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Smart Room Occupancy Detection System

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ABSTRACT: The Smart Room Occupancy Detection System is an intelligent automation framework designed to improve energy efficiency, occupancy monitoring, and smart appliance control using embedded systems and Internet of Things (IoT) technology. The proposed system utilizes ESP32/Raspberry Pi controllers, ultrasonic sensors, IR sensors, temperature sensors, LDR modules, and wireless communication technologies to continuously monitor room occupancy conditions in real time.

The developed system automatically detects human presence inside the room and controls electrical appliances such as lights and fans according to occupancy conditions. When a person enters the room, the occupancy count is incremented and the appliances are activated automatically. Similarly, when the room becomes vacant, the system switches OFF the appliances to minimize unnecessary power consumption. The occupancy details and environmental parameters are displayed through a real-time IoT monitoring dashboard.

The implementation also integrates Raspberry Pi camera modules and computer vision techniques for intelligent human monitoring and occupancy analysis. Experimental results demonstrate that the system provides accurate occupancy detection, reliable appliance control, low power consumption, and efficient real-time monitoring performance. The proposed system is suitable for smart classrooms, offices, conference halls, homes, libraries, and intelligent building automation applications.

KEYWORDS: Green Energy Gazebo, Solar PV, Gazebo, Public charging station, Hybrid inverter, Battery storage, Earthing, Surge protection, IoT monitoring..

I. INTRODUCTION

Rapid development in smart automation and IoT technologies has increased the demand for intelligent occupancy monitoring systems in modern infrastructure. Conventional electrical systems depend on manual switching operations, which often lead to energy wastage and inefficient management of electrical appliances. Smart occupancy detection systems provide an effective solution for automating room monitoring and improving energy efficiency [2].

Occupancy detection technology is widely used in smart classrooms, offices, commercial buildings, and home automation systems. These systems automatically monitor human presence and control appliances according to occupancy conditions. The integration of embedded controllers, sensors, and IoT communication technologies has enabled the development of intelligent and cost-effective automation systems [4,5].

The proposed Smart Room Occupancy Detection System is designed to detect human presence using ultrasonic and IR sensors integrated with ESP32 and Raspberry Pi controllers. The system continuously monitors occupancy conditions and automatically controls electrical appliances such as lights and fans. IoT integration enables remote monitoring through web dashboards and mobile interfaces. The developed system reduces manual effort, improves monitoring accuracy, conserves electrical energy, and enhances automation efficiency. The proposed model is suitable for modern smart infrastructure applications where intelligent monitoring and automation are essential requirements. [1], [12].

II. LITERATURE SURVEY

Rapid growth in distributed solar PV has encouraged small, standalone applications for public utility spaces. Industry outlook reports emphasize the suitability of modular PV for decentralized services in campuses, parks, and transport locations [1], [12].

Several researchers have proposed different occupancy detection and automation techniques using embedded systems and IoT technologies [2,3].

Traditional room automation systems used IR sensors and Microcontroller-based visitor counters for automatic room light control. These systems successfully reduced electricity wastage by activating lighting systems only when occupancy was detected [4].

Recent research introduced Raspberry Pi and OpenCV-based occupancy monitoring systems for intelligent human detection and automated room management. Vision-based occupancy detection improved monitoring accuracy and enabled real-time analysis of room conditions [5].

IoT-enabled smart automation systems using ESP32 controllers, ultrasonic sensors, and wireless communication technologies were developed for real-time environmental monitoring and appliance control. These systems demonstrated efficient energy management and remote monitoring capabilities [6].

Researchers also integrated temperature sensors, LDR modules, and cloud-based monitoring platforms to improve intelligent building automation applications. These systems provided better control, automation flexibility, and environmental monitoring performance [7].

The proposed Smart Room Occupancy Detection System combines occupancy monitoring, automatic appliance control, IoT communication, and environmental sensing within a single intelligent automation platform [8].

III. METHODOLOGY

The proposed Smart Room Occupancy Detection System consists of the following major sections:

A. Power Supply Unit

The system operates using a regulated DC power supply. The AC mains supply is converted into regulated DC voltage required for the ESP32 controller, Raspberry Pi module, sensors, and relay circuits. The regulated power supply ensures stable system operation.

B. ESP32 / Raspberry Pi Controller

The ESP32 and Raspberry Pi modules act as the central processing units of the system. These controllers receive sensor data, process occupancy information, and execute automation operations. The inbuilt Wi-Fi capability supports IoT communication and remote monitoring.

C. Ultrasonic and IR Sensors

Ultrasonic sensors and IR sensors are used for occupancy detection and human movement monitoring. These sensors continuously detect the entry and exit of persons inside the room and update occupancy information accordingly.

D. Temperature Sensor

The temperature sensor monitors environmental conditions inside the room. The measured temperature values can be used for intelligent fan or air-conditioner control.

E. LDR Sensor

The Light Dependent Resistor (LDR) measures room illumination levels. Based on ambient lighting conditions, the controller automatically controls room lights to reduce electricity consumption.

F. Relay Driver Circuit

The relay driver section controls electrical appliances such as lights, fans, and other automation devices according to occupancy conditions and programmed control logic.

G. IoT Monitoring Dashboard : The IoT dashboard provides real-time monitoring of occupancy count, environmental parameters, relay status, and sensor readings using wireless communication technologies.

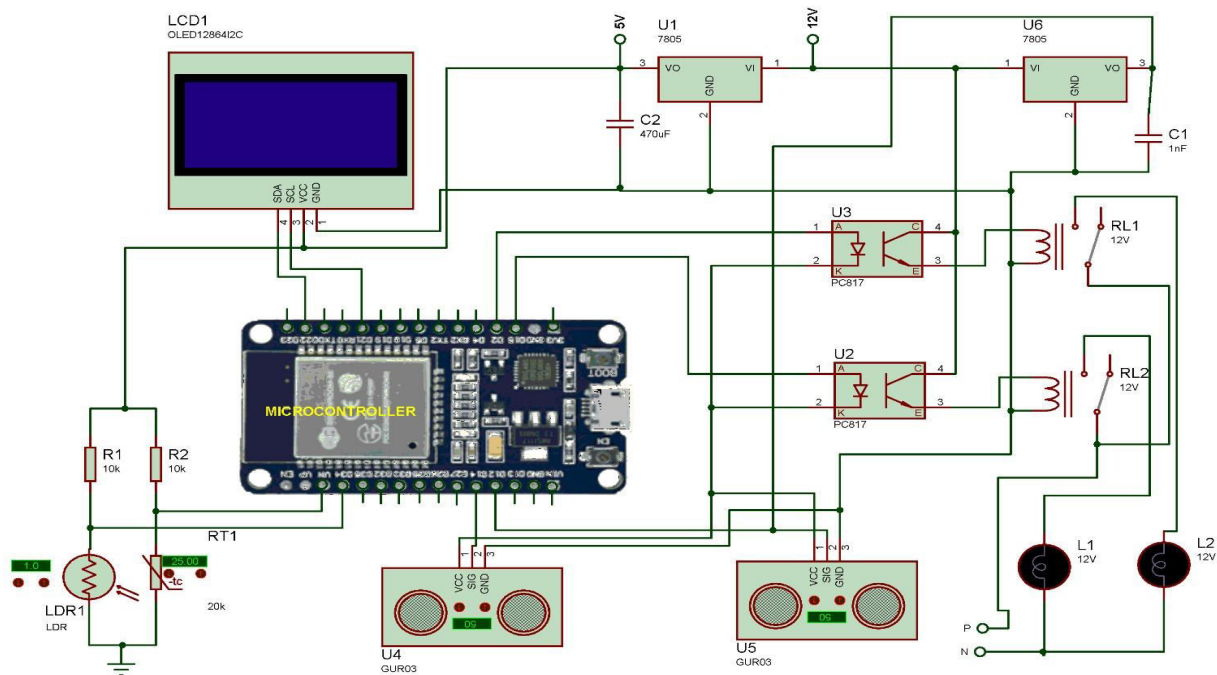


Figure 3.1 Circuit Block Diagram Smart Room Occupancy Detection System

IV. WORKING PRINCIPAL

Initially, the system receives power from the regulated power supply unit. The ESP32 and Raspberry Pi controllers continuously monitor the ultrasonic sensors, IR sensors, temperature sensor, and LDR module. Whenever a person enters the room, the occupancy count increases automatically. The controller processes the sensor signals and activates room appliances such as lights and fans through the relay driver circuit. Similarly, when all occupants leave the room, the appliances are switched OFF automatically. The occupancy information and environmental parameters are displayed on the OLED display and transmitted to the IoT monitoring dashboard through Wi-Fi communication. The Raspberry Pi camera module additionally supports intelligent occupancy monitoring and computer vision-based human detection applications. In addition, piezo sensor modules are used for attendance tracking purposes. The piezo sensors help in detecting student presence and classroom activity. By integrating these sensing modules with the MICROCONTROLLER, the teacher can automatically receive attendance information without manually calling student names in the classroom.

The attendance collected by the system is automatically sent to the registered email ID through the MICROCONTROLLER communication module. This feature reduces the time required for attendance management and improves classroom efficiency.

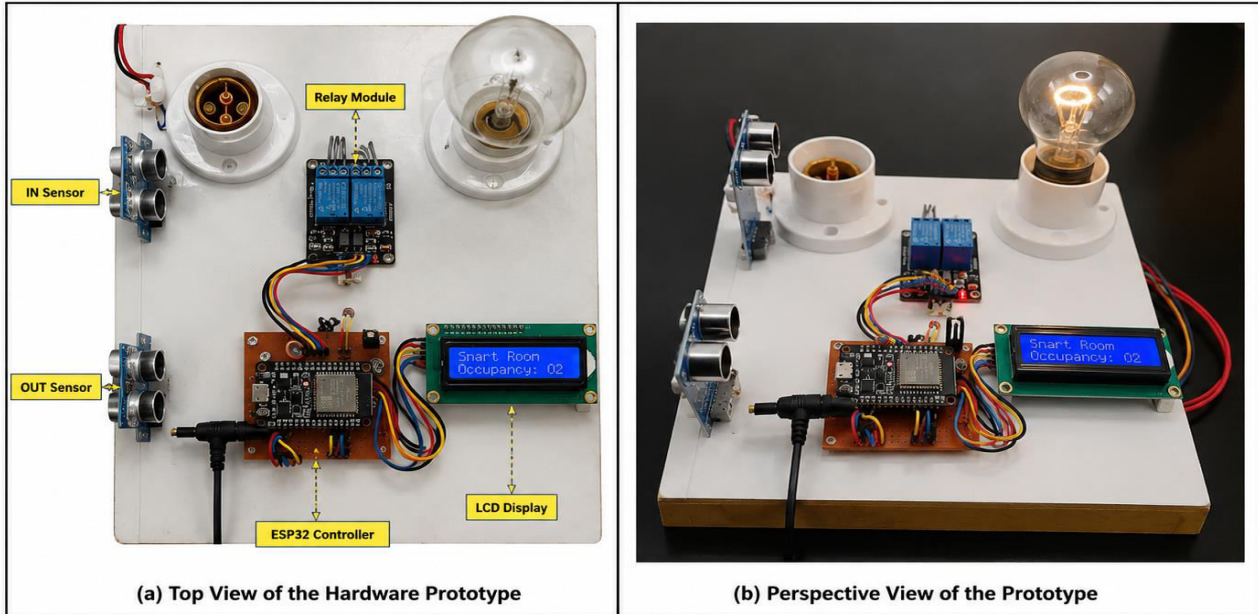


Figure 1. Hardware implementation of the Smart Room Occupancy Detection System: (a) Top view showing all components and connections, (b) Perspective view showing real-time operation of the system.

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|----------------------|-----------------------|
| 1. IN Sensor (Entry) | 5. LCD Display |
| 2. OUT Sensor (Exit) | 6. Bulb Holder (Load) |
| 3. Relay Module | 7. Power Supply |
| 4. ESP32 Controller | |

For intelligent monitoring, OpenCV and Python libraries are installed and configured on the MICROCONTROLLER platform. A camera or sensor module is connected to the MICROCONTROLLER board to perform student counting and monitoring operations. The implemented computer vision algorithm uses OpenCV-based object recognition techniques to identify and count students present in the classroom.

The recognized student information is compared with the stored database inside the MICROCONTROLLER system to determine which students are present. Once the verification process is completed, the attendance records are automatically generated and stored digitally.

The system then sends the attendance details to the registered mail ID configured in the MICROCONTROLLER. Thus, the proposed system provides an automated, reliable, and time-saving solution for classroom attendance management and smart classroom automation. The integration of sensors, computer vision, and IoT communication technologies makes the system efficient, accurate, and suitable for modern educational institutions.

V. EXPERIMENTAL RESULT

The developed Smart Room Occupancy Detection System Classroom Automation and Attendance Tracking System was successfully implemented and tested using IR sensors, occupancy detection modules, GSM communication, Raspberry Pi monitoring, and IoT-based web interface technology. The system effectively monitored classroom occupancy, controlled electrical appliances automatically, and provided real-time attendance and monitoring information.

The experimental results in Figure 5.1. show that the occupancy detector accurately detected the number of persons entering and leaving the classroom. The system continuously updated the person count and displayed the values on the monitoring dashboard. The web-based interface successfully displayed parameters such as the total number of persons, distance measurements from sensors, temperature values, LDR readings, threshold values, and relay status conditions.

During testing, the system automatically switched ON the classroom lights when persons were detected inside the room and switched OFF the lights when the classroom became empty. This demonstrates the energy-saving capability of the smart classroom automation system. The relay modules operated correctly according to occupancy conditions and threshold settings.

The Raspberry Pi-based monitoring system successfully hosted the occupancy detector dashboard using the local IP address. Real-time data transmission and monitoring were achieved through IoT integration. The GSM module and display interface were also capable of sending and showing classroom status information effectively.

The Students Count detection and monitoring process using the Raspberry Pi Sensors worked efficiently for classroom attendance applications. The data can be further integrated with cloud storage and database systems for future smart classroom enhancements.

5.1. Observed Results

- Accurate person counting using IR sensors.
- Automatic light control based on occupancy.
- Real-time monitoring through mobile/web interface.
- Successful relay switching operations.
- Temperature and LDR monitoring performed correctly.
- IoT dashboard displayed live classroom parameters.
- Reduced manual attendance effort.
- Improved classroom energy efficiency.

5.2. Analysis

The implemented system provides a reliable and intelligent solution for smart classroom automation. The integration of sensors, embedded controllers, Raspberry Pi, and IoT technology improved monitoring accuracy and automation efficiency. The project successfully reduced unnecessary power consumption and minimized human intervention in attendance tracking and classroom management.

The results indicate that the system is suitable for deployment in schools, colleges, universities, and smart educational institutions where automated attendance and energy-efficient classroom operation are required.



Figure.5.1. Real Time implementation of Smart Room Occupancy Detection System

VI. CONCLUSION

The The Smart Room Occupancy Detection System provides an efficient and intelligent solution for occupancy monitoring and automated room management using IoT and embedded system technologies. The developed system successfully integrates occupancy detection sensors, ESP32 controllers, Raspberry Pi modules, relay automation circuits, and wireless communication technologies for real-time intelligent monitoring.

The proposed system reduces manual operation, minimizes energy wastage, and improves appliance control efficiency. The implementation demonstrated accurate occupancy detection, reliable automation performance, and efficient environmental monitoring capability.

The developed model is cost-effective, user-friendly, and suitable for smart homes, classrooms, offices, conference halls, and intelligent building automation applications. Future improvements may include artificial intelligence integration, cloud-based data storage, advanced computer vision algorithms, and mobile application support for enhanced smart automation functionality.

REFERENCES

- [1] A. K. Jain and S. Z. Li, Handbook of Face Recognition, 2nd ed. New York, NY, USA: Springer, 2011.
- [2] R. Rajalakshmi and P. Mahalakshmi, "Smart classroom automation using IoT," International Journal of Engineering Research & Technology (IJERT), vol. 8, no. 5, pp. 112–116, May 2019.
- [3] M. A. Mazidi, J. G. Mazidi, and R. D. McKinlay, The 8051 Microcontroller and Embedded Systems, 2nd ed. Upper Saddle River, NJ, USA: Pearson Education, 2006.
- [4] S. Monk, Programming Raspberry Pi: Getting Started with Python, New York, NY, USA: McGraw-Hill Education, 2016.
- [5] K. Ashton, "That 'Internet of Things' Thing," RFID Journal, vol. 22, no. 7, pp. 97–114, Jun. 2009.
- [6] D. A. Patterson and J. L. Hennessy, Computer Organization and Design, 5th ed. Burlington, MA, USA: Morgan Kaufmann, 2013.
- [7] S. V. Viraktamath and P. B. Mane, "Automatic room light controller with visitor counter using microcontroller," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 4, no. 6, pp. 5120–5125, Jun. 2015.
- [8] Raspberry Pi Foundation, "Raspberry Pi Documentation." [Online]. Available: <https://www.raspberrypi.org/documentation/>
- [9] A. N. Tambe and S. P. Bhosale, "IoT based smart attendance monitoring system using face recognition," International Journal of Innovative Research in Computer and Communication Engineering, vol. 7, no. 4, pp. 2210–2215, Apr. 2019.
- [10] M. Schwartz, Internet of Things with ESP8266. Birmingham, U.K.: Packt Publishing, 2016.
- [11] S. K. Singh and R. Kumar, "Embedded based smart classroom monitoring system," International Journal of Scientific Research in Science and Technology, vol. 5, no. 2, pp. 345–350, 2018.
- [12] P. Horowitz and W. Hill, The Art of Electronics, 3rd ed. Cambridge, U.K.: Cambridge University Press, 2015.



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