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Full Length Article

Smart Voice Light Controlling System

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Abstract
The Smart Voice Controlled Lighting System is an IoT-based home automation project designed to provide intelligent, efficient, and user-friendly control of electrical appliances through voice commands and wireless communication. The system uses the NodeMCU ESP8266 microcontroller as the main controller due to its built-in Wi-Fi capability and compact design. It integrates components such as Bluetooth module, PIR sensor, temperature sensor, relay driver circuits, OLED display, and buzzer to automate lighting and appliance control in smart home environments.The primary objective of the project is to reduce manual operation and improve energy efficiency by enabling users to control lights and fans using voice commands and IoT technology. The PIR sensor detects human presence and automatically switches appliances ON or OFF, while the temperature sensor helps in automatic fan control based on environmental conditions. The OLED display provides real-time system information, and the buzzer gives audio indications during operation.

Keywords
Smart Home Automation, IoT, NodecMCU ESP8266, Voice Control, Smart Lighting, Bluetooth, PIR Sensor, Embedded System, Energy Efficiency, Wireless Communication, Remote Monitoring.

Introduction

With the rapid advancement of technology, smart home automation systems are becoming increasingly popular due to their convenience, energy efficiency, and intelligent control features. Traditional lighting systems require manual operation, which may result in unnecessary power consumption and reduced user comfort. To overcome these limitations, smart lighting systems using Internet of Things (IoT) and voice recognition technologies have been developed to provide automated and efficient control of electrical appliances.

The Smart Voice Controlled Lighting System is an IoT-based automation project that enables users to control lighting appliances through voice commands and wireless communication. The system uses the NodeMCU ESP8266 microcontroller as the main processing unit along with technologies such as Wi-Fi, Bluetooth, sensors, and relay modules for controlling lights and fans. Voice recognition technology allows users to operate the system without physical interaction, making it highly beneficial for elderly and physically challenged individuals.

The proposed system also supports remote monitoring and control through smartphones and internet connectivity. Additional components such as PIR sensors, OLED displays, and temperature sensors improve the overall functionality and energy efficiency of the system. Automatic control based on occupancy and environmental conditions helps reduce unnecessary power consumption and enhances user convenience.

This project demonstrates the practical implementation of embedded systems, IoT, and automation technologies in developing a cost-effective and intelligent lighting solution. The system aims to improve accessibility, flexibility, energy management, and security in modern smart home environments.

Literature Review

Smith, J., et al. developed an IoT-based smart lighting system using NodeMCU ESP8266 and Wi-Fi technology for remote lighting control and improved energy efficiency.

Kumar, R., et al. proposed a voice-controlled home automation system using Arduino and speech recognition technology to provide hands-free appliance control.

Sharma, P., et al. designed a PIR sensor-based automatic lighting system that reduces power consumption through motion detection.

Hassan, A., et al. developed a cloud-based IoT smart lighting system for remote monitoring and real-time appliance control using smartphone applications.

Lee, D., et al. researched wireless communication technologies such as Wi-Fi, Bluetooth, and Zigbee

for smart home automation systems.

Existing System

The existing lighting control systems mainly depend on manual switches and conventional electrical wiring for operating lights and home appliances. These traditional systems require direct human interaction for switching devices ON and OFF, which leads to inconvenience and unnecessary power consumption. In many homes and industries, lights remain turned ON even when not required, resulting in energy wastage and increased electricity costs.

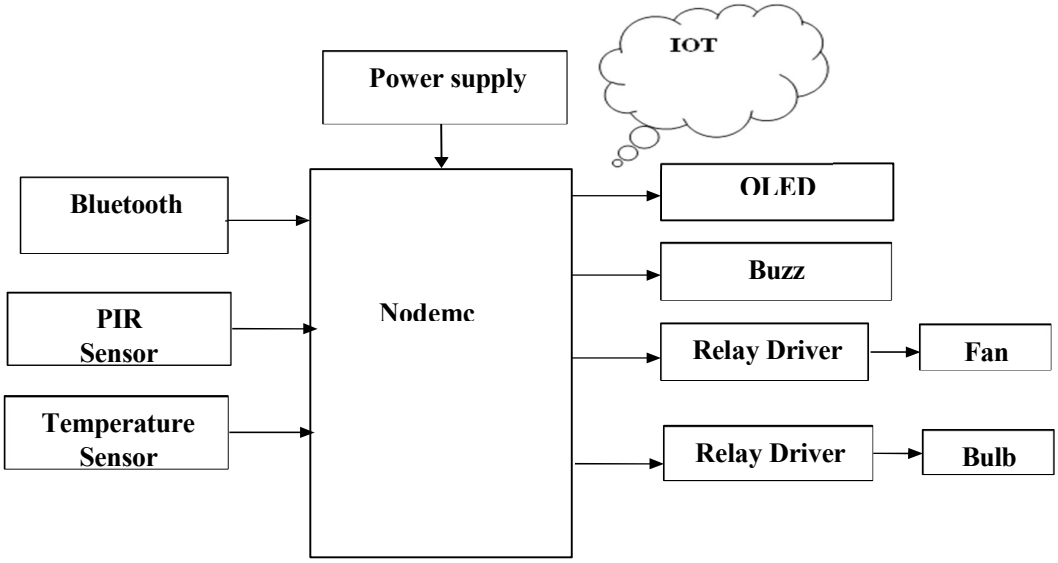
Some existing automation systems use basic wireless technologies such as infrared remote controls or Bluetooth communication. However, these systems have limited operating range, low flexibility, and lack internet connectivity for remote access. Most traditional systems also do not support intelligent features such as voice control, motion detection, or automatic

Proposed System

The proposed system is an IoT-based Smart Voice Controlled Lighting System designed to provide intelligent, automated, and energy-efficient control of home appliances. The system uses the NodeMCU ESP8266 microcontroller as the central processing unit because of its built-in Wi-Fi capability and low power consumption. The system integrates voice recognition technology, wireless communication, and sensors to automate lighting and appliance control.In the proposed system, users can control lights and electrical appliances using voice commands through a smartphone or voice assistant. The NodeMCU receives commands through Wi-Fi or Bluetooth communication and controls the connected appliances using relay modules. A PIR sensor is used to detect human presence and automatically switch lights ON or OFF based on motion detection. Temperature sensors can also be integrated for automatic fan control according to environmental conditions.

The OLED display is used to show real-time system status and sensor readings, while the buzzer provides audio indications during operation. The system supports remote monitoring and control through internet connectivity, allowing users to operate appliances from anywhere using mobile devices.

Block Diagram



Working Principle:

The Smart Voice Controlled Lighting System works on the principle of IoT-based wireless communication and automation using the Node MCU ESP8266 microcontroller. The system receives voice commands from the user through a smartphone application or voice assistant using Wi-Fi or Bluetooth communication. These commands are processed by the NodeMCU controller, which controls the connected electrical appliances through relay modules.When a user gives a voice command such as turning a light ON or OFF, the command is transmitted wirelessly to the NodeMCU. The controller analyzes the received command and activates the corresponding relay circuit to operate the appliance. The relay acts as an electronic switch that controls the power supply to the connected devices.The PIR sensor continuously monitors human movement in the room. When motion is detected, the sensor sends a signal to the microcontroller, which automatically turns ON the

lights. If no motion is detected for a certain period, the system automatically switches OFF the lights to save electrical energy.The OLED display shows the current status of the appliances and sensor readings in real time. The buzzer provides audio indications during system operation. The entire system can also be monitored and controlled remotely through internet connectivity, enabling users to operate appliances from anywhere using a smartphone.Thus, the system combines voice recognition, wireless communication, sensors, and automation technologies to provide intelligent, convenient, and energy-efficient lighting control.
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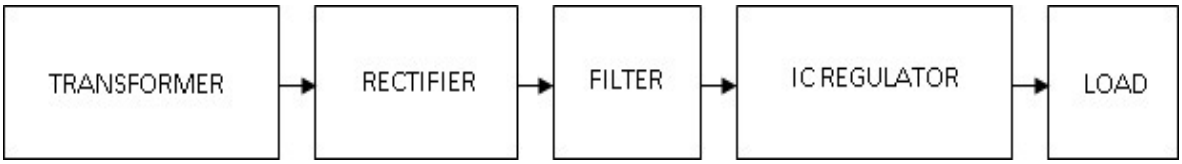
Hardware Implementation :

- Node MCU ESP8266
- Relay Module
- Bluetooth Module
- PIR Sensor
- OLED Display
- Buzzer
- Power Supply Unit
- Connecting Wires
- PCB (Printed Circuit Board)
- LED Lights
- Temperature Sensor

Power Supply:
The power supply section is the section which provide +5V for the components to work. IC LM7805 is used for providing a constant power of +5V.The ac voltage, typically 220V, is connected to a transformer, which steps down that ac voltage down to the level of the desired dc output. This resulting dc voltage usually has some ripple or ac voltage variation.



Bridge Rectifier:
When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B the positive potential at point A will forward bias D3 and reverse bias D4.

MICROCONTROLLER:
The NodeMCU ESP8266 is the main microcontroller used in the Smart Voice Controlled Lighting System. It is an open-source IoT development board based on the ESP8266 Wi-Fi module. The NodeMCU contains a built-in microprocessor, Wi-Fi capability, GPIO pins, memory, and communication interfaces required for embedded and IoT applications.In this project, the NodeMCU acts as the central controlling unit. It receives voice commands from the smartphone through Wi-Fi or Bluetooth communication and processes them to control electrical appliances. The controller activates relay modules to switch lights and fans ON or OFF automatically.

OLED Display:
An OLED display have the following advantages over an LCD display:
>Improved image quality - better contrast, higher brightness, fuller viewing angle, a wider colour range and much faster refresh rates.
>Lower power consumption.
>Simpler design that enables ultra-thin, flexible foldable and transparent displays.
Better durability - OLEDs are very durable and can operate in a broader temperature range.

Bluetooth Module :
HC-05 Bluetooth Module is a wireless communication module used for short-range data transmission between electronic devices. It is commonly used in embedded systems and IoT projects for wireless control and communication.
In the Smart Voice Controlled Lighting System, the HC-05 module is used to establish communication between the smartphone and the NodeMCU microcontroller. Voice commands given through a mobile application are transmitted wirelessly via Bluetooth to the controller for controlling lights and appliances.

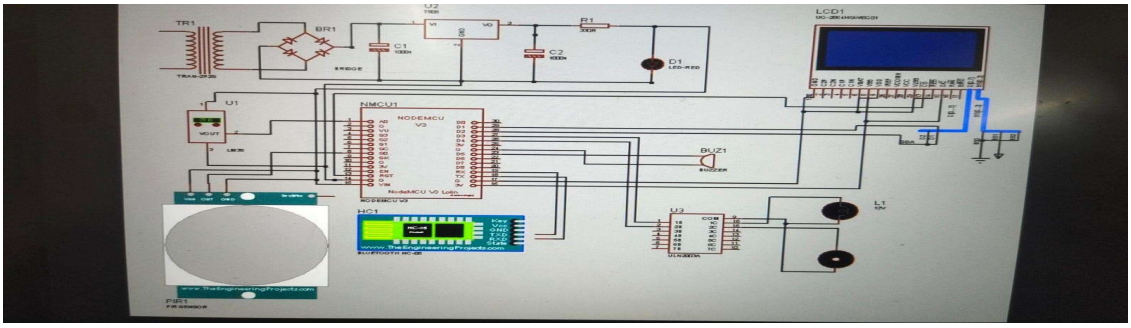
RELAY:
A relay is an electromechanical switch, which perform ON and OFF operations without any human interaction. General representation of double contact relay is shown in fig. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

PIR Sensor:
PIR Sensor is an electronic sensor used to detect human movement by sensing infrared radiation emitted from the human body. It is widely used in security systems, automatic lighting systems, and smart home automation projects.In the Smart Voice Controlled Lighting System, the PIR sensor automatically detects the presence of a person in the room. When motion is detected, the sensor sends a signal to the NodeMCU microcontroller, which automatically turns ON the lights. If no movement is detected for a certain period, the system switches OFF the lights to save electrical energy.

BUZZER:
A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, house hold appliances such as a microwave oven, or game shows.It most commonly consists of a number of switches or sensors connected to a control unit that determines if and which button was pushed or a preset time has lapsed, and usually illuminates a light on the appropriate button or control panel, and sounds a warning in the form of a continuous or intermittent buzzing or beeping sound. Initially this device was based on an electromechanical system which was identical to an electric bell without the metal gong (which makes the ringing noise).

DHT11–Temperature and Humidity Sensor:
The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers.Sensor physical interfacing is realized through a 0.1" pitch 3-pin connector: +5V, GND and DATA. First two pins are power supply and ground and they are used to power the sensor, the third one is the sensor digital output signal

SCHEMATIC DIAGRAM :



RESULTS :

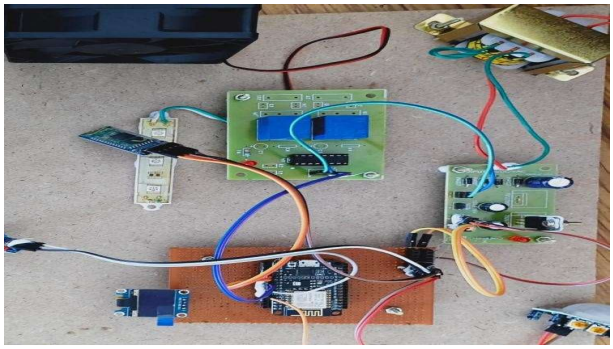


Fig.1: Hardware Kit in OFF Condition

The figure shows the complete hardware setup in the OFF or idle state. In this condition, the power supply is connected but the system is not actively processing or displaying sensor data. The microcontroller remains in an initial standby mode, and no signals are sent to the output devices such as the OLED display, relay, or buzzer.

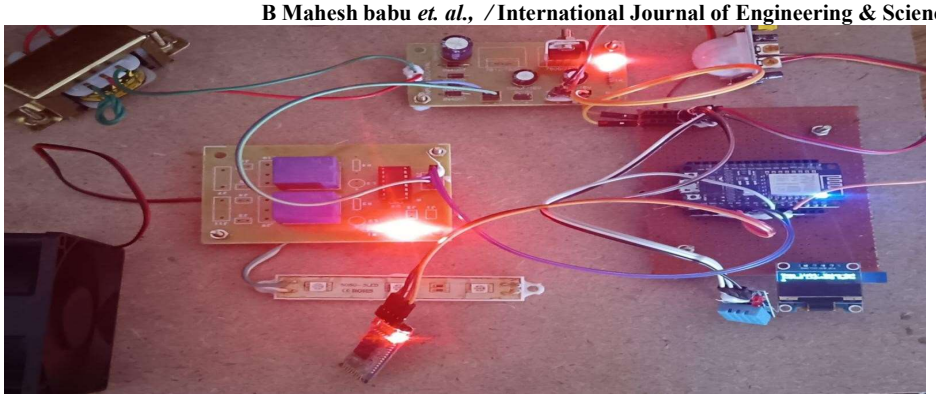


Fig.2 : Hardware Kit in ON Condition

All sensors and components are active. The system begins collecting and processing environmental data. initializes all connected sensors and begins real-time data acquisition. The sensors start detecting environmental rameters. Output devices such as the OLED display and IoT module become active.

Fig.3 : Display shows Temperature

The OLED display in this figure shows real-time temperature and humidity readings obtained from the DHT11 sensor. The values are updated periodically and displayed in a clear, readable format. This helps users understand the surrounding environmental conditions instantly.

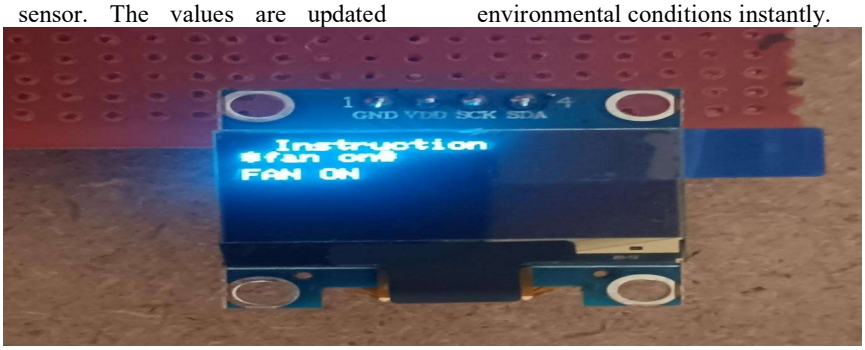


Fig.4: Display shows Fan ON instruction Value

This figure displays the air quality data measured by the MQ135 sensor. The sensor detects harmful gases such as ammonia, carbon dioxide, benzene, and smoke, and outputs corresponding values. Higher readings indicate poor air quality and increased pollution levels.

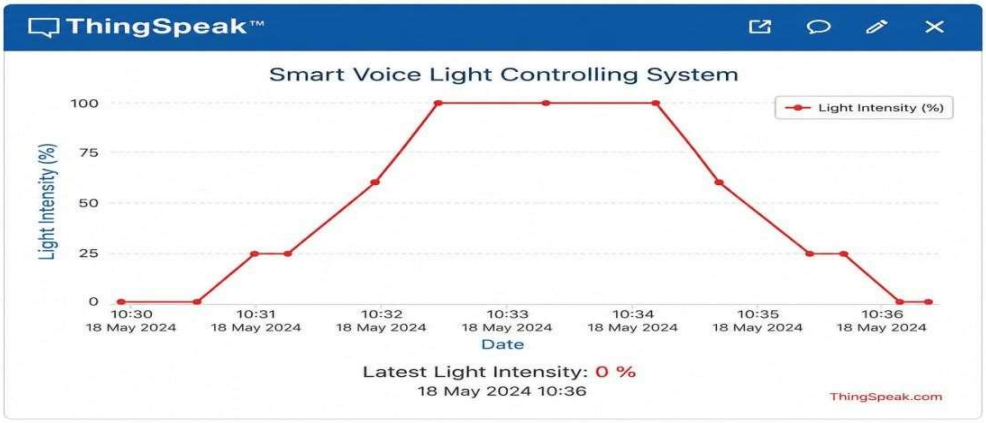


Fig.5 : Displaying sensors data through Thingspeak

The above ThingSpeak graph represents the real-time monitoring and control of a Smart Voice Light Controlling System. The graph shows the variation in light intensity (%) over time based on voice commands given by the user.

CONCLUSION:

The Smart Voice Controlled Lighting System is an efficient and intelligent home automation solution developed using IoT technology, NodeMCU ESP8266, sensors, and wireless communication modules. The system enables users to control lights and appliances through voice commands, Bluetooth, and Wi-Fi connectivity, providing greater convenience and flexibility.

The integration of PIR sensors and DHT11 sensors helps in automatic lighting and environmental monitoring, which reduces unnecessary power consumption and improves energy efficiency. The system also supports remote monitoring and hands-free operation, making it highly useful for smart homes, offices, elderly people, and physically challenged individuals.

Overall, the project demonstrates the practical implementation of embedded systems, IoT, and automation technologies in modern smart environments. The proposed system is cost-effective, reliable, user-friendly, and capable of improving comfort, security, and energy management in daily life

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