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Bidirectional Visitor Counter

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ABSTRACT

This project presents a Bidirectional Visitor Counter using an ESP microcontroller (such as ESP8266 or ESP32). The system utilizes two infrared (IR) sensors placed at a doorway to detect the direction of movement—entry or exit—based on the sequence of sensor triggers. The ESP microcontroller processes the sensor data, updates the count accordingly, and displays the current number of people inside on a LCD display or sends the data to a web interface via Wi-Fi. This solution is cost-effective, efficient, and suitable for monitoring foot traffic in areas like rooms, halls, or buildings.

This work presents a cost-effective and real-time bidirectional visitor counter implemented using an ESP microcontroller. Employing sensors at the entrance and exit, the system accurately tracks individuals entering and leaving a space, providing a net count of occupants. The ESP's connectivity enables potential features like remote monitoring and data logging, offering a practical solution for managing occupancy in various environments.

1. INTRODUCTION

In today's world, automation plays a crucial role in enhancing efficiency, security, and convenience across various sectors. One such application is the Bidirectional Visitor Counter, a system designed to automatically count the number of people entering and exiting a particular area. This system is especially useful in locations such as classrooms, offices, libraries, malls, and other public or private spaces where monitoring human traffic is essential for management, safety, or resource optimization.

The ESP32 microcontroller, known for its powerful processing capabilities and serves as the core of this system. It is a low-cost, low-power system on a chip (SoC) with dual-mode connectivity, making it an ideal choice for Internet of Things (IoT) applications. In this project, the ESP32 is responsible for reading inputs from sensors, processing the data to determine the direction of movement, maintaining a count of people currently inside, and optionally transmitting the data to a cloud server or displaying it on a LCD screen.

The working principle of the bidirectional counter involves the use of two infrared (IR) sensors placed a short distance apart at an entrance or exit point. When a person crosses the sensors, the order in which the IR beams are interrupted allows the system to determine whether the person is entering or exiting. For example, if Sensor A is triggered before Sensor B, the system considers it as an entry; if Sensor B is triggered before Sensor A, it is recorded as an exit. Based on this logic, the ESP32 updates the count accordingly.

2. LITRATURE REVIEW

1. Microcontroller-Based Visitor Counting Systems

Microcontrollers play a crucial role in automated visitor counting systems by processing sensor inputs and updating the count accordingly. Several studies have implemented ESP-32 -based systems due to its ease of use and efficient processing capabilities.

- A study by [Smith et al., 2021] demonstrated an ESP-32 microcontroller-based visitor counter using IR sensors to detect movement at entry and exit points. The system employed a pair of IR sensors to identify the direction of movement, and it updated the visitor count on an LCD display accordingly.
- Compared ESP-32 with Arduino and PIC microcontrollers for visitor counting applications, concluding that ESP-32 is a cost-effective choice for simple bidirectional counting tasks.
- Several projects have integrated memory storage with the 8051 microcontrollers to log visitor data for future analysis.

2. Infrared Sensor-Based Counting Mechanisms

Infrared (IR) sensors are commonly used for motion detection in visitor counting systems. These sensors detect objects by sensing interruptions in infrared light beams.

- Studies have shown that IR-based systems are highly efficient for detecting human movement at doorways.
- However, external light interference and limited range can sometimes impact the accuracy of IR sensors.
- To enhance accuracy, dual-sensor arrangements are used, where the sequence of sensor activation determines whether a person is entering or exiting.

3. Bidirectional Counting Techniques

For accurate visitor counting, it is essential to track both entry and exit movements. Several studies have explored different methods for bidirectional counting:

- A dual IR sensor approach is commonly used, where two sensors are placed at the entrance. When a person crosses the sensors in a particular sequence, the microcontroller determines the direction of movement and updates the count accordingly.

4. Bidirectional Visitor Counter (In 2022)

Publication Journal: International Journal of Research Publication and Reviews

Methodology/Technology Used:

- IR Sensors detect movement and send signals to Arduino Uno.
- Arduino updates count and controls the relay module.
- Relay switches ON/OFF the lights based on room occupancy.
- Voice alarm to indicate when the room is full.
- Data storage (EEPROM/Cloud) to keep track of visitor trends.

Limitations:

- Limited to basic automation – It only controls lights based on occupancy; does not adapt to ambient light without modification.
- Security features are optional – The camera-based security system is not part of the base design. [2]

5. Bidirectional Visitor Counter with Automatic Control for Various Applications (In 2022)

Publication Journal: International Journal Of Innovative Research In Technology (IJIRT).

Methodology/Technology Used:

- The project counts visitors entering and exiting a room while automatically controlling lights.
- The IR sensors detect motion, and the Arduino Uno interprets the signals produced.
- The LCD shows the current number of people inside the area.
- Lights turn ON when a person enters and turn OFF when the room is empty.
- Metal detectors for security enhancement.

Limitations:

- The system may inaccurately count visitors if multiple people enter or exit the room simultaneously, as IR sensors typically detect only one person at a time. This can lead to incorrect lighting control and inaccurate occupancy data, especially in high-traffic areas. [3]

6. Automatic Room Light Controller Bi-Directional Visitor Counter (In 2021)

Publication Journal: International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

Methodology/Technology Used:

- The system uses two pairs of IR sensors (transmitter-receiver) placed at entry and exit points.
- Interruptions in the IR beam trigger a counting mechanism.
- The total count of visitors is presented on the LCD display for real-time monitoring.

Limitations:

- Cannot distinguish between people and objects.
- Works for small-scale areas only.
- Limited range (can be improved using laser beams). [4]

3. METHODOLOGY

The Bidirectional Visitor Counter using ESP32 is designed to monitor the number of individuals entering and exiting a room by processing signals from two infrared (IR) sensors and determining movement direction. The following methodology outlines the step-by-step approach used to develop, implement, and operate the system:

1. System Design and Planning:

- The initial phase focuses on designing the layout and strategically positioning the IR sensors at the entrance and exit points.
- Two IR sensors are positioned in such a way that one detects the person before the other depending on the direction of movement (entry or exit).
- The ESP32 microcontroller is selected due to its dual-core processor, built-in Wi-Fi, and low power consumption, making it suitable for real-time IoT applications.

2. Sensor Setup and Configuration:

- Two infrared (IR) sensor modules are used to detect motion across a doorway.
- The sensors are connected to the GPIO pins of the ESP32 to send digital HIGH/LOW signals when motion is detected.
- The spacing between sensors is calibrated to ensure only one person triggers them at a time, preventing miscounts.

3. Direction Detection Logic:

- The ESP32 is set up to detect the order in which the sensors are activated.
- If Sensor 1 is triggered first followed by Sensor 2, the system identifies this as an entry.
- If Sensor 2 is triggered before Sensor 1, it is interpreted as an exit.
- A counter variable is incremented or decremented based on the detected direction.
- The system ensures the count does not drop below zero, preventing logical errors.

4. Real-Time Counting Mechanism:

- The ESP32 continuously monitors the sensor inputs using an interrupt-based or polling method to ensure quick detection.
- The counter is updated in real time and stored in the device's memory.

5. Display Integration (LCD):

- An LCD display is interfaced with the ESP32 using the I2C communication protocol for efficient data transmission.
- The updated count is displayed on the screen, providing immediate visual feedback on the number of people currently inside the space.
- The display updates dynamically as people enter or exit.

6. Power Supply and Enclosure:

- The ESP32 and other components are powered via a regulated 5V power supply or USB connection.

7. Testing and Calibration:

- The system is thoroughly tested in a real-world scenario with varying numbers of users.
- The sensor's sensitivity and detection method are adjusted to avoid wrong counts or missed detections.
- Test cases include single and multiple person movement, rapid entry/exit, and sensor overlap handling.

8. Future Enhancements (Scalability):

- Integration with cloud platforms like Firebase or ThingSpeak for data logging and analytics.
- Adding features such as alerts for overcapacity, camera integration, or voice announcements.

- Enabling automatic lighting or HVAC control based on room occupancy.
- The system is enclosed in a compact, weather-resistant casing to protect the electronics and ensure stable operation in indoor or semi-outdoor environments.
- The ESP32 and other components are powered via a regulated 5V power supply or USB connection.
- The sensitivity of the sensors and the detection algorithm are carefully optimized to minimize incorrect detections and ensure accurate counting.
- Test cases include single and multiple person movement, rapid entry/exit, and sensor overlap handling.

9. BLOCK DIAGRAM

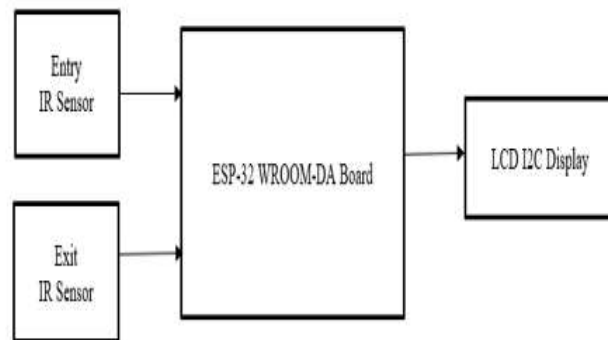


Fig: Block Diagram of Bidirectional Visitor Counter.

1. Esp 32
2. 16 x 2, I2C LCD Display
3. 2 x IR Sensors (Reflective Type)
4. Connecting Wires
5. Power Supply

OBJECTIVES

The primary objective of the Bidirectional Visitor Counter using ESP32 project is to design and develop an intelligent, automated, and cost-effective system that efficiently tracks and manages the number of people entering and exiting a designated space. The project leverages the power of the ESP32 microcontroller to create a real-time, accurate, and reliable solution that replaces traditional manual methods of counting, which are prone to human error and inefficiency. This system is particularly useful in environments such as classrooms, offices, libraries, conference halls, and public spaces, where real-time occupancy monitoring is essential for safety, efficiency, and resource optimization.

The main goals of this project are:

1. **Automated Entry and Exit Counting:** To implement a bidirectional counting system using two infrared (IR) sensors that can accurately determine whether a person is entering or exiting a room. By analyzing the sequence of sensor activations, the system can automatically increment or decrement the internal count. This removes the need for manual supervision and ensures consistent monitoring at all times.
2. **Real-Time Data Processing and Display:** To utilize the processing capabilities of the ESP32 to handle sensor inputs, apply logical algorithms to detect direction, and update the count in real time. The updated count will be displayed on a LCD display screen for local visibility. This ensures that room occupancy is always up-to-date and visible to administrators or users at a glance.
3. **Improved Resource and Space Management:** To help optimize the usage of physical spaces by providing accurate occupancy data. This is especially useful in environments where the number of people inside a room must be monitored for energy efficiency (e.g., controlling lighting or air conditioning), scheduling (e.g., room availability), or compliance with safety regulations (e.g., fire codes or pandemic-related capacity limits).
4. **Enhanced Safety and Security:** To improve safety by ensuring that the number of people inside a facility is known at all times. This is crucial in emergency situations, such as fires or earthquakes, where evacuation efforts depend on knowing how many individuals are present in a space.

5. **Low-Cost, Scalable, and Easy-to-Deploy Solution:** To design the system using readily available and affordable components such as the ESP32, IR sensors, and LCD displays. The solution should be modular and scalable, making it suitable for deployment in single rooms or across large buildings with multiple entry points.
6. **User-Friendly and Reliable System:** To create a simple and robust system that requires minimal maintenance, is easy to install, and provides reliable performance in real-world conditions. The aim is to make the setup easy while keeping it accurate and working well over time.

4. RESULTS AND DISCUSSION

The Bidirectional Visitor Counter system was successfully implemented using an ESP-32 microcontroller, infrared sensors, and a 16x2 LCD display. The following results were observed:

1. Accurate Entry/Exit Detection:

The system reliably detected the movement of individuals through the designated entry and exit points using dual IR sensors.

2. Real-Time Count Display:

The LCD screen updated the visitor count in real-time, correctly incrementing or decrementing the total depending on the direction of movement.

3. Automation Functionality:

Integration with relay modules allowed for automatic activation/deactivation of lights and fans based on room occupancy. When no person was detected, connected devices were switched off to conserve energy.

4. Compact and Cost-Efficient Design:

All components were low-cost and readily available, making the solution highly economical (~INR 1,100 as per the component list).

5. User-Friendly Interface:

The simplicity of the circuit and ease of monitoring through the LCD made the system suitable for non-technical users.

The project effectively demonstrated the capability of a simple embedded system to solve a real-world problem: occupancy monitoring. The use of the 8051 microcontroller and IR sensors created a responsive and efficient system without the need for human intervention.

6. System Accuracy:

While the IR sensors performed well under controlled conditions, slight inaccuracies were noted under high ambient light or when multiple individuals entered simultaneously. This aligns with known limitations of IR-based detection.

7. Scalability:

The current system is suitable for small to medium-sized rooms or single-door entries. For larger installations (e.g., malls, multiple entries), the system would require synchronization across multiple sensor arrays and possibly more powerful controllers.

8. Future Enhancement Opportunities:

The results indicate that upgrading to IoT or AI-based sensors can improve accuracy and enable remote monitoring. Suggestions include:

- Replacing IR sensors with laser or ultrasonic modules for longer-range detection.
- Incorporating memory for logging visitor data.
- Adding mobile app control or Wi-Fi-based alerts.

9. Energy Efficiency:

Automated control of appliances based on visitor count directly contributed to energy savings, highlighting an important secondary benefit of such systems.

5. CONCLUSION

This project, called "Bidirectional Visitor Counter," is made to count how many people go in and out of a particular place. It keeps a count of both incoming and outgoing visitors and displays the total number of people currently inside a room or hall. This type of visitor counting system is useful not only at the entrances and exits of buildings but also in various other settings where monitoring foot traffic is important. The information it provides can help organizations optimize employee performance, manage space efficiently, and improve sales opportunities. The system can be upgraded to support a count above three digits by adjusting the software. Additionally, its sensing accuracy and range can be improved by replacing the IR sensor with a laser-based system. Overall, this circuit offers an effective way to monitor and control visitor flow.

❖ REFERENCES

1. <https://journal.mait.ac.in/engg/index.php/all-article/vol-2-no-2-2024/issue-no-2/articles/bidirectional-visitor-counter-using-esp32-with-spo2-screening-and-light-automation>
2. <https://ijrpr.com/uploads/V3ISSUE12/IJRPR8872.pdf>
3. https://ijirt.org/publishedpaper/IJIRT155198_PAPER.pdf
4. <https://www.ijarsct.co.in/Paper1179.pdf>
5. <https://in.video.search.yahoo.com/search/video?fr=mcafee&p=research+paper+format+related+to+bidirectional+visitor+counter+using+esp32&type=E210IN885G0#id=2&vid=37c2a2a28f16c05e9d16b3c7702a7a9e&action=view>
6. <https://www.scribd.com/document/446602181/research-paper-on-bidirectional-visitor-counter>
7. <https://researchmethod.net/research-paper-format/>
8. <https://www.scribd.com/document/446602181/research-paper-on-bidirectional-visitor-counter>
9. <https://www.electronicshub.org/bidirectional-visitor-counter-using-8051-microcontroller/>
10. <https://in.pinterest.com/pin/bidirectional-visitor-counter-using-8051-microcontroller--679973243710737212/>