International Journal of Sustainable Applied Sciences (IJSAS)
Vol. 4, No. 8, 2026: 859-864

Monitoring Long-Distance Light Control Combination of Switch and Cross Based on Iot

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ARTICLEINFO

Keywords: IoT, ESP32, toggle switch, cross switch, Telegram Bot.

Received : 20, June
Revised : 22, July
Accepted: 25, August

ABSTRACT

The development of industrial electronics technology has undergone significant changes with the advent of the Internet of Things (IoT). Remote control of lights has become very easy with the help or collaboration with other devices such as the ESP32, which already has several input and output pins as well as Wi-Fi and Bluetooth availability. Commands via smartphone are executed using a Telegram Bot to instruct the ESP32 to activate or deactivate the relay. The relay contact, which functions similarly to a toggle switch, can turn the light on and off remotely. The combination with a cross switch allows the light in a building to be operated from two locations and can be applied in corridors or staircases. In addition, remote checking of the lamp status can still be performed. From the research conducted, a prototype module for remote lamp control using a toggle switch and a cross switch yielded the expected results.

DOI: https://doi.org/10.59890/ijsas.v4i8.42
ISSN-E: 3025-5597
http://ijsasjournal.my.id/index.php/ijsas

INTRODUCTION

Many lamp control systems have been implemented using IoT, making it easier for users to control and monitor the status of the lamps while being far from their homes or office buildings. This article discusses controlling lights from three locations, including remotely using the Internet of Things. In previous research, light control was conducted from two locations, namely in buildings or residences, and could be controlled remotely using the Internet of Things. By utilizing microcontrollers, sensors, and the internet network, the IoT-based lighting control system provides a practical solution that allows users to flexibly manage lighting and save electricity thru devices such as smartphones, laptops, or computers.

There have been several previous studies that only controlled two points, namely in buildings and/or residential areas, and the other points were located far apart. This research uses more than two points, allowing control functions to be performed in several locations according to the needs of room functions such as corridors and stairs. Checking the status of the lights can be done remotely using the ESP32 for IoT applications. The toggle switch and cross switch for operating two locations are still used within the building itself, for example, when entering the corridor or climbing the stairs and exiting the corridor or after reaching the end of the stairs to turn off the lights again after use. When outside and at a distance from the building, the status of the lights can be checked and turned off remotely as an effort to save electrical energy.

LITERATURE REVIEW

Internet of Things (IoT) is a concept of internet development to connect everyday objects so they can communicate and be controlled automatically. In the field of lighting, IoT has been utilized for remote control of lights, thereby enhancing user comfort and energy efficiency. Previous research has been conducted by [Researcher's Name, Year] on "Implementation of Internet of Things in Home Lighting Control System Using Telegram Bot and NodeMCU ESP8266". The results of the research indicate that the control of the lights can be done in real-time. However, the research is still limited to just one room. Therefore, in this research, the development of the lighting control system is not limited to just one room, but can also be applied to corridor and stair areas. In addition, this system integrates a combination of toggle switches, cross switches, and relays operated using the ESP32 microcontroller.

METHODOLOGY

This research was conducted with experiments on a trial module based on practical course lectures, and then developed into a function with more operational points.

The addition of a cross switch allows the operation of lights in the building, especially in the corridors, to still be controlled from two places or two points, while the use of the ESP 32 enables remote operation, even allowing the status of the lights to be monitored from a distance. The initial stage of the research is to create a basic installation for operation from 3 locations/3 operation points in laboratory 204 of the Electronics Technology study program at Aceh

Polytechnic, where the components used are one cross switch and two toggle switches. Then, one of the toggle switches is replaced with a relay that has contacts identical to a toggle switch.

Next, programming/coding for the ESP 32 is carried out with the following objectives:

1. Operating the relay remotely via commands from a smartphone, turning the light on/off.
2. Checking the status of the light from the smartphone to see if it is on or off.

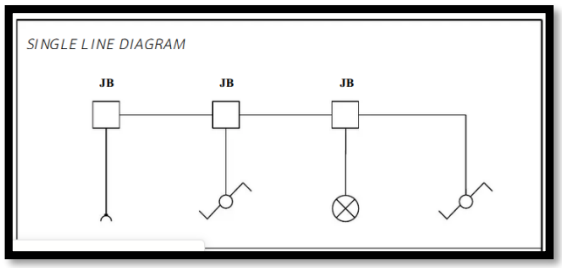

Figure 2.1 Installation of the toggle switch wiring (1)

In the above Figure 1.1, it shows the one-line diagram installation of the toggle switch, where turning on and off can be done with one of the toggle switches. In the previous journal, one of the toggle switches was replaced with a relay function that can be controlled remotely using IoT. (2). Control development is carried out by controlling the lights not only at 2 points but also at 3 points, namely in the building/residential area there are 2 points and the 3rd point is remotely.

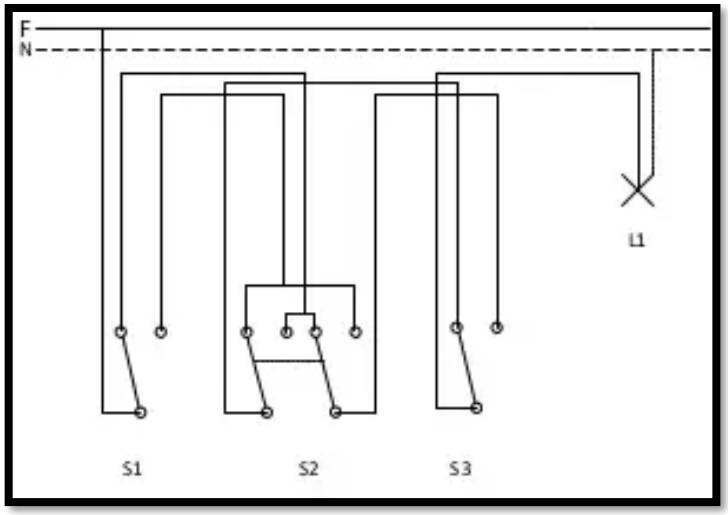

Figure 2.2 Installation of toggle and cross switches

In Figure 2.2, the operation of the lights can be done from 3 points, allowing manual control of the lights in the corridor or stairs from 2 points, with the 3rd point utilized for IoT control. This development enables the operation of the building corridor and stairs to still be performed from two places, namely turning on the lights when entering the corridor or climbing the stairs. After

using the corridor and stairs, the lights can be turned off at the second switch. The third switch function can be replaced with a relay, where the operation is done remotely using a Telegram bot on a mobile phone and ESP32 to give the relay on/off command.

RESEARCH RESULT AND DISCUSSION

The trend of IoT usage is now very widespread, making it easier for operators in the industry and even for individual purposes.

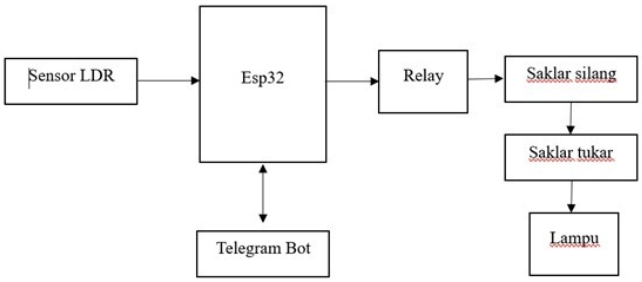

Figure 2.3 System block diagram

In Figure 2.3, there is a block diagram showing how the system works.

A building with a corridor will use lights when entering the corridor and turn them off at the end. When outside the building, users or responsible personnel can monitor the status of the corridor lights using a phone and ESP32.

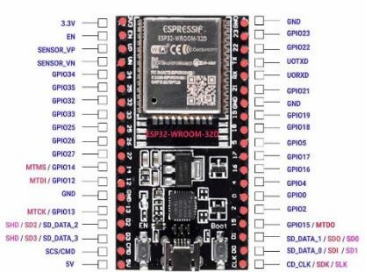

Figure 2.3. ESP 32

ESP32 is a highly popular microcontroller chip used as an IoT module, which can be considered a derivative of Arduino and has Wi-Fi and Bluetooth capabilities. ESP32 is developed by Espressif. This device is equipped with a dual-core processor. (3)

ESP32 Devkit V1 is a popular IoT development board with 30 or 38 pins (usually 30), featuring Wi-Fi & Bluetooth, 25+ GPIO, 15 channels of 12-bit ADC, and 16 channels of PWM. This board has power pins (3.3V, VIN 5V, GND), UART, SPI, and I2C, making it versatile for various sensors and actuators.

Main Pinout of ESP32 Devkit V1 (30 Pins)

Power Pins:

- VIN/5V: 5V voltage input (can be from USB or external adapter).
- 3V3: Regulated 3.3V output to power sensors.
- GND: Ground (voltage reference).
- GPIO (General Purpose Input Output): Pins that can be programd as digital input/output.

• ADC (Analog to Digital Converter): Pins 34, 35, 36, 39 can only be used as analog input, not for output.
• ADC2 (Pin ADC2): Do not use when Wi-Fi is active, as it can cause errors.
• DAC (Digital to Analog Converter): GPIO 25 and 26, produce original analog signals.
• Touch Pins (Capacitive Touch): Some GPIOs (e.g., 0, 2, 4, 12, 13, 14, 15, 27, 32, 33) have internal touch sensor capabilities.
Communication:
• UART: TX2/RX2 (GPIO 17/16) and TX0/RX0 (GPIO 1/3)
• I2C: Default SDA (GPIO 21) and SCL (GPIO 22)
• SPI: VSPI (GPIO 5, 18, 19, 23) and HSPI (GPIO 12, 13, 14, 15)
Special Pins (Strapping Pins): GPIO 0, 2, 4, 5, 12, 15 have special functions during booting for flashing.
EN (Enable/Reset): Pin to reset the microcontroller (active low).

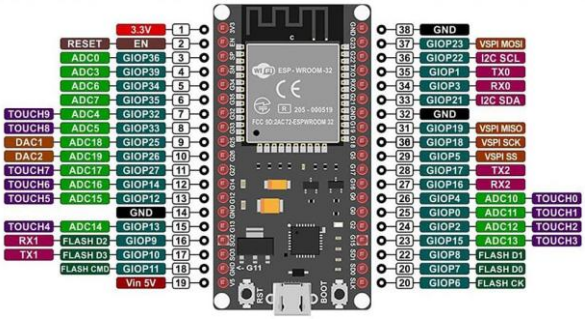

Figure 2. 42 Pinout from ESP32 Devkit V1 telegram bot

Figure 2.43. Telegram Bot

In image 2.43, there is a telegram bot menu where there are commands to check the lamp status and commands to turn the lamp off/on.

- To know the lamp's status, type "status" and send it, the ESP32 will send the lamp's status.

- To operate the relay, type "press." Then the ESP32 will send a command to activate the relay, so the lamp will turn on or off according to the toggle switch function.

CONCLUSIONS AND RECOMMENDATIONS

Based on the design and testing results of the remote light control monitoring system using a combination of toggle switches and cross switches based on IoT, it can be concluded that:

1. The system was successfully designed with 3 control points. Two points use toggle switches and cross switches for manual operation in corridors/stairs, and one point uses a relay controlled via ESP32 and Telegram Bot.
2. Users can turn the lights on and off manually or remotely using a smartphone. The status of the lights can be monitored in real-time thru the Telegram Bot by typing the status command.
3. The implementation of this system can increase electrical energy efficiency because the lights can be turned off remotely when not in use.

For further development, it is recommended:

1. Adding an automatic scheduling feature to turn the lights on and off.
2. Adding PIR or LDR sensors so that the lights can turn on automatically based on the presence of people or light intensity.
3. Developing a dedicated mobile application to make the monitoring interface more user-friendly compared to the Telegram Bot.

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