Automatic Room Light Controller with Bidirectional Visitor Counter

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Abstract - Wastage of electricity is a significant problem faced today. In various settings like homes, schools, colleges, or industries, lights and fans are often left on even when rooms are unoccupied due to negligence, forgetfulness, or hurry. To mitigate these situations, the "Automatic room light controller with visitor counter" project has been designed. This project comprises two modules: a "Digital Visitor counter" and an "Automatic room light controller". The core concept behind this project is the "Visitor counter," which measures the number of persons entering a room, such as a seminar hall, conference room, or classroom. This function is implemented using a pair of Infrared (IR) sensors. An LCD display positioned outside the room shows the current person count. The person count increments when someone enters the room, and concurrently, the lights are turned on. Conversely, the person count decrements when someone leaves the room. When the number of persons inside the room reaches zero, the lights are turned off using a relay interface, thereby performing the "Automatic room light controller" operation. Since two infrared sensors are utilized, the system also functions as a bidirectional person counter.

Keywords:- Microcontroller, IC, Sensor, Transformer, Reset, Disc capacitor, Reset button switch, Rectifier diode, Transistor, Segment Display

1.INTRODUCTION

The "Digital visitor counter" project is based on the interfacing of components like sensors and motors with a microcontroller. This counter is capable of counting people in both directions. This circuit can be used to count individuals entering a hall, mall, home, or office at the entrance gate, and it can also decrement the count for persons leaving the hall at the same or an exit gate, depending on sensor placement. It is also applicable at gates of parking areas and other public places. This project is structured into four main parts: sensors, a controller, a counter display, and a gate. The sensor detects an interruption and provides input to the controller, which then increments or decrements the counter based on whether a person is entering or exiting. The count is then displayed on a 16x2 LCD via the controller. When someone enters the room, one IR sensor is interrupted by the object, and a delay is introduced to prevent the other sensor from immediately triggering

2.LITERATURE SURVEY

The concept of automatic room light control coupled with visitor counting has been a subject of ongoing research, primarily driven by the need for energy conservation and efficient space management. Traditional approaches often suffer from human oversight, leading to significant electricity wastage. Early systems frequently relied on basic motion detection, which could result in lights remaining on even when a room was vacant but motion was still being detected from, for example, an external source, or conversely, turning off prematurely if occupants were stationary.The advent of digital visitor counters marked a significant improvement. These systems, often microcontroller-based, brought precision to occupancy tracking. A foundational aspect of these advancements involved the use of infrared (IR) sensors, which proved effective in detecting the presence and movement of individuals. The ability of IR sensors to detect motion and even the heat of an object made them suitable for applications beyond simple counting.

Initial visitor counting systems might have been unidirectional, providing a count of entries without a corresponding decrement for exits. However, the progression to bidirectional counting, utilizing pairs of IR sensors, significantly enhanced accuracy by accounting for both entries and exits, thereby maintaining a real-time, accurate occupancy count. This bidirectional capability allowed for more precise control over room resources.

The integration of such visitor counters with automatic room light control systems represents a

logical next step in optimizing energy usage. By linking the light control to the actual occupancy count, systems could ensure lights are only active when people are present, and crucially, are turned off when the room is empty. This direct correlation between occupancy and lighting status provides a robust solution to the problem of electricity wastage due to human negligence.Prior work has explored various microcontroller platforms for implementing these systems, with Arduino boards emerging as a popular choice due to their accessibility, ease of programming, and robust integration capabilities with other components. The Arduino Uno, with its 14 digital I/O pins and 6 analog inputs, provides ample connectivity for sensors, displays, and actuators like relays. Displaying the count information is also a critical aspect, and 16x2 Liquid Crystal Displays (LCDs) have been widely adopted for their cost- effectiveness, programmability, and ability to present clear character-based information.While existing literature has demonstrated the feasibility of automatic light control and visitor counting, continuous efforts are directed towards improving the reliability, cost-effectiveness, and potential for advanced features like wireless connectivity and sophisticated data analysis. The use of protection mechanisms, such as transistors for power surge protection, also highlights a focus on system robustness and longevity.

3. PROPOSED METHODOLOGY

The main aim of this paper is to propose a model for a visitor counter. The proposed system architecture is shown in the block diagram (Figure 1: Block Diagram). The system is built on the interference of an infrared wave, with an infrared beam as the light source. The Bidirectional Visitor Counter with Automatic Room Light Controller uses Arduino as the master controller. An IR diode is used as the transmitter, powered by a 5-volt DC supply and installed on one side of the door frame. On the front end of the receiver is an RX.

4.DESCRIPTION OF THE PROJECT

The hardware consists primarily of a digital cpu, an Arduino Uno circuit, an Infrared Sensor module, 16x2 LCD screens, all of which are addressed in detail along with their basic functions

II. HARDWARE PLATFORM

The hardware platform is composed of several key electronic components that work in conjunction to achieve the system's objectives. These include a digital CPU, the Arduino Uno development board, Infrared (IR) Sensor modules, and a 16x2 Liquid Crystal Display (LCD) screen.

4.1. Arduino UNO

The Arduino Uno is a popular open-source microcontroller board based on the ATmega328P microcontroller. It is widely used for prototyping and developing electronic projects due to its ease of use, extensive community support, and robust design.

- **Function:** The Arduino Uno serves as the central control unit for interfacing with sensors, processing their input, and controlling output devices. It reads data from the Infrared Sensor, processes this data according to the programmed logic, and then sends commands to display relevant information on the 16x2 LCD screen. Its primary function is to execute the embedded firmware that defines the system's behavior.

4.2. Infrared Sensor Module

Infrared sensors are electronic devices that measure or detect infrared radiation in their environment. In the context of a short-range detection system, they are commonly used as proximity sensors or for object detection.

- **Function:** The IR Sensor module emits infrared light and detects the reflection of this light from an object. By measuring the intensity of the reflected IR light, or by using a photodiode to detect the presence or absence of the reflected light, the sensor can determine the proximity or presence of an object within its detection range. Many modules include a comparator circuit that provides a digital output (HIGH/LOW) based on a preset threshold, indicating whether an object is detected.

4.3. Liquid Crystal Display (LCD)

16x2 LCD Screen

A 16x2 Liquid Crystal Display (LCD) is a common alphanumeric display device used for displaying textual information. The "16x2" denotes that it can display 16 characters per line across 2 lines.

- **Function:** The 16x2 LCD screen is used to provide visual feedback and display important information to the user. This can include status messages, sensor readings, time, or other relevant data processed by the Arduino. It offers a simple and effective way to present alphanumeric output without requiring a full graphical display.
- **Key Characteristics:**
  - **Display Format:** 16 characters per line, 2 lines.
  - **Characters:** Displays ASCII characters and some custom characters.
  - **Backlight:** Often comes with an LED backlight for visibility in low-light conditions.
  - **Interface:** Typically uses a parallel interface (4-bit or 8-bit mode) or can be interfaced via I2C using an PCF8574 I2C module (reducing pin count).

5. FEATURES & ADVANTAGES:

The Automatic Room Light Controller with Bidirectional Visitor Counter offers a multitude of features and advantages, making it a highly effective and practical solution for modern spaces:

- **Electricity Wastage Reduction:** The primary advantage is the significant reduction in electricity wastage. By automatically turning lights off when a room is unoccupied and on when it is, the system directly addresses the common problem of lights being left on due to negligence or forgetfulness.

- **Automatic Light Control:** The system provides automatic control of room lights based on real-time occupancy. Lights are turned on when someone enters and turned off when the room becomes empty, eliminating the need for manual intervention.
- **Bidirectional Visitor Counting:** Utilizing two infrared (IR) sensors, the system accurately counts people entering and leaving a room. This bidirectional capability ensures an accurate, dynamic count of occupants.
- **Real-time Occupancy Display:** The current number of persons inside the room is displayed on a 16x2 LCD placed outside the room. This provides immediate and clear information about the room's occupancy.
- **Enhanced Accuracy:** The implementation of a delay mechanism prevents erroneous double-counting when a person interrupts multiple sensors in quick succession, contributing to more reliable data.
- **Cost-Effective Implementation:** The project is designed using low-cost, off-the-shelf materials, making the overall deployment cost very low and affordable for the average consumer.
- **Improved Convenience and Quality of Living:** By automating light control, the system enhances convenience for occupants and contributes to a better quality of living by ensuring appropriate lighting without manual effort

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6. RESULT:

A functional prototype representing the "Automatic Room Light Controller with Bidirectional Visitor Counter" system was successfully constructed and implemented to validate the technically formed design. The entire structure, as conceptualized and detailed, was successfully realized.

The implemented circuit board showcases distinct sections, all appropriately connected to the digital and analog pins of the Arduino. The accompanying figure (Figure: Implementation of Project) visually depicts the assembled visitor counter panel, modeled and controlled by the Arduino Integrated Development Environment (IDE), which incorporates all the aforementioned components.

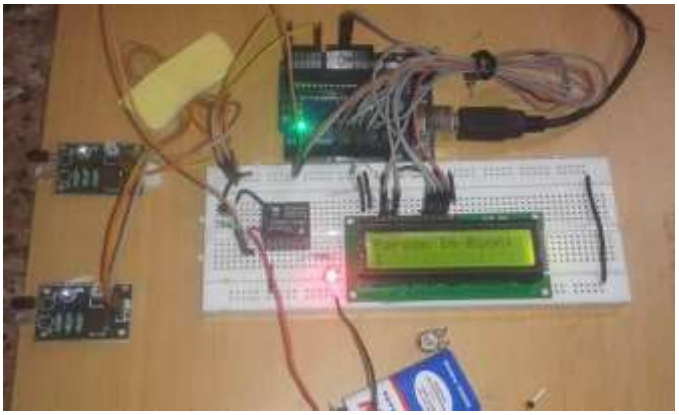

Figure: Implementation of Project

7. CONCLUSIONS

This research successfully presents the design and implementation of an automatic room light controller integrated with a bidirectional visitor counter. The developed system effectively addresses the challenges of energy wastage due to manual light operation and provides accurate occupancy monitoring within a given space. By employing infrared (IR) sensors for visitor detection and a microcontroller-based control unit, the system autonomously switches the room lights ON when an entry is detected and OFF when the last person exits, significantly optimizing electricity consumption. The bidirectional counting mechanism ensures precise tracking of occupants, enabling efficient light control irrespective of the entry/exit sequence. Experimental results demonstrate the system's reliability, accuracy, and quick response time in diverse environmental conditions.

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