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AUTO DIMMING STREET LIGHTING SYSTEM

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ABSTRACT: This paper presents about the static analyze on the Urban Street lighting using hybrid systems. Urban Street lighting is a critical component of city infrastructure, ensuring safety and visibility for residents and commuters alike. However, conventional street lighting systems often operate at a fixed intensity, irrespective of varying environmental conditions, leading to unnecessary energy consumption and light pollution. To mitigate these challenges, the integration of Auto-Dimming Technology into street light systems offers a promising solution. This Abstract presents an overview of the implementation of Auto Dimming Technology in street lighting, highlighting its key features and benefits. Auto Dimming technology employs a combination of sensors, data, analytics, and intelligent control algorithms to dynamically adjust the brightness of streetlights in response to real time factors such as ambient light levels, traffic patterns, and pedestrians activity, By dimming lights during periods of low demand and brightening them, when necessary, Auto dimming technology optimizes energy usage while maintaining optimal illumination levels for road users.

KEYWORDS: Auto-Dimming Technology, algorithms, Illumination.

INTRODUCTION:

The relentless pursuit of progress and development characterizing our modern era, the critical need for renewable energy has emerged as a beacon guiding us towards a sustainable and responsible future. The ever-increasing demands of our globalized society, coupled with the undeniable environmental consequences of conventional energy sources, underscore the urgency of transitioning to renewable alternatives. This imperative is not merely an eco-centric notion; it is a strategic response to a multitude of challenges that define our contemporary energy landscape.

Solar energy, harnessed through photovoltaic panels, exemplifies reliability in the face of varying energy needs. During daylight hours, solar panels convert sunlight into electricity, providing a consistent and clean power supply to meet the demands of homes, businesses, and industries. The scalability of solar installations allows for tailored solutions, from individual rooftop systems to expansive solar farms, contributing to grid stability and energy security.

Complementing solar energy, wind power adds a layer of dynamism to the energy mix. Wind turbines, strategically positioned to harness the kinetic energy of the wind, thrive in diverse climates and geographic locations. This adaptability ensures a continuous energy flow, especially during periods of low solar generation. The variability of wind energy, often inversely correlated with solar output, creates a balanced and resilient energy supply, addressing the intermittency concerns associated with individual renewable sources.

BLOCK DIAGRAM OF HYBRID STREET LIGHTING SCHEME:

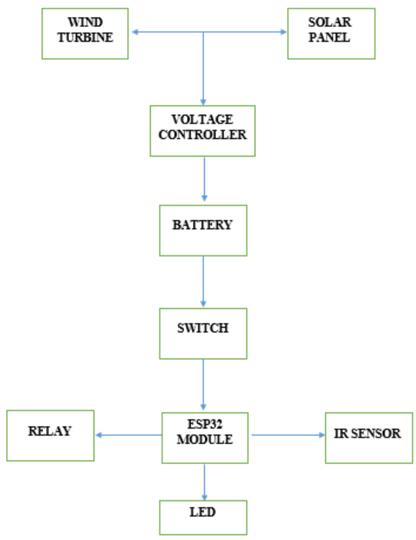

FIGURE 1

Figure 1 shows the block diagram of hybrid street lighting scheme. The components of the hybrid street lighting scheme are wind turbines, Solar panels, voltage controller, Battery, Switch, Relay, ESP32 module, IR sensor and LED. The wind turbine and the solar panel acts as the energy source in the circuit. The two renewable energy sources together produce enough power to the system. The wind turbine which converts kinetic energy of wind into electrical energy is fixed at top in order to capture more energy and produce more electricity. The solar panel which converts solar energy into electricity by photovoltaic effect is fixed below the wind turbine in a position to capture more solar energy. The voltage controller is placed in between the battery and the energy sources. The voltage controller prevent the battery from being overcharged by controlling the voltage and current coming from the energy sources to the battery.

Battery is placed to store the energy from the wind turbine and the solar panel after compensated by the voltage controller. The switch is fixed to manually turn on and off the circuit. Separated switches is provided to sensor circuit, lighting circuit. Relay, ESP32 module and IR sensor acts as the main circuit in the scheme. Relay is used to allow the IR sensor signal to control over the lighting circuit. ESP32 module is placed to control the light system along with the IR sensor. IR sensor detects the motion of objects. The energy is fed to the LED light through the battery. The motion of object detected by the IR sensor is transmitted to the ESP32 module to control the light by adjusting the brightness and the relay allow the IR sensor and ESP32 module to control the light circuit. LED light is fixed below the wind turbine on top which acts as the load of the entire circuit. The brightness of the LED is adjusted by the circuit containing Voltage controller, IR sensor and the ESP32 module. The detailed explanation of components is derived below.

WIND TURBINE

FIGURE 2

Figure 2 shows the image of Wind turbine. A wind turbine is a device that converts the kinetic energy of the wind into mechanical energy, which is then harnessed to generate electricity. These structures are part of the broader category of renewable energy technologies, as they utilize the natural and abundant resource of wind to produce clean and sustainable power.

Wind turbines come in various sizes, ranging from small turbines for residential or agricultural use to large utility-scale turbines in wind farms.

SOLAR PANEL

FIGURE 3

Figure 3 shows the image of Solar panel. A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of solar cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and/or solar tracker and interconnection wiring. Photovoltaic cells or panels are only one way of generating electricity from solar energy. They are not the most efficient, but they are the most convents to use on a small to medium scale. PV cells are made of silicon, similar to that used in computer "chips". While silicon itself is a very abundant mineral, the manufacture of solar cells (as with computer chips) has to be in a very clean environment. This causes production costs to be high. A PV cell is constructed from two types of silicon, which when hit by solar energy, produce a voltage difference across them, and, if connected to an electrical circuit, a current will flow.

VOLTAGE REGULATOR

FIGURE 4

Figure 4 shows the image of Voltage controller. A voltage regulator is an electronic device or circuit that maintains a constant output voltage regardless of changes in the input voltage or load conditions. Its primary function is to stabilize and control the voltage supplied to electronic devices or systems, ensuring a reliable and consistent power supply. Here's a description of the key aspects and functions of a voltage regulator.

Voltage regulators use various techniques to maintain a steady output voltage. One common method involves feedback control, where the output voltage is monitored and compared to a reference voltage. Any deviations result in adjustments to the regulator's internal components to bring the output voltage back to the desired level.

BATTERY

FIGURE 5

Figure 5 shows the image of Battery. A battery is an electrochemical device that stores and provides electrical energy through a chemical reaction. It consists of one or more electrochemical cells, each with two electrodes, a positive (cathode) and a negative (anode) and an electrolyte that facilitates the movement of ions between the electrodes. The anode is the electrode where oxidation occurs during the discharge (power delivery) of the battery. It releases electrons into the external circuit. The cathode is the electrode where reduction occurs during the discharge of the battery. It accepts electrons from the external circuit.

The electrolyte is a substance that facilitates the movement of ions between the anode and cathode. It can be liquid, gel, or solid, depending on the type of battery. The electrolyte allows the flow of ions to maintain a balance of charge during the electrochemical reactions. During the discharge of a battery, chemical reactions take place at the anode and cathode. These reactions release energy, and the

electrons flow through an external circuit, producing electrical power.

RELAY

FIGURE 6

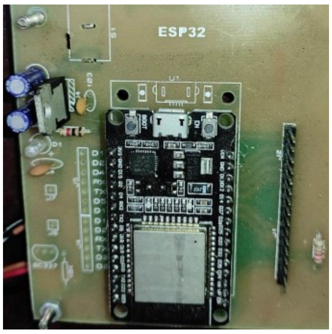

Figure 6 shows the image of Relay. A relay is an electrical switch that uses an electromagnet to control the opening and closing of one or multiple sets of contacts. It is a device designed to allow a low-power or low-voltage signal to control a higher-power or higher-voltage circuit. Relays are widely used in various applications to control electrical circuits, automate processes, and provide isolation between different parts of a system.

Relays are versatile components that provide a means to control high-power circuits with low-power signals, facilitating automation, remote control, and the protection of electronic systems. The choice of relay depends on the specific requirements of the application.

ESP32 MODULE

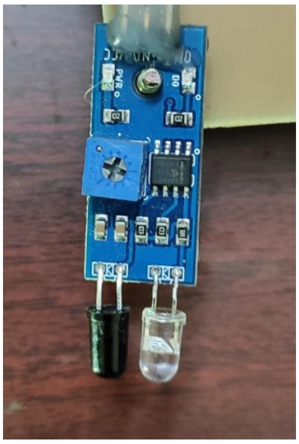

FIGURE 7

Figure 7 shows the image of ESP32 module. The ESP32 is a versatile and widely used microcontroller module that belongs to the ESP family, developed by Espressif Systems. It is known for its integrated Wi-Fi and Bluetooth capabilities, making it suitable for a variety of IoT (Internet of Things) applications. The ESP32 module is powered by a Tensilica Xtensa LX6 dual-core microcontroller. It provides processing power and flexibility for a range of applications. The ESP32 includes a built-in Wi-Fi module that supports 802.11 b/g/n standards, allowing it to connect to wireless networks.

IR SENSOR

FIGURE 8

Figure 8 shows the image of IR sensor. An Infrared (IR) sensor, also known as an infrared detector or IR receiver, is a device that detects and responds to infrared radiation. Infrared radiation is electromagnetic radiation with wavelengths longer than those of visible light, making it invisible to the human eye. IR sensors are commonly used in various applications, including remote controls, motion detectors, proximity sensors, and temperature sensors. IR sensors work based on the principle that objects emit infrared radiation in the form of heat. The sensor detects this infrared radiation and converts it into an electrical signal, which can then be processed or used to trigger a specific action.

LED

FIGURE 9

Figure 9 shows the image of LED. Light Emitting Diodes, commonly known as LEDs, are semiconductor devices that emit light when an electric current passes through them. LEDs are a type of solid-state lighting and have become increasingly popular due to their energy efficiency, long lifespan, and versatility. LEDs are made from semiconductor materials, typically compounds like gallium arsenide (GaAs), gallium phosphide (GaP), or gallium nitride (GaN). The specific materials used determine the colour of the emitted light. An LED typically consists of several layers of semiconductor materials. The two main layers are the p-type (positive) and n-type (negative) layers. When a voltage is applied across the p-n junction, it allows the flow of electrons from the n-type region to the p-type region. As electrons recombine with holes (positively charged vacancies), energy is released in the form of light. LEDs are highly energy-efficient compared to traditional incandescent and fluorescent lights.

SIMULATION SOFTWARE DESCRIPTION

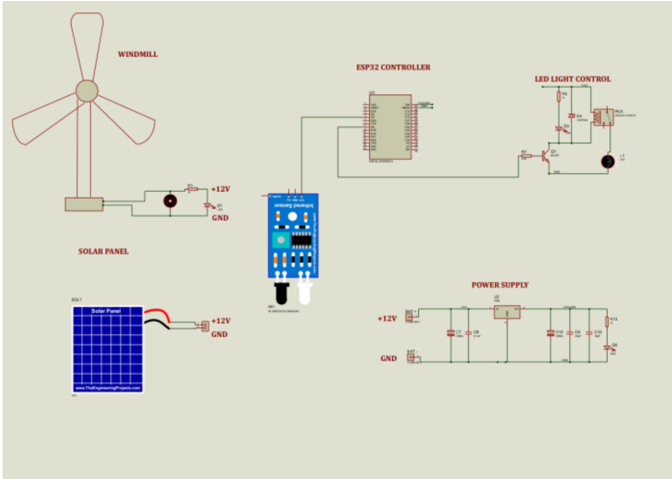

FIGURE 10

Figure 10 shows the simulation diagram of hybrid street lighting scheme. The simulation is done through Proteus software.

Proteus is a popular software tool primarily used for electronic design automation (EDA) and simulation of schematic designs, especially in the field of microcontrollers and embedded systems. The Proteus software suite includes two main components: ISIS and ARES.

ISIS (INTELLIGENT SCHEMATIC INPUT SYSTEM)

- ISIS is the schematic capture tool in Proteus. It allows users to draw electronic schematics for circuits and systems using a wide range of components like resistors, capacitors, microcontrollers, sensors, etc.
- Users can connect these components to simulate the flow of electricity and test how the circuit behaves under different conditions. ISIS is used to perform schematic diagram and simulation of different electronic circuits.
- ISIS supports simulation of both analog and digital circuits. **ARES (ADVANCED ROUTING AND EDITING SOFTWARE)**
- ARES is the PCB (Printed Circuit Board) layout editor in Proteus. Once you have designed and simulated your circuit in ISIS, you can transfer it to ARES for the PCB layout.
- ARES provides tools for placing components on the PCB, routing traces, and ensuring that the final layout meets design constraints and electrical specifications.
- It allows for the creation of professional-looking PCB layouts.

KEY FEATURES OF PROTEUS SOFTWARE

Simulation Proteus allows for the simulation of the designed circuits, enabling users to analyse and test their functionality before physically implementing them.

Microcontroller Simulation It supports the simulation of microcontroller-based projects, allowing users to program and test their code in a virtual environment. Virtual Instrumentation Proteus includes a variety of virtual instruments like oscilloscopes, function generators, and logic analysers that aid in testing and debugging circuits. Mixed-Signal Simulation It can simulate both analog and digital components, making it suitable for projects that involve a mix of signal types.

USAGE

Education Proteus is widely used in educational institutions for teaching electronics and circuit design. Prototyping Engineers and hobbyists use Proteus for prototyping and testing circuits before moving to physical hardware. Embedded Systems Development Proteus is valuable for developing and testing firmware for microcontroller-based projects.

CONCLUSION:

The implementation of hybrid street lights with auto-dimming technology represents a significant leap forward in optimizing energy efficiency and enhancing sustainability in urban infrastructure. This innovative approach combines traditional street lighting with advanced automation, resulting in a system that adapts intelligently to its surroundings.

The auto-dimming technology plays a pivotal role in this hybrid solution, allowing the street lights to dynamically adjust their brightness based on real-time factors such as ambient light levels, traffic conditions, and the time of day. By doing so, the system not only ensures optimal visibility for pedestrians and drivers but also minimizes energy consumption during periods of lower activity, contributing to overall energy savings.

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