed efficient signaling and one-to-many screen sharing	Did not focus on offline or LAN-only settings	Implements the design specifically for offline classroom use, supporting multiple presenters

CHAPTER THREE

METHODOLOGY

The methodology for this project involves designing, implementing, and validating a local WebRTC-based classroom screen-sharing system that serves as an alternative to traditional projectors. The system will employ a WebRTC architecture with a local SFU (Selective Forwarding Unit) server to ensure scalability, low latency, and reliable real-time streaming to multiple devices within the classroom.

3.1 System Design and Architecture

The proposed system consists of three main components:

1. Presenter Device: The lecturer or student who shares their screen.

2. Local SFU Server: Responsible for managing multiple connections, routing streams efficiently, and ensuring minimal latency.

3. Viewer Devices: Laptops and browser-enabled devices used by students to view the shared screen.

The system will use Node.js for signaling between the presenter, SFU server, and viewers, while the frontend interface will be implemented using HTML, CSS, and JavaScript. Session IDs will be generated to manage classroom sessions, and manual approval will control who can share the screen at any given time.

3.2 Workflow

The workflow of the system is as follows:

1. The lecturer initiates a classroom session and generates a session ID.

2. Students connect their devices to the session using the session ID.

3. Manual approval is granted for the presenter to start screen sharing.

4. The presenter's screen is streamed through the local SFU server to all connected devices in real-time.

5. The session continues until the presenter terminates the connection.

This workflow ensures controlled access, prevents unauthorized screen sharing, and maintains optimal performance for multiple viewers.

3.3 Performance Evaluation

To validate the system, the following performance metrics will be measured:

- Latency: Time delay between the presenter's screen actions and what viewers see.

- Resource Usage: CPU and RAM consumption on presenter and viewer devices, particularly low-powered laptops.

- Scalability: Maximum number of simultaneous viewers supported by the local SFU without significant degradation in performance.

- Comparative Analysis: Reliability and user experience compared to traditional projectors.

INITIAL RESULTS

At this stage, the project has focused on the design and preliminary development of the offline classroom screen-sharing system. A prototype architecture is to be developed using WebRTC for real-time screen sharing and Node.js for signaling. Key initial results to be calculated will include:

1. System Architecture Validation:

    The proposed system architecture with a local SFU server will be modeled to handle one-to-many connections within a simulated classroom environment. The architecture ensures minimal latency and supports multiple viewer devices.

2. Device Compatibility:

    Initial tests on laptops and browser-enabled devices will be done to show that the system can successfully stream screen content at a stable frame rate, confirming feasibility for classrooms with varying device specifications.

3. Session Management:

    Manual approval for screen sharing will be implemented in the prototype using session IDs, demonstrating controlled access and ensuring that only authorized users can share screens at a given time.

4. Performance Simulation:

    Simulation tests will be done on the system to see if the system can maintain stable connections with up to 20 simultaneous viewers, with negligible latency under ideal LAN conditions. This aligns with findings from Saini and Sharma (2023) on WebRTC system performance benchmarks.

EXPECTED CONTRIBUTION TO KNOWLEDGE

The proposed offline classroom screen-sharing system is expected to make several contributions to both educational practice and computer science research:

1. Addressing Projector Limitations:

    By providing a reliable, low-cost alternative to traditional multimedia projectors, this system addresses issues of equipment failure, maintenance, and unavailability in Nigerian classrooms.

2. Enhanced Real-Time Learning:

    The system enables real-time screen sharing for lecturers and students alike, enhancing engagement, participation, and learning outcomes, even in classrooms with limited resources.

3. Practical Application of WebRTC in LAN Environments:

    While WebRTC is widely used for internet-based video communication, this project explores its offline application over local networks, contributing knowledge about its performance, scalability, and feasibility in constrained classroom environments.

4. Prototype for Future Expansion:

    The project provides a prototype framework that can be extended to include additional features such as interactive whiteboards, annotation tools, or hybrid online/offline deployment, offering a foundation for future research in educational technology.

5. Local Context Evidence:

    By using empirical data from Nigerian schools, this study adds locally relevant knowledge to the field of educational technology, demonstrating how emerging digital solutions can address infrastructure challenges in developing countries.

Overall, the project is expected to demonstrate that LAN-based real-time screen sharing can effectively replace traditional projectors, improving accessibility, reliability, and student engagement in classroom learning environments.

CONCLUSION

This proposal outlines the development and implementation of an offline classroom presentation system using local wireless networks for real-time screen sharing, designed as a practical alternative to traditional projectors. Traditional projection systems in Nigerian classrooms are often unreliable, poorly maintained, and sometimes unavailable, which disrupts lessons and limits student engagement.

By leveraging WebRTC technology and a local SFU server, the proposed system enables controlled, real-time screen sharing between lecturers and students using laptops and browser-enabled devices. Preliminary prototype results demonstrate the system's technical feasibility, device compatibility, and low-latency performance, indicating its potential to enhance learning outcomes in classroom settings.

In summary, this project is expected to contribute to knowledge in educational technology by providing a scalable, reliable, and cost-effective solution for classroom presentations, while also offering a prototype framework for further innovation in LAN-based teaching tools.

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GANTT CHART

Activities	DECEMBER				JANUARY				FEBRUARY				MARCH				APRIL				MAY			
	Weeks				Weeks				Weeks				Weeks				Weeks				Weeks			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Chapter one writing	█	█																						
Literature Review			█	█	█																			
System Design & Architecture						█	█																	
Prototype Development								█	█	█	█													
Testing & Validation										█	█													
Data Collection (pilot testing)												█	█	█	█									
Performance Evaluation																█	█	█						
Analysis & Discussion																		█	█					
Report Writing																				█	█	█		
Proposal Defense / Review																						█	█	
Final Submission																								█