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IOT Based Automatic Light Control System Using Mqtt Protocol

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Abstract: An Internet of Thing-based automatic light control system using the MQTT protocol is an efficient solution for controlling lights on or off. This study aims to design and implement an IOT-based automatic light control system that can be accessed and controlled via the internet network. This system uses the MQTT protocol to communicate between the hardware and software connected to the MQTT Broker. This system also consists of several main components, namely a light sensor, NodeMCU ESP8266, and a user application. The light sensor is used to detect the intensity of surrounding light, NodeMCU ESP8266 to connect to Wi-Fi networks and broker MQTT. The MQTT broker serves as a communication center between publishers and subscribers. MQTT Dash is a user application that provides an interface for manually controlling the user's lights or setting the automatic mode.

Keywords: Auto Light, Light Sensor, MQTT protocol.

1. Introduction

Lamps are a very important and useful lighting medium for humans, because before lamps existed, humans used fire which was developed by burning objects to form a group of lights as lighting at night. When electricity was discovered, humans began to use electricity for lighting with the media in the form of lamps. Lights are used for various purposes, such as lighting at home, roads, decorations and so on.

In everyday life, people often forget to turn off lights that are no longer in use so that this condition causes electricity consumption to continue to be used which causes the cost of using electricity to be higher. Not to mention the distance between the switches which are far from each other. So that the way to control these lights can be done by connecting to the Internet of

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Things (IOT) so that light control can be done easily so as to minimize the use of electrical energy beyond necessity.

Internet of Things (IOT) is a concept where physical devices such as sensors, actuators, or other electronic devices can communicate with each other via the internet because later the Internet of Things (IOT) uses devices that allow them to connect to internet networks such as the NodeMCU ESP8266 device. This module is a platform that is truly effective for communication or control over the internet because it is equipped with an ESP 8266 chip to facilitate development and prototyping in IOT applications and other electronic projects.

2. Literature Review

2.1 Control System

Systems used to control a process automatically to monitor certain conditions associated with the process or system, and take appropriate action if these variables or parameters are at the desired limits [1].

In general, the control system consists of main components, namely sensors, controllers and actuators. Sensors are used to measure variables related to the process or system being controlled. The controller then uses the data from the sensors to take the action to be performed. Finally, actuators are used to implement the action.

There are several types of control systems, including open-loop control systems and closed-loop control systems. Open control systems only use input from the user or operator, while closed control systems use feedback from sensors to regulate the actions taken.

2.2 Auto Light

A type of lamp designed to automatically turn itself on and off depending on specific environmental conditions. Automatic lights generally use sensors such as motion sensors, light sensors, or temperature sensors to detect environmental conditions. Generally, automatic lights are used to save energy and convenience in use in various places such as homes, offices, buildings, or streets.

2.3 Internet Of Things

The term Internet of Things was first introduced by Kevin Aston around 1999. IOT can be described in a collection of devices that are connected to other devices on the Internet network. The device consists of Things whose job is to record data on an environment or object. The results of the recording in the form of data are then forwarded or sent to an application that is on the Internet. The data obtained is then further processed to display the information stored behind a set of data. The benefits of implementing IoT, data from an environment can be accessed from anywhere and anytime.

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2.4 MQTT protocol

Protocol specially designed for machine to machine which has small resources. The MQTT work system implements Publish and Subscribe data. And in practice, the device will be connected to a broker and have a certain topic [2].

Brokers on MQTT function to handle publish and subscribe data from various devices, you can think of it as a special server. Some examples of existing brokers such as Mosquitto, HiveMQ and Mosca.

Publish is a way for a device to send its data to its subscribers. Usually this publisher is connected to a device with a certain sensor.

Subscribe is a way for a device to receive from the publisher. Subscribers can be in the form of monitoring applications and so on, these subscribers will later request data from the publisher.

Topic is like grouping data in a certain category. In the MQTT work system, this protocol is mandatory, every data transaction between Publisher and Subscriber must have a certain Topic.

2.5 NodeMCU ESP8266

An open-source hardware development platform designed to make IoT applications easier. NodeMCU is equipped with a WiFi module, allowing devices connected to NodeMCU to communicate with the internet network. NodeMCU is basically a development of ESP8266 with processing-based firmware. NodeMCU is equipped with a micro USB port which functions for programming and powersupply. NodeMCU uses the processing programming language or the simpler C language which is a package from the ESP8266. The processing language has the same logic and programming structure as the C programming language, only the syntax is different [3].

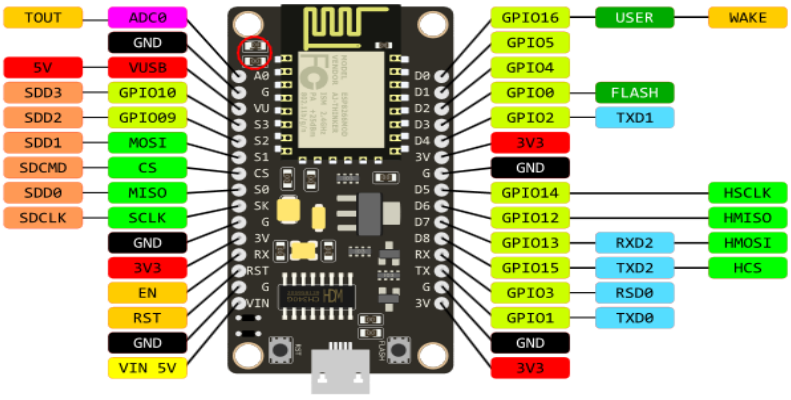

Figure 1 NodeMCU ESP8266

2.6 LDR sensors

Light Dependent Resistor is a type of resistor whose resistance changes due to the influence of the surrounding light. The value of the resistance on the light sensor depends on the size of the

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light received by the LDR itself. This type of resistor is commonly used as a light detector or light conversion quantity meter. The method of installing LDR in a circuit is exactly the same as installing ordinary resistors [4].

The quality of light intensity on sensor readings can indicate the sensor's sensitivity to the light intensity received by the sensor, the sensor has a certain light range so that, when light enters the appropriate area the sensor can activate or detect changes in light intensity when light in the appropriate range enters the LDR sensor, resistance will change according to the intensity of light received by the sensor. In general, the higher the intensity of light received by the sensor, the lower the resistance of the LDR sensor, and vice versa.

Figure 2 Physical LDR

2.7 Relay

Relay is a mechanically controlled or electronically controlled (electro magnetic) switch. The switch on the relay will change its position from OFF to ON when current is flowing through the electromagnet, a magnetic field will be created that can pull or release the switch, so that it can connect or disconnect electricity in the circuit connected to the relay [5].

In general, the condition of the relay or the position of the relay is divided into two, namely:

1. NC (Normally Close), is the initial condition or condition where the relay is in the closed position because it does not receive an electric current.
2. NO (Normally Open), is a condition where the relay is in the open position because it receives an electric current.

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Figure 3 Relays

2.8 C Programming Language

C language is a high-level programming language developed in 1972 by Dennis Ritchie at Bell Labs. This language is used widely in the development of operating systems, compilers, and IOT applications or devices. C language can also be used to implement the MQTT protocol on IoT devices, an example of the MQTT library that can be used in Arduino IDE applications is PubSubClient.

3. Design

3.1. Sensor Circuit Design

This circuit serves as sensor reading input to detect surrounding light and then used by the system as output control data.

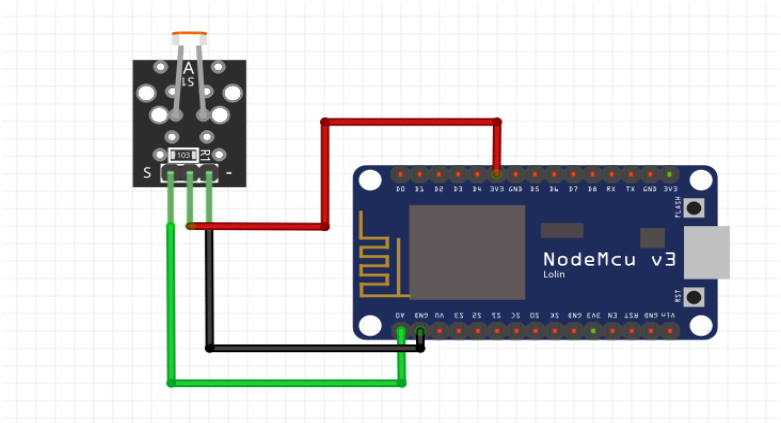

Figure 4 Sensor Circuit

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The design of the sensor circuit path scheme to be made is as follows:

1. The black wire on the sensor is connected to the GND pin on the NodeMCU.
2. The red wire on the sensor is connected to the 3V pin on the NodeMCU.
3. The green cable on the sensor is connected to pin A0 on NodeMCU.

3.2. Rangkaian Modul Relay

This circuit functions as a control switch on or off the lights based on the conditions that have been programmed through the NodeMCU ESP8266.

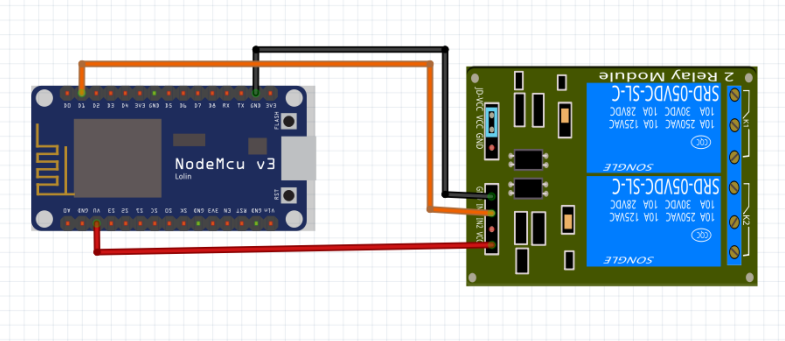

Figure 5 Relay Module Circuit

The circuit path scheme design for the relay module to be made is as follows:

1. The VCC on the relay module is connected to the NodeMCU VU.
2. The GND on the relay module is connected to the NodeMCU GND.
3. IN1 on the relay module is connected to D1 NodeMCU.

This relay module is needed as a substitute for a manual light switch. The way it works is based on the principle of electromagnetic field induction. If a conductor is electrified, a magnetic field arises around the conductor. The magnetic field generated by the electric current is then induced to the ferromagnetic metal.

3.3. Overall System Design

In this series, all of these components form a series arrangement that will be made later. The NodeMCU component is the main component of this design because from the NodeMCU ESP8266 all input and output devices can provide results with the conditions given in a program. To program, Arduino IDE software is needed as a programming tool so that it can run according to what has been programmed.

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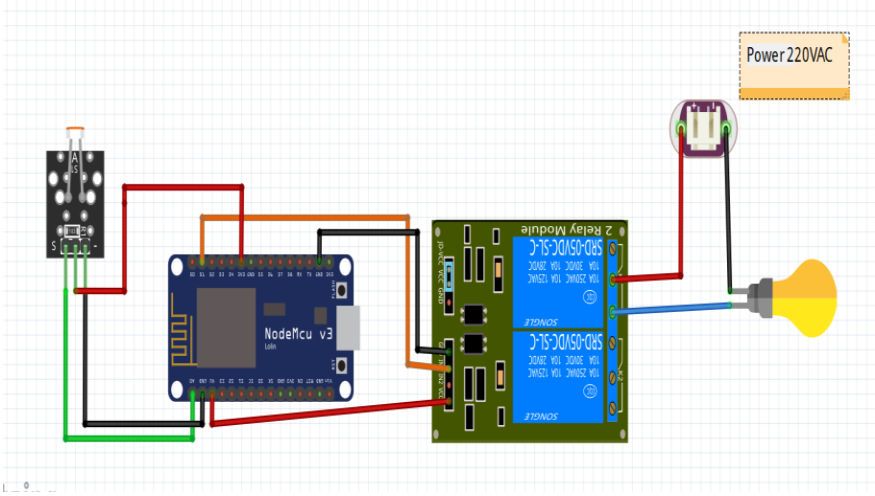

Figure 6 Overall Series

In working this tool accepts two modes, namely automatic and manual. In automatic mode the lights turn on based on the influence of the light sensor that has been programmed through the NodeMCU ESP8266 and in manual mode the system receives commands via a smartphone, in this case the MQTT Dash application, the application gives commands 1 (HIGH) to turn on the lights and 0 (LOW) to turn off the light in manual mode.

4. Results and Discussion

4.1. LDR Sensor Testing

Temporary LDR sensor testing is carried out by giving a flashlight to the sensor and also bringing your palm closer to the sensor to compare the values read by the sensor that appear on the serial monitor in the Arduino software. The following is a test image using the LDR sensor

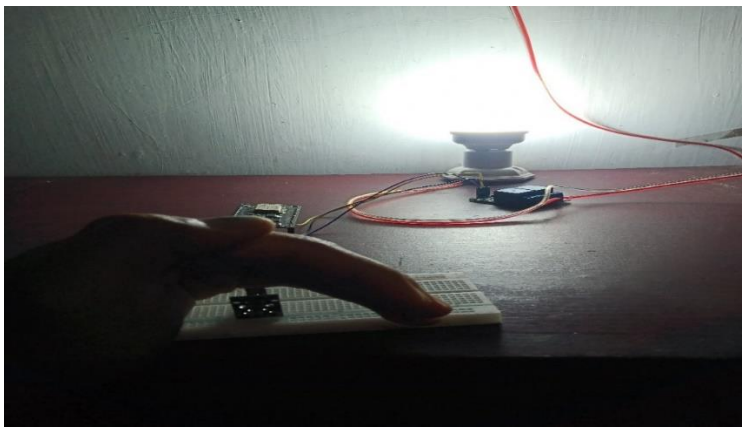

Figure 7 Testing Sensors

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4.2. Communication Design Using Smartphones

Testing the control of lights using a smartphone is carried out using the MQTT Dash application, in which the application interface has been designed to make it easier to use. The following is an overview of MQTT communication using a smartphone, among others :

1. Process 1
   In this process the smartphone publishes data to the MQTT broker, in this case the smartphone sends data or payload "1" to the MQTT broker.
2. Process 2
   After the publisher sends the data to the broker, the NodeMCU ESP8266 subscribes or receives published data and processes the data, in this case, turning on the lights
3. Process 3
   After the light is on, NodeMCU ESP8266 will again publish payload "1" to the MQTT broker.
4. Process 4
   In this process, the smartphone subscribes data from the broker to find out that the data communication process with the MQTT protocol has been implemented.

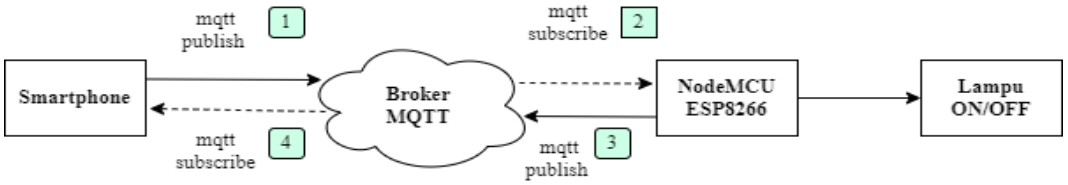

Figure 8 MQTT Protocol Communication Design

The results of testing using a smartphone are shown in the image below:

Figure 9 Test Results with a Smartphone

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5. Conclusion

After the design and manufacture stages of the system were carried out, which were then followed by the testing and analysis stage, the following conclusions were drawn:

1. The design of this light control system uses components such as light sensors which are useful for measuring and comparing light intensity values in automatic light control systems.
2. This tool also uses the NodeMCU ESP8266 microcontroller as a link to IOT, which later in communication with this tool uses the MQTT protocol.
3. In this tool there is a relay as an actuator that regulates the flow of electric current that enters the lamp. By activating and breaking the flow of electricity when a special signal comes in.
4. In this tool, for controlling lights manually with a smartphone, the MQTT Dash application is used.

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