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Smart Classroom

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A B S T R A C T

Automatic Room Light Controller Using Arduino and PIR Sensor can be used to turn ON and OFF the illumination system of home / office routinely by sensing the presence of a human in the room by detecting motion. We often leave the lights and fans switched on when not in use in classrooms, faculty cabins, garages, staircases etc. Thus, automatically controlling the electricity in such a way that the lighting level can be accurately matched to the actual need allows saving on energy costs and also improving the human comfort as it reduces manual switching and errors. This project focuses on interfacing of different elements to create a home automation system using Arduino, PIR sensor, LDR sensor and relay module. PIR will spot any human movement based on the output of the PIR sensor, simultaneously checking the output of the LDR sensor to detect presence of sunlight thus controlling the automatic switching of light and fan. Proposed system will help reduce consumption of electricity and automate the existing system making it efficient.

Keywords: (Arduino NANO, LDR Sensor, PIR sensor, Relay, Home Automation, Room light)

1. Introduction

In traditional classrooms, lighting systems often operate on manual switches, requiring constant monitoring and adjustment by teachers or staff. This approach not only consumes unnecessary energy but also leads to inefficiencies in managing classroom environments. To address these challenges, there is a growing need for an automatic light control system tailored specifically for classrooms.

In the realm of education, the integration of technology has significantly enhanced the learning experience. Smart classrooms, equipped with various digital aids, have become increasingly popular due to their ability to create dynamic and interactive environments. One key aspect of smart classrooms is the automation of routine tasks, such as controlling lighting and ventilation systems. In this context, the implementation of an Automatic Light and Fan Control system using Arduino presents a promising solution.

1.1 Smart Classroom Environment: Smart classrooms are designed to optimize the learning environment by incorporating advanced technologies. These environments typically feature interactive whiteboards, digital projectors, audio systems, and more recently, IoT (Internet of Things) devices for automation.

1.2 Need for Automation: Traditional classrooms often rely on manual control for adjusting lighting and ventilation, which can be inefficient and time-consuming. Moreover, factors such as natural light availability and occupancy levels fluctuate throughout the day, necessitating a dynamic control system. 3. Introduction to Arduino: Arduino, an open-source electronics platform, offers an ideal platform for building automation solutions. Its versatility, affordability, and ease of use make it a popular choice for hobbyists, educators, and professionals alike. Arduino boards can interact with various sensors and actuators, enabling the creation of complex control systems.

1.3 Components of the System: The Automatic Light and Fan Control system consists of several components, including: Arduino microcontroller board Light sensors to detect ambient light levels Motion sensors to detect occupancy Relay modules for controlling lights and fans Connectivity modules (e.g., Wi-Fi or Bluetooth) for remote access and monitoring

1.4 Functionality: Light Control: The system adjusts the intensity of artificial lighting based on ambient light levels detected by sensors. During periods of ample natural light, artificial lighting is dimmed or turned off to conserve energy. 2 Fan Control: The system regulates fan speed based on room occupancy. When the classroom is empty, fans operate at low speed or remain off to save energy. As occupancy increases, fan speed adjusts accordingly to maintain a comfortable environment.

1.5 Benefits of Automation: Energy Efficiency: By dynamically adjusting lighting and ventilation, the system reduces energy consumption and operational costs. Enhanced Comfort: Automation ensures that environmental conditions are optimized for comfort and productivity, enhancing the learning experience. Convenience: Automated control eliminates the need for manual intervention, allowing educators to focus on teaching without distractions.

1.6 Integration with Smart Classroom Systems: The Automatic Light and Fan Control system can be seamlessly integrated with existing smart classroom infrastructure. It can communicate with other IOT devices and central control systems to provide a cohesive and synchronized learning environment.

In [1] design and features of a Smart Home Automation System have been shown. It is Bluetooth based, hence wireless and can be flexible. It has a special feature for smart speech sense, which would decode users‟ sentences into appropriate commands. In [2] HOME AUTOMATION OF LIGHTS & FANS USING IOT, a design is proposed using IR and LDR sensor for automation of lights and fans using Arduino with Internet of Things for smart homes. [3] SMART HOME AUTOMATION SYSTEM USING ARDUINO talks about a system in which the electrical appliances like fan and light are operated at a suitable distance with the help of Bluetooth module and Arduino.

[4] Fail proof Home Automation System Using Arduino This paper presents a home automation system with manual backup, with the help of Arduino Uno, Bluetooth, Infrared Remote, Smartphone which uses an android application and Manual switch boards. [5] Energy-efficient Intelligent Street Lighting System AUTOMATIC ROOM LIGHT AND OTHER APPLIENCES CONTROLLER WITH BIDIRECTIONAL VISITOR COUNTER The objective of this project was to make a controller based model to count number of persons visiting particular room and accordingly light up the room. Automatic Room Light Controller Using PIR Sensor and Arduino.

This system is used in controlling the lights and fans in a room and keeps track of number of persons / visitors entered or exit from the room. Researchers also have employed vacancy sensor that replaced the standard wall switches. Using passive Infrared Technology called IR, these sensors combined the occupancy detection and voltage switching in a single package. In addition to home based lighting control, there has also been research conducted on street lights towards controlling the energy saving. But in all the research discussed, there are some few limitations like two people entering room at the same time if doors are wide open, range of sensors to cover the large room and also cost effectiveness So we here have developed a Automatic Lighting control with for classrooms by considering our class rooms being divided into grids. 3 Here we have one IR sensor placed at the entrance of class room and also another IR sensor inside the class room where classrooms divided into grids to sense the presence of human. The reason behind placing sensor is that the ceiling mounted sensors are expensive and that these sensors can sense object/personnel to a limited range only. This means that one sensor might not cover a full room and as such requires additional wiring in case of wired sensors. The advantage of our system is that electrical appliances be switched on or off in a particular area in class room based on the presence.

2. Proposed System

The proposed system integrates advanced technologies to optimize energy usage, enhance user experience, and create dynamic learning environments in both traditional classrooms and smart classrooms. Here are the key components and features of the proposed system:

2.1 Occupancy Sensors with AI Integration: Advanced occupancy sensors will be installed in classrooms to detect the presence of occupants accurately. These sensors will use artificial intelligence (AI) algorithms to differentiate between human presence and other environmental factors, reducing false positives. AI algorithms will analyze occupancy patterns over time to predict usage trends and optimize lighting schedules accordingly. This adaptive approach ensures that lights are activated only when needed, reducing energy waste during periods of low occupancy.

2.2. Daylight Harvesting System with Dynamic Control: A daylight harvesting system will be implemented to leverage natural light effectively. Sensors will measure ambient light levels and adjust artificial lighting levels dynamically to supplement natural light. The system will include dynamic control features that automatically dim or brighten lights based on real-time changes in natural light conditions. This ensures consistent illumination levels and minimizes energy consumption by optimizing the balance between natural and artificial lighting.

2.3. Integration with Smart Building Management System (BMS): The automatic light control system will be seamlessly integrated with the broader smart building management system (BMS). This integration allows for centralized monitoring, control, and optimization of various building functions, including lighting, HVAC, security, and occupancy. Data exchange between the light control system and BMS enables coordinated operation and responsive adjustments based on occupancy, scheduling, and environmental conditions. It enhances overall building efficiency and supports smart building initiatives.

2.4. User-Centric Control Interface: A user-centric control interface will be developed to empower teachers and occupants to adjust lighting settings according to their preferences and specific classroom activities. The interface will feature intuitive controls accessible via wall-mounted panels, mobile applications, or voice commands. Users can easily adjust lighting levels, switch between preset modes (e.g., presentation mode, group work mode), and override automated settings as needed.

2.5. Energy Monitoring and Reporting: The system will include energy monitoring capabilities to track and analyze energy usage patterns in real-time. Detailed energy consumption data will be collected and presented through user-friendly dashboards and reports. Educators and facility managers can use this information to identify opportunities for further optimization, implement energy-saving strategies, and track the system's impact on energy efficiency and cost savings over time.

2.6.Integration with Smart Classroom Technologies: For smart classrooms, the automatic light control system will seamlessly integrate with other advanced technologies, such as interactive whiteboards, audio-visual systems, and collaborative tool

Objective of System:

- to automatically turn on or off the lights in a room by detecting the Illumination using LDR and PIR sensor.
- to control the temperature of devices, rooms, electronic components etc. by monitoring the temperature.

3. Proposed Block Diagram

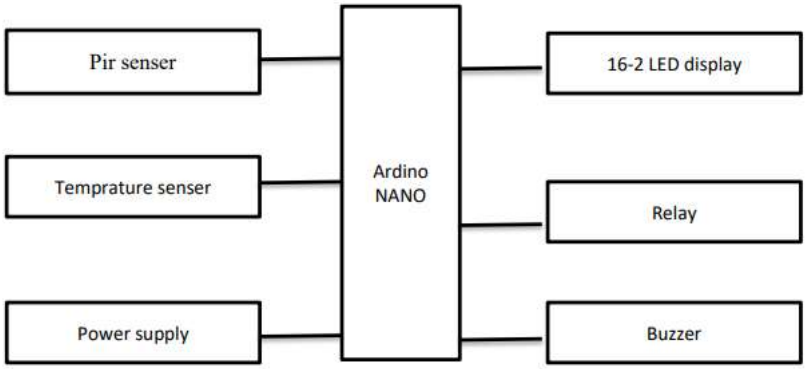

Fig. 1– Block Diagram of System

Working:

Arduino is a microcontroller which provides open source platform to perform software and hardware operations. This is an advantageous project as Arduino Uno and PIR Sensor is used thereby lights in the room will turn ON automatically by detecting a human motion and stay turned ON as long as the person remain present in the room. At the beginning, when no human is present in the room, the PIR Sensor's OUT pin is in the LOW mode. Hence, light of the room is OFF.

The output of the PIR Sensor goes HIGH as the person enters the room. PIR Sensor detects the Infrared (IR) radiation in the room. The Digital pin 8 of Arduino Uno is used to connect the Data OUT pin of PIR Sensor. When this becomes HIGH, the activation of relay takes place by Arduino Uno. So that relay pin is in the LOW mode; because relay is an active LOW device. Now, the lights will turn ON. This light maintains its state as ON as far as there is motion in the room. If the person exits the room or takes a nap, the motion in front of sensor stops and there will be no changes in the IR radiations. Therefore, Data OUTpin of PIR sensor will be in LOW mode. This leads to turn OFF the relay. So, relay now is in the HIGH mode. Hence, room light will be turned OFF.

4.Scope of System

This work composes of PIR sensor, relay module and arduino microcontroller which made up the complete system. Automatic Room Lights using Arduino and PIR Sensor is to be used where the lights in the room will automatically turn ON and OFF by detecting the presence of human. This Automatic Boom Lights can be implemented in your garages, staircases, bathrooms, etc where we do not need continuous light but only when we are present

Automatic Light Control:

Light sensors: Utilize sensors like LDRs (Light Dependent Resistors) to detect ambient light levels.

Control circuitry: Interface the Arduino Nano with relay modules or solid-state relays (SSRs) to switch lights on or off based on the sensor readings.

Threshold adjustment: Implement adjustable thresholds to customize when the lights should turn on or off.

Time-based control: Incorporate a real-time clock (RTC) module to schedule specific times for the lights to be activated or deactivated.

Automatic Fan Control: Temperature sensors: Integrate temperature sensors like TMP36 or DHT11 to measure room temperature.

PWM control: Use Pulse Width Modulation (PWM) to adjust the speed of the fan based on temperature readings.

Temperature thresholds: Set thresholds for turning the fan on and off based on the temperature readings. Hysteresis control: Implement hysteresis to prevent rapid cycling of the fan due to small temperature fluctuations.

User Interface:

LCD display: Add an LCD display to show current sensor readings, status, and settings.

Push buttons or rotary encoders: Allow users to adjust settings such as threshold levels or fan speeds manually.

LED indicators: Provide visual feedback on the system's status, such as whether the lights or fan are currently active.

Wireless Connectivity (Optional):

Bluetooth or Wi-Fi: Enable remote monitoring and control of the system using a smartphone or computer.

IoT integration: Connect the system to IoT platforms like Blynk or Thing speak for data logging and remote control.

Safety Features: Overheat protection: Implement safeguards to shut off the fan or trigger an alarm if the 23 temperature exceeds a certain threshold.

Short circuit protection: Use appropriate circuitry and fuses to prevent damage in case of electrical faults.

Energy Efficiency: Power-saving modes: Design the system to minimize power consumption during idle periods.

Optimize control algorithms: Fine-tune the control logic to ensure efficient operation while maintaining comfort levels.

Expandability and Customization:

Modular design: Design the system with expansion ports or interfaces to add additional sensors or control devices in the future.

Open-source code: Provide well-commented and modular code to allow users to customize and extend the functionality according to their needs.

Debugging and Diagnostics:

Serial communication: Implement serial communication to facilitate debugging and monitoring of sensor readings and system behavior.

Error handling: Include error detection and reporting mechanisms to identify and troubleshoot issues.

4. Applications:

- Energy Efficiency: By automatically turning off lights and fans when the classroom is unoccupied or when natural light is sufficient, the system helps reduce energy consumption, leading to cost savings and environmental benefits.
- Convenience: Teachers and students don't need to manually adjust lights and fans throughout the day. The system takes care of these tasks automatically, allowing occupants to focus on teaching and learning without distractions.
- Enhanced Comfort: Maintaining optimal lighting and ventilation levels contributes to a comfortable learning environment. The system ensures that lights and fans are appropriately adjusted based on ambient conditions, helping to prevent discomfort due to inadequate lighting or poor air circulation. Extended
- Equipment Lifespan: By controlling the usage of lights and fans based on actual needs, the system helps prolong the lifespan of these devices, reducing maintenance costs and downtime associated with premature failures.
- Educational Tool: Implementing the automatic control system provides an opportunity for students to learn about electronics, programming, and automation concepts. They can actively participate in designing, building, and troubleshooting the system, gaining valuable hands-on experience in STEM education.
- Remote Monitoring and Control: Depending on the implementation, the system can be integrated with remote monitoring and control capabilities. Teachers or facility managers can remotely monitor the status of lights and fans and adjust settings as needed using a smartphone app or web interface.
- Data Collection and Analysis: The system can collect data on occupancy patterns, light levels, temperature, and energy consumption over time. This data can be analyzed to identify trends, optimize system performance, and make informed decisions for future improvements or adjustments.
- Scalability: The basic framework of the automatic control system can be scaled up to manage lighting and ventilation in multiple classrooms or even entire buildings. This scalability allows for consistent energy savings and comfort improvements across educational facility.

Conclusion

Electricity has become a modern blessing infrastructure and modern features architectural structures. Most of the energy component it is simply overused and creates more „burden" generation. So in short, a large amount of energy when considered to be spent in daily because of human tendency of procrastination. With the same mindset this wasting energy can be saved if used wisely too will eventually lead to greater value offering Energy saving

and this can be done either to change one's actions or by introducing traditional ones automation system. Obviously it is 1 unit of power stored equals 1 unit of energy generated. So is the project it is considered this as an important factor to be highlighted a simple consideration of energy saving as well active use. In order to detect the entry / exit of a room used PIR sensor, which can detect human presence at a great distance and the LDR sensor is used to detect the presence of light at the sometime. The cost of this program is relatively low compared to other products on the market which is all the most advantageous of the system. If this principle is adopted as often as possible everything will contribute to greater savings and not just the inside .Energy saving policies will show us debt power but on the basis of generation too

There is also the option to include a subheading within the Appendix if you wish.

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