

# IoT Based Full Range Audio System with Gesture Control.

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**Abstract-** The IoT-based full-range audio system with gesture control is a smart audio system that allows users to control music using hand gestures without physical touch. An ESP32 microcontroller works as the main controller, while an APDS9960 gesture sensor detects hand movements such as up, down, left, right, and near to perform functions like play/pause, next track, previous track, and volume control. The audio signal is processed using a 3-way active crossover and amplified by TPA3116D2 class-D amplifiers to drive a subwoofer, midrange speaker, and tweeter, producing clear full-range sound. The system is powered using a 12-0-12 transformer and voltage regulation circuits. This project combines IoT technology, gesture-based control, and high-quality audio output to create a modern and user-friendly sound system.

**Keywords –** Faculty Development Programmes, Age Differences, Professional Development, Higher Education, One-Way ANOVA, Life-Cycle Model.

## I. INTRODUCTION

Audio systems are widely used for entertainment in homes, vehicles, and public spaces. Traditional audio systems require physical buttons or remote controls to operate, which may be inconvenient at times. With the advancement of IoT and sensor technology, it is possible to control devices using simple hand gestures without touching them.

The IoT-based full-range audio system with gesture control is designed to provide a modern and interactive way of controlling music. In this system, an ESP32 microcontroller acts as the main controller, while an APDS9960 gesture sensor detects hand movements. These gestures are used to perform functions such as play/pause, next track, previous track, and volume control.

The system uses a 3-way active crossover and class-D amplifiers to distribute audio signals to a subwoofer, midrange speaker, and tweeter, producing clear and balanced sound across different frequency ranges. By combining gesture-based control, IoT capability, and high-quality audio components, this project demonstrates an innovative and user-friendly audio solution for modern smart environments.

### System Overview

The proposed IoT-based full-range audio system with gesture control is designed to provide high-quality sound with a convenient touch less control interface. The system integrates hardware components such as a gesture sensor, microcontroller, audio decoder, amplifiers, and speakers to perform audio control and playback functions.

The ESP32 microcontroller acts as the central controller of the system. It receives gesture input from the APDS9960 gesture

sensor through I2C communication. Based on the detected gesture, the ESP32 sends control signals to the audio decoder using transistor switching circuits. These signals perform actions such as play/pause, next track, previous track, and volume adjustment.

The audio signal from the decoder is passed through a 3-way active crossover, which separates the signal into low, mid, and high frequency bands. These signals are then amplified using TPA3116D2 class-D amplifiers and sent to the respective speakers: subwoofer, midrange speaker, and tweeter. This ensures clear and balanced full-range sound output.

The system is powered using a 12-0-12 centre-tapped transformer and a buck converter to provide appropriate voltage levels for both the audio amplifiers and control electronics. Overall, the system combines gesture-based control, IoT capability, and efficient audio amplification to deliver a modern and user-friendly audio experience.

## II. METHODOLOGY

The proposed system is developed by integrating gesture sensing, microcontroller processing, and a multi-speaker audio system. A 12-0-12 center tapped transformer is used to convert AC mains into low-voltage power, which is then regulated to provide 24V for the amplifiers and 5V using a DC buck converter for the ESP32 and gesture sensor. The APDS9960 gesture sensor detects hand movements such as up, down, left, right, and near, and sends this data to the ESP32 microcontroller through I2C communication. The ESP32 processes these gestures and generates control signals that simulate button presses on the audio decoder using transistor switching circuits. The audio signal from the decoder is then passed through a 3-way active crossover, which divides the signal into low, mid, and high frequency bands. These signals

are amplified using TPA3116D2 class-D amplifiers, where the mono amplifier drives the subwoofer and the stereo amplifier powers the midrange speaker and tweeter. Finally, the amplified signals are delivered to the speakers mounted in a ported MDF enclosure, producing clear and balanced full-range audio output while allowing the system to be controlled through simple hand gestures.

### III. RESULTS



#### Advantages

- Touch less Operation – Music can be controlled using hand gestures without touching buttons.
- High Sound Quality – The 3-way audio system provides clear bass, mid, and high frequencies.
- Energy Efficient – Class-D amplifiers use less power and generate less heat.
- User Friendly – Simple gestures control play/pause, next track, and volume.
- Smart Technology – Uses an ESP32 for IoT connectivity and smart control.
- Less Mechanical Damage – No physical buttons means reduced wear and tear.

#### Hardware Components List

IoT Full Range Audio System with Gesture Control - Components List	
1x 12-0-12 Center Tapped 3A Transformer	8x 1k Ohm Resistors
1x TPA3116D2 150W Mono Amplifier	8x BC547 NPN Transistors
1x TPA3116D2 80W x 80W Stereo Amplifier	1x 24V to 5V DC Buck Converter
1x 150W 8-inch Subwoofer	Various Connecting Wires
1x 50W 5-inch Midrange Speaker	1x Soldering Kit
1x 80W 3-inch Tweeter	1x Pack of Solder
1x Ported MDF Subwoofer Enclosure	1x Wooden Component Box
1x ESP32 Microcontroller	1x Electrical Tape
1x APDS9960 Gesture Sensor	1x Double Sided Tape
1x Audio Decoder Module	4.7µF Capacitor

#### Future Scope

Mobile Application Integration via Wi-Fi – A mobile application can be developed to control the audio system wirelessly using Wi-Fi. Users will be able to manage playback, volume, and system settings directly from their smartphones.

- DSP-Based Digital Equalizer – A Digital Signal Processing (DSP) equalizer can be added to improve sound quality by adjusting bass, midrange, and treble frequencies more precisely.
- OLED Display for System Status – An OLED display can be integrated to show information such as track name, volume level, connection status, and gesture detection.
- Advanced Gesture Customization – The system can allow users to assign different gestures for specific functions, making the control system more flexible and personalized.

### IV. CONCLUSION

The IoT-based full-range audio system with gesture control demonstrates an innovative approach to controlling audio devices using touch less technology. By integrating the ESP32 microcontroller, APDS9960 gesture sensor, and high-efficiency class-D amplifiers, the system provides an easy and modern way to control music through simple hand gestures. The use of a 3-way active crossover with subwoofer, midrange, and tweeter ensures clear and balanced sound across different frequency ranges. Overall, the project successfully combines IoT technology, gesture recognition, and high-quality audio output, making it a smart and user-friendly audio system suitable for modern applications

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### **REFERENCE**

1. Gesture recognition using APDS9960 sensor for contactless control systems – IEEE Xplore.
2. IoT-based smart home automation using ESP32 – various IEEE and Springer publications.
3. Design of Class-D audio amplifiers for high-efficiency sound systems – IEEE journals.