Implementation of Automatic Lighting System for Saving Electrical Energy on Public Roads

Muhammad Rizki[1], Taufik Qurrohman[2], Muhammad yusron karim[3], Iqbal Alallah[4]
Nurul Jadid University, Probolinggo, 67291, Indonesia[1,2,3,4]

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ABSTRACT

Street lighting is an important need to improve public safety and comfort, especially at night. However, manual operation of street lights often results in energy waste due to forgetting to turn off the lights during the day. This study aims to design and test an automatic lighting system based on an LDR (Light Dependent Resistor) sensor that can automatically control the lights based on light intensity. This system uses a combination of main components, namely LDR, 100k preset to adjust sensitivity, 47k resistor to limit current, Diac DB3 diode as a trigger, and Triac BT136 as an electronic switch. The test results show that the system can work effectively, where the lights turn on automatically in dark conditions and turn off when it is bright. The use of this system has proven to be efficient in saving energy, easy to operate, and provides high reliability in street lighting applications. This system also offers easy installation and low maintenance costs. For further development, supporting sensors can be added to improve accuracy in various environmental conditions.

Related Authors:

Muhammad Rizki, Electrical Engineering,Jl. Kyai Katsir, Dusun Talar 2, Sumberan, District. Besuk, Probolinggo Regency, East Java 67283, Indonesia
E-mail: Riskisumberan61@gmail.com

1. BACKGROUND

Energy is a basic human need that continues to increase along with the development of life. Fossil fuels, such as petroleum, are the main source of nonrenewable energy sources and have long been the mainstay in meeting energy needs in various sectors.(Diantari et al., 2019).However, the lack of public understanding of the process of generating electrical energy causes minimal awareness to save electricity in daily activities. Most students have also not considered the impact of using electrical energy on environmental sustainability. Therefore, saving electrical energy is an important step in maintaining the availability of energy resources for future generations while reducing negative impacts on the environment.

Uncontrolled increase in electricity consumption can lead to energy waste and increased cost burdens. Public street lighting (PJU) is one of the major contributors to electricity consumption. Street lights that are on all night, even though there is no activity on the street, cause significant energy waste.(Prafitasiwi et al., 2023). And the lack of public awareness of public facilities such as street lights that are often ignored if they are still on during the day. However, the lack of public street lighting can cause dangers such as traffic accidents and crime. Therefore, saving electricity in the public street lighting sector is very important to realize more efficient and environmentally friendly energy use.(TAMBUNAN et al., 2020).

Previous studies have made important contributions to the development of energy-efficient automatic lighting systems. The first study discussed solar-based public street lighting, where solar panels are used as the main energy source to capture and convert sunlight into electricity through the photovoltaic process. This system is equipped with an Arduino Uno microcontroller, LDR light sensor, and MQ-2 sensor that allows street lights to turn on automatically when the light intensity is low or there is fog/ smoke, thereby reducing

conventional electricity consumption.(Generous & Apriaskar, 2020). The second research focuses on the use of light sensors such as LDR, photo transistors, and photo diodes to detect changes in light intensity, which are applied to automatic lighting systems. This technology helps create more efficient lighting solutions by reducing reliance on manual operation.(Syaiful, 2020). The third study developed an automatic garden lighting system that utilizes an LDR light sensor to detect light or dark conditions, as well as an ultrasonic sensor to detect the presence of objects. The lights are designed to turn on and off automatically based on sensor input, providing a significant energy efficiency solution.(Prasetya & Aulia, 2020). These three studies are related works that support the research on the Application of Automatic Lighting Systems for Saving Electrical Energy on Public Roads, by integrating solar power, sensor technology, and automation to create a more energy-efficient and sustainable street lighting system.

The implementation of an automatic lighting system is a solution to this problem. This system allows for automatic regulation of street lighting. Thus, the lights will only turn on at night, thus significantly reducing energy consumption without reducing its main function. In addition, the development of this automatic lighting system is in line with global efforts to support energy sustainability and reduce environmental impacts. With proper implementation, this system not only increases energy efficiency, but also has a positive impact on reducing government operational costs and improving the quality of public services. Therefore, research and implementation of an automatic lighting system for public street lighting is a relevant and strategic solution in answering the challenges of energy efficiency and supporting sustainable development.

2. METHOD

This research method begins with a literature study to understand the basic concepts and technologies related to energy-efficient automatic lighting systems. Furthermore, the system is designed using the main components. After the design, the implementation is carried out by installing hardware to automatically control the lights based on data from the sensors. The system is then tested to ensure the function of each component to observe performance in real conditions. The test results are analyzed to evaluate energy efficiency and system response, and improvements are made if necessary. All processes are documented in the report to provide an overview of the results and recommendations for future development.

a. Theory

The LDR-based automatic lighting system is designed to automatically control the light based on light intensity, using a combination of main components such as LDR, 100k preset, 47k resistor, DB3 Diac diode, and BT136 Triac. LDR (Light Dependent Resistor) functions as a light sensor whose resistance changes according to the light intensity around it.(Desmira, 2022). When the light is dim or dark, the LDR resistance increases, producing a different voltage in the circuit. This voltage becomes a signal to trigger the control system. The 100k preset is used to set the circuit's sensitivity threshold to light, allowing calibration to turn the light on or off according to environmental conditions. The 47k resistor plays an important role in limiting the current in the circuit, protecting sensitive components such as the LDR and Diac from damage due to excessive current, and ensuring the stability of the electrical signal produced. The DB3 Diac diode is used to regulate the triggering of the Triac by providing a stable voltage only when a certain value is reached. This ensures that the BT136 Triac works optimally as an electronic switch that regulates the flow of electric current to the lamp. The BT136 Triac, as the main control component, is able to handle the large current required to turn on the lamp, making this system reliable for public street lighting applications. The combination of all these components creates an automatic system that is energy efficient, works without manual intervention,

and is responsive to changes in light intensity. With this design, the lamp can be turned on efficiently at night and off during the day, providing a more energy efficient and sustainable lighting solution.

Table 1. Components List

Component Name	Number of Components	Component Values
LDR (Light Dependent Resistor)	1	-
VR (Variable Resistor) 104	1	100k
Resistor	1	47k
DB3 Diac Diode	1	32V
BT136 Triac	1	600V
Light	1	12V

b. Design

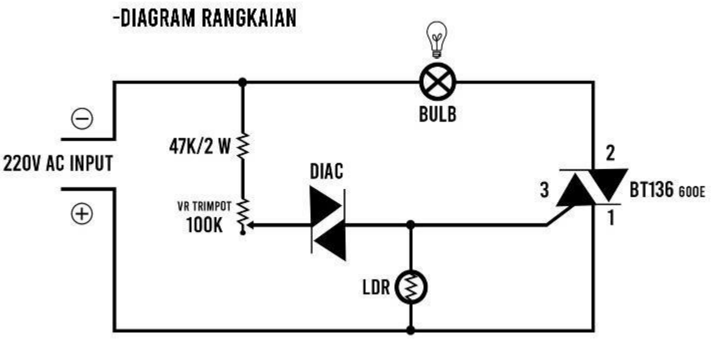

Figure 1. Design diagram

3. RESULTS AND DISCUSSION

Assembly begins with creating a circuit design or electronic schematic of the hardware to be used. After all the designs are complete, the actual assembly of the device is carried out by racing against the schematic that has been made, thus saving time during assembly, avoiding the risk of short circuits in the electric current and minimizing errors in pin matching that make component readings inaccurate.

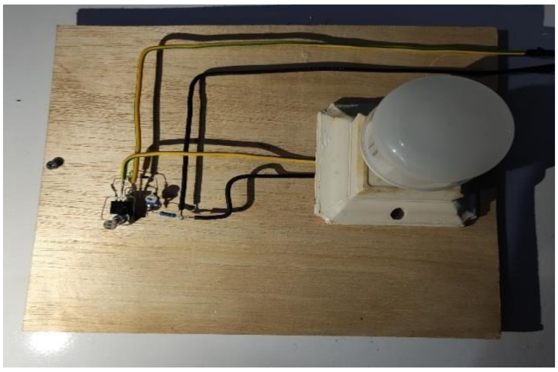

Figure 2. Bright Condition

Testing of the automatic lighting system based on LDR sensors shows that the system can work effectively in controlling the lights based on changes in light intensity. In bright conditions (daytime), the LDR resistance decreases, producing enough voltage to keep the Triac in the off state so that the lights remain off. Conversely, when it is dark (nighttime), the LDR resistance increases, producing a trigger voltage that activates the Diac and Triac, so that the lights turn on automatically. The 100k preset is successfully used to set the system's sensitivity threshold to light intensity, ensuring that the lights only turn on at a certain level of darkness. In addition, the 47k resistor works well in limiting the current, maintaining circuit stability, and preventing damage to components. The system works efficiently without requiring manual operation.

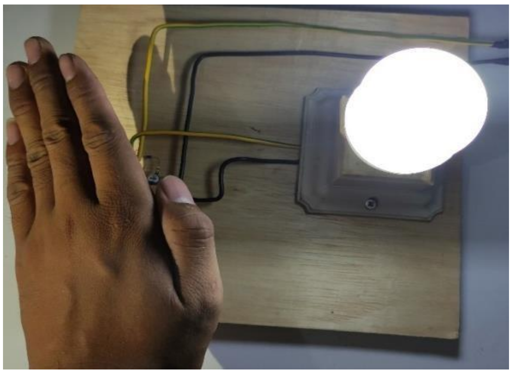

Figure 3. Dark Condition

For LDR Sensor testing, the tool is tested to see if it is able to read and respond to lighting. If the sensor does not detect any lighting, the output value received by the system operator will turn on the light, and vice versa if the sensor detects light around it will turn off.

4. CONCLUSION

The test results show that this system is able to provide an efficient solution for public street lighting. The use of LDR as the main sensor allows automatic control based on the light intensity in the surrounding environment, replacing manual switches that are less practical. The combination of components such as 100k presets and 47k resistors provides flexibility in setting sensitivity and circuit protection. Diac DB3 and Triac BT136 play an important role in ensuring that electricity flows to the lights only in dark conditions. This system is also proven to be energy efficient because the lights only turn on when needed. Although the results are satisfactory, this system is completely dependent on light intensity so it can be affected by extreme weather such as thick clouds. For further development, a backup system or supporting sensors can be added to improve its accuracy and reliability in various environmental conditions. Overall, this system shows effective, economical, and easy-to-implement performance for public street lighting.

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AUTHOR BIOGRAPHY

	**Muhammad Rizki** Born in Sumberan, Probolinggo, November 2, 2006, 1st Semester Student of Electrical Engineering, Nurul Jadid University, Paiton, Karanganyar, and a Graphic Designer, in a Printing Company, Graduated from MA Nurul Wahid Al-wahyuni, precisely in Sumberan Village, the 3rd child of 3 siblings, Achievements that have been achieved, as the 2nd Winner of District Level Graphic Design in the 2022 Sports and Arts Week (Porseni). Email: Riskisumberan61@gmail.com
	**Taufik Qurrohman** Born in Probolinggo, March 17, 2005. 1st semester student of Electrical Engineering, Nurul Jadid University, Paiton, Karanganyar, graduated from Darul Lughah Wal Karomah Vocational School, Sebaung-gending, the 2nd child of 3 siblings. Email: ikorozi2005@gmail.com
	**Muhammad Yusron Karim** Born in Karanganyar-Paiton, Probolinggo, February 18, 2006, 1st semester student of Electrical Engineering, Nurul Jadid University, Paiton, Karanganyar, Graduated from Darullughah Wal Karomah Vocational School, precisely in Kraksaan Village, the 3rd child of 3 siblings. Email: yusronale05@gmail.com
	**Iqbal, may Allah bless you** Born in Karang Anyar Paiton Probolinggo on March 25, 2006, a 1st semester student of electrical engineering at Nurul Jadid University, Karang Anyar Paiton, a graduate of Darullughah Wal Karomah Vocational School in Kraksaan Probolinggo, the second child of 2 siblings. Email: iqbalalallah2@gmail.com