Automatic Public Lighting System

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Abstract:- Motion and ambient light sensors are used by an automatic public lighting system to dynamically adjust illumination for both safety and efficiency. When it's not in use, it optimizes energy use and lowers expenses and its impact on the environment thanks to central control. With an emphasis on sustainability and efficiency, this adaptable solution reimagines the infrastructure of urban lighting for a more resource-aware and brighter future.

***Keywords**:- Arduino UNO R4 , Irsensors, LED, LDR, Auxillary Power Supply, ConnectedComponent .*

I. INTRODUCTION

Introducing an advanced automated public lighting system utilizing ambient light and motion sensors for dynamic illumination control. This system optimizes energy consumption through a centralized management structure, resulting in up to 30% energy savings compared to traditional systems. It represents a sustainable solution, delivering consistent and adaptive lighting, accompanied by significant cost reductions through enhanced safety and reduced carbon emissions.

Employing state-of-the-art sensor technology, the automatic public lighting system provides an innovative solution applicable to both commercial and rural lighting. Motion and ambient light sensors collaboratively facilitate real-time adjustments, ensuring energy conservation and optimal lighting conditions. This system establishes a new standard for contemporary city lighting infrastructure, showcasing its ability to achieve substantial energy efficiency gains of up to 30%, while emphasizing efficiency, safety, and environmental responsibility in urban settings.

II. RELATED WORK

The study conducted by K. Santha and colleagues on a Street Lighting System Dependent on Vehicle Movements concentrated on the automatic adjustment of streetlights through algorithms for brightness and dimness, as well as light intensity. The research employed a PIC microcontroller for effective control and regulation.

Another proposal involves a ZigBee-based Remote Control Automatic Street Light System, integrating ZigBee modules for detecting faulty lights and implementing intelligent decision- making for ON/OFF/DIMMING based on vehicle movement, pedestrians, and environmental conditions, utilizing a PIR motion sensor.

M. Abhishek et al. implemented a traffic flow-based street light control system utilizing solar energy, employing an 8052 series microcontroller, and replacing conventional bulbs with LEDs to achieve a threefold reduction in power consumption.

C.Bhuvaneshwari and colleagues investigated a solar street light equipped with an automatic tracking system to improve the efficiency of solar power generation. The system incorporated a sun-tracking sensor, Light Dependent Resistor (LDR), amplifier unit, LM324 IC,and AT89C51microcontroller.

III. METHDOLOGY

The current system utilizes a single-phase power delivery to streetlights, incorporating five additional components for power regulation. An Infra-Red Proximity Sensor at the base detects presence, and data is sent to the Arduino for real-time adjustments. The Arduino commands dim and bright modes, controlling streetlight brightness. A battery eliminator, powered by the single-phase line, supplies 5V inputs to sensors and Arduino.

➢ *Working of the circuit:*

The circuit employs an LDR connected to A0 to control streetlight activation based on ambient light. IR sensors (IR1, IR2, IR3, IR4) and object sensors are connected to A1, A2, A3, A4. LEDs are activated based on sensor readings, with the first and last LEDs serving as start and end indicators.

➢ *Circuit diagram:*

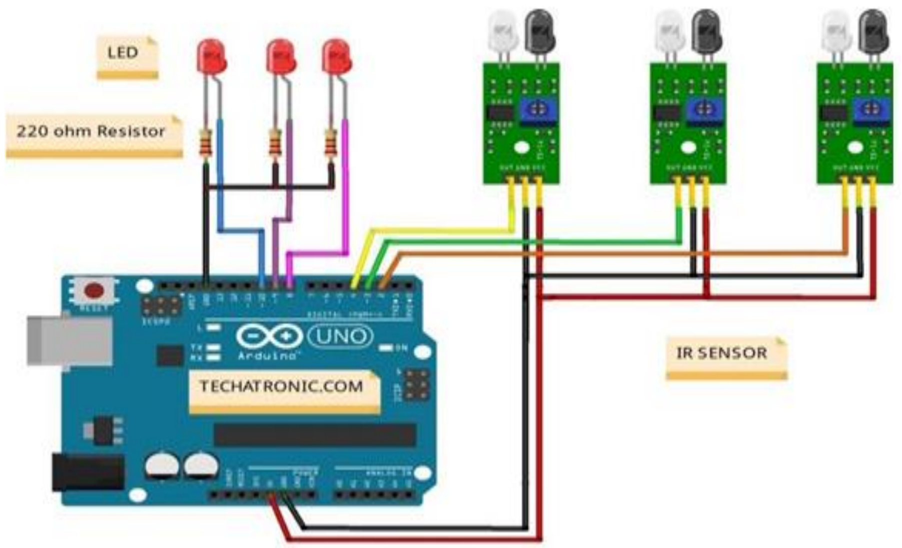

Fig.1 Circuit diagram

➢ *Flow chart:*

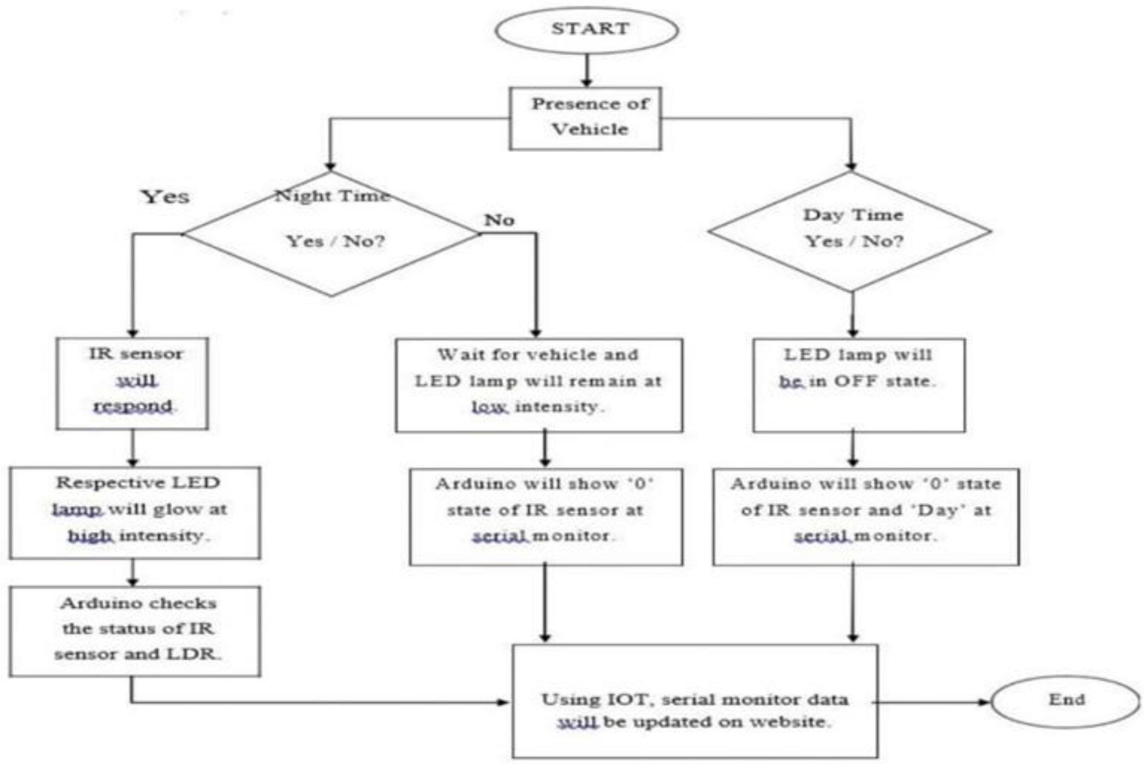

Fig 2. Flow Chart

➢ *Components :*

- *LEDs :*

LEDs come in various sizes and shapes, including the compact 3mm LED. Our inventory comprises a diverse selection of the most commonly used models, ranging from 3mm to 10mm. The size designation corresponds to the outer diameter of the LED. The 3mm LEDs, being the smallest, are ideal for applications with limited space, while the 8mm and 10mm models are preferred when maximum light output is desired. The super-bright 3mm LEDs are exceptionally luminous, making them suitable for a wide range of applications such as projects, illuminations, headlamps, spotlights, car lighting, and models. These LEDs are efficient for low-power, high- intensity lighting and indicators, fitting easily into breadboards to enhance the visual appeal of yourprojects.

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- *IR Sensor:*

The Infrared Obstacle Avoidance IR Sensor Module (Active Low) consists of a pair of infrared transmitting and receiving tubes. When the transmitted light waves encounter obstacles and are reflected back, the receiver tube captures the reflected IR waves. The onboard comparator circuit processes this information, activating the green indicator LED. The module utilizes a 3-wireinterface with Vcc, GND, and an OUTPUT pin, compatible with 3.3 to 5V levels. Upon detecting an obstacle, the OUTPUT pin generates a digital signal (low-level). A built-in preset allows for fine-tuning the operational range, with an effective distance spanning from 2cm to 80cm.

Fig. 3 IR SENSOR

- *Arduion Uno R4:*

Two Uno R4 boards are available: Uno R4 Minima and Uno R4 WiFi. The later has a WiFi coprocessor and LED matrix, but the Minima doesn't.
Common features on both Uno R4 Minima[14] and Uno R4 WiFi[15] boards:Microcontroller (MCU):[16]
IC: Renesas R7FA4M1AB (32-bit ARM Cortex-M4F core with single-precision FPU)Clock Speed: 48 MHz
Flash Memory: 256 KB boot rom
SRAM: 32 KB (16 KB ECC) (16 KB parity)
EEPROM: 8 KB (data flash)USART peripherals: 4
SPI peripherals: 2
I²C peripherals: 2 Operating Voltage: 5 Volts USB-C connector.
Barrel jack connector and VIN pin on shield header supports up to a maximum of 24 volts DC. Additional features only available on the Uno R4 Minima board:[14]

The SWD programming connector is a 10-pin 5x2 1.27mm header designed for connecting to the Arduino UNO R4 WiFi. This board combines the processing capabilities and innovative peripherals of the RA4M1 microcontroller from Renesas with the wireless connectivity features of the ESP32-S3 from Express. In addition to these features, the UNO R4 WiFi includes an onboard 12x8 LED matrix, Qwiic connector, HID support, VRTC, and OFF pin, catering to various needs that makers might have for their projects.

Offering expanded memory, a faster clock, and additional onboard peripherals, the UNO R4 WiFi facilitates precise calculations, smooth handling of complex projects, and the capability to handle demanding tasks effortlessly. The board introduces a 12-bit DAC, CAN BUS, OP AMP, OFF pin, VRCT pin, and Qwiic connector, enhancing its capabilities and allowing for greater design flexibility.

Maintaining compatibility with UNO hardware and operating at 5V, the UNO R4 WiFi extends its versatility by supporting a wider input voltage range, up to 24V. This broader range enables seamless integration with motors, LED strips, and other actuators, simplifying projects by using a single power source and allowing for easy porting of projects developed with previous UNO form factor boards.

The UNO R4 WiFi stands out with its Wi-Fi and Bluetooth connectivity capabilities, thanks to the ESP32-S3 co-processor. This integration frees up the RA4M1 microcontroller for other tasks. With built-in Wi-Fi and Bluetooth, makers can develop IoT projects, leveraging standardized APIs and existing projects. The board is fully compatible with Arduino Cloud, facilitating remote data storage, interactive dashboards, Over-the-Air uploads, and variable sharing among boards.

LED matrix creativity: The UNO R4 WiFi boasts a vibrant 12x8 red LED matrix (96 dots) perfect for creative projects, animating visuals or plotting sensor data, all without requiring extra hardware. Users can utilize the provided API and tutorials for manual LED control via sketch code. Access a gallery of pre-made animations and leverage our online tool for easy creation of custom visual effects.

Fig.4 ARDUINO UNO R4

IV. EXPERIMENTAL RESULTS

The implemented project successfully detects obstacles through IR sensors, switching on the lights as expected. The design incorporates three modes: OFF mode (daytime), Active mode (low natural light triggers motion sensors), and ON mode (pedestrian presence triggers LED lights).

The design basically includes three working modes:

- OFF mode: When there is enough natural light in the surrounding ie. during the daytime, the entire system is switched off and the batteries are charging
- Active mode: When the natural light drops below a certain level the system automatically turns on and the motion sensors are powered.
- ON mode: On the presence of pedestrians, the sensors turns on which in turn switches on the LEDlights. These lights turns off after a period of time.

V. CONCLUSION

This smart project demonstrates the potential to estimate vehicle speed, recognize number plates, and enhance road safety. It proves beneficial in both rural and urban areas, emphasizing the use of renewable resources for power efficiency. The project's scope extends to various applications, such as industrial lighting, campus illumination, and parking lots. Its cost-effectiveness, eco-friendliness, and remote accessibility make it a practical solution for energy conservation.

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