MONITORING SYSTEM FOR TRAFFIC LIGHT LAMP DAMAGE USING BLYNK APPLICATION BASED ON IOT ESP32

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ABSTRACT
The performance of traffic lights often encounters issues such as lights being out or other malfunctions, which can result in erratic traffic patterns and even total gridlock at the same intersection, potentially leading to accidents among drivers. Therefore, it is crucial to design a monitoring system for traffic light malfunctions using the Blynk application based on IoT ESP32. This system aims to facilitate technicians in monitoring the condition of traffic lights in case of malfunctions across all lanes. It utilizes an ESP32 microcontroller, LED lights or traffic lights, resistors as converters, and the Blynk application as a monitoring tool. From the testing of the prototype device, it was found that the average values for red light were ADC 1.367, voltage 1.10 volts, and current 5.01 mA. For yellow light, the values were ADC 1.265, voltage 1.02 volts, and current 4.63 mA. As for green light, the values were ADC 1.283, voltage 1.03 volts, and current 4.70 mA. The average delays for red, yellow, and green lights were 2 seconds, 2 seconds, and 5 seconds respectively, with the green light flashing three times for 0.5 seconds each time for all lanes.

Keywords: BLYNK; ESP32; microcontroller; led; traffic light

INTRODUCTION
The world is now equipped with traffic lights, also known as traffic signals, stoplights, and road signals, installed at intersections globally to control traffic flow. To guide traffic, the three basic colors Red, Yellow, and Green (Stop, Caution/Proceed, and Go, respectively) are used. The performance of traffic light systems often encounters issues such as lights going out or other malfunctions, which can lead to disorganized traffic systems, potentially causing total congestion at the same point and even accidents among drivers. Therefore, it is crucial to design a monitoring system for traffic light malfunctions using the IoT-based Blynk application on ESP32. This facilitates technicians in monitoring the condition of red, yellow, and green traffic lights on each lane using the Blynk application.

In previous research conducted by Ade Mufti Imam Hidayat on April 4, 2022, titled "Traffic Light Monitoring and Control System Using Labview Based on Arduino," the aim of the study was to create and design a traffic light monitoring and control system using Labview based on Arduino Uno. The methodology of this research involved engineering the monitoring and control of traffic lights A, B, C, and D using Labview as the software, Arduino Uno as the microcontroller, traffic lights as the medium for regulating vehicle flow, and infrared sensors as vehicle flow detectors. Based on the test results of the prototype tool, the Traffic Light Monitoring and Control System Using Labview Based on Arduino Uno, the time adjustment in each lane is such that if one lane's infrared sensor detects vehicle density, the infrared indicator on Labview will remain on and extend the green light duration to 15 seconds (an increase of 5 seconds from the previous duration) to reduce congestion (Ade Mufti Imam Hidayat, 2022).

In subsequent research conducted by Slameta, Anisa Pirana, and Griffani Megiyanto R on August 27, 2020, titled "Smart Traffic Prototype with Integrated Traffic Light Damage Detection Feature Using Google Firebase," the research methodology involved using BH1750 light sensors and ACS712 current sensors, Google Firebase as the database, and the internet as the medium for data transmission to the receiver. The BH1750 light sensors and ACS712 current sensors would inform the microcontroller if a traffic light malfunction was detected, after which the microcontroller would send the data to an Android smartphone via the internet. The research design process involved the microcontroller collecting data from the light and current sensors. If the data received by the microcontroller were abnormal or did not match the predetermined program data, the microcontroller would send information to the Google Firebase application via the internet (Slameta, Anisa Pirana, and Griffani Megiyanto R, 2020).

Subsequent research conducted by Adam, Muharnis, Ariadi, and Jefri Lianda, titled "Application of IoT for Public Street Lighting Monitoring Systems," addresses the issue of public street lighting (PJU) as an infrastructure element that supports the comfort and safety of road users at night. The existing systems for inspecting and reporting PJU lamp malfunctions are limited, prompting this research to apply Internet of Things (IoT) technology to monitor disruptions and damage to PJU lamps. The methodology used in developing the monitoring system includes literature review, needs analysis, design, development, and testing, employing ZMPT101B sensors, ACS712 sensors, and the ESP8266-01 WiFi module. The ZMPT101B sensor measures PLN voltage values, while the ACS712 sensor measures the current in the street lights. The ESP8266-01 is a WiFi module that can connect directly to WiFi and establish a TCP/IP connection, enabling data transmission from the Arduino Mega2560 microcontroller to the internet. Consequently, the system can be accessed via a mobile phone or laptop. The test results show that the voltage sensor has an accuracy rate of 96.7%, thus voltage and current monitoring are displayed in the form of graphs and indicators (Adam, Muharnis, Ariadi, and Jefri Lianda, 2020).

METHOD

This type of research is experimental, where the process involves creating a prototype system for monitoring traffic light malfunctions using the IoT-based Blynk application on ESP32.

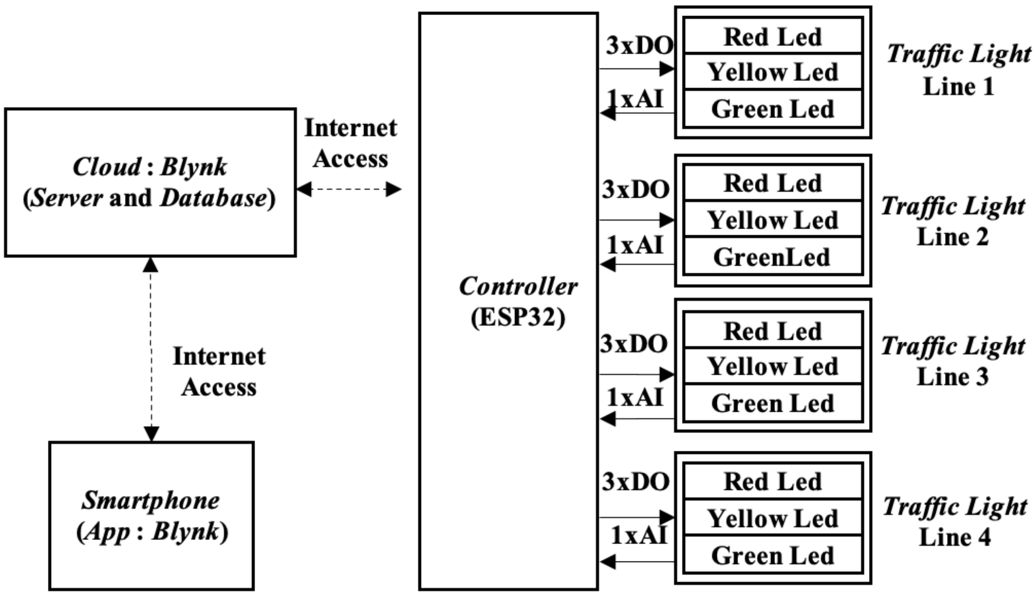
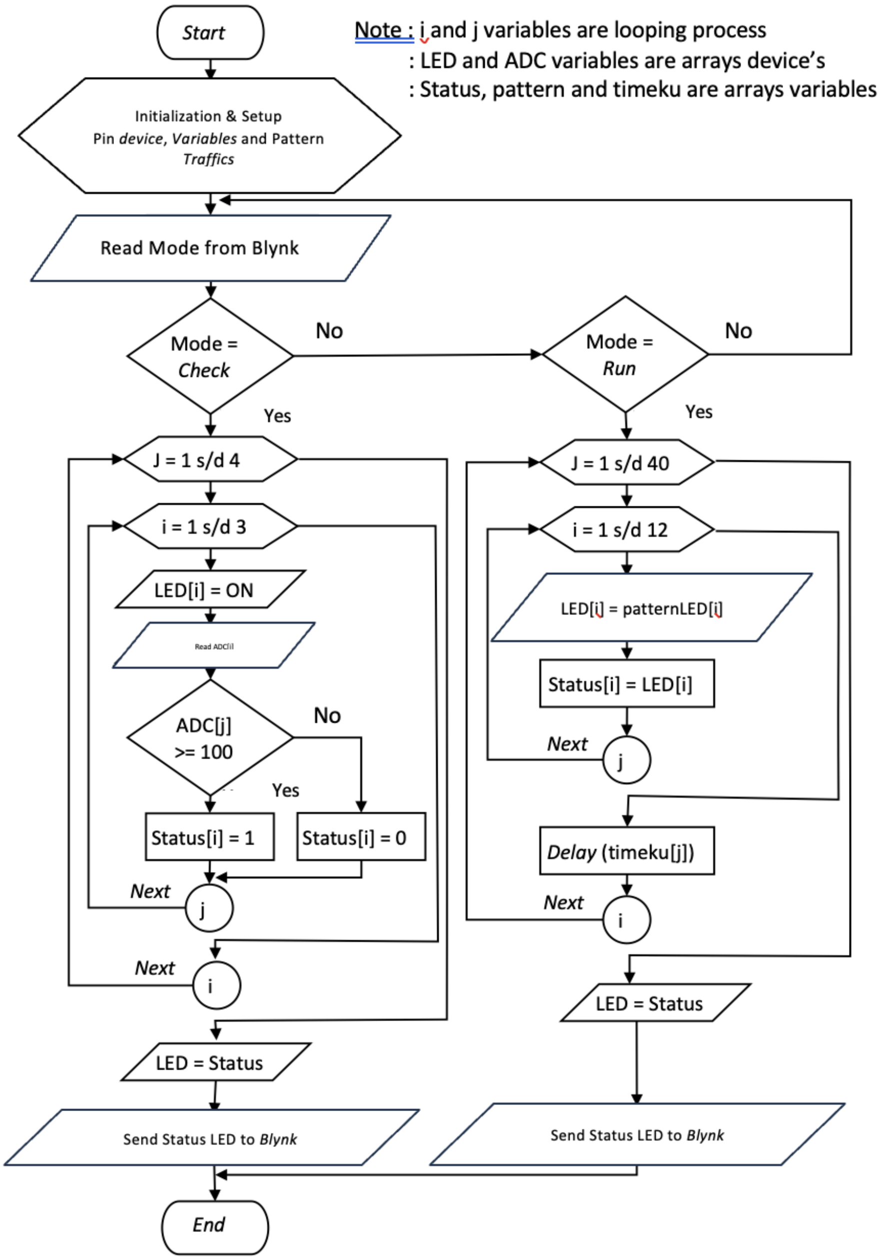


Figure 1. Block Diagram

Figure 1 shows the block diagram of the traffic light malfunction monitoring system using the IoT-based Blynk application on ESP32. The performance of the traffic light system can be



monitored through the Blynk application, and if there is a malfunction in one of the LEDs or traffic lights, the microcontroller will send information to the Blynk application connected to the internet.

Figure 2. Flowchart monitoring traffic light lamp

In Figure 2, the traffic light monitoring system operates in two stages: Check Mode and Run Mode. In Check Mode, the system checks 12 LED lamps or traffic lights using the Blynk application. If all the LED lamps or traffic lights are on, the ADC (Analog to Digital Converter) will read their logic value as (1) and send the status of the LED being on to the Blynk application. If one of the LED lamps or traffic lights is off, the ADC will read the logic value as (0) and send the status of the LED being off to the Blynk application. In Run Mode, the system monitors the performance of the traffic lights using the Blynk application. The LED status on the prototype device will be sent to the Blynk application through the microcontroller connected to the internet.

The data to be tested includes the performance of the traffic light prototype against the monitoring system on the Blynk application, as well as the overall system testing.

1. Testing the performance of the prototype device and the Blynk application on traffic lights for lanes 1, 2, 3, and 4 at each intersection.
2. Testing the monitoring system for malfunctions in 12 LED traffic lights using the Blynk application.
3. Testing the response time of the Blynk application in receiving malfunction information from the traffic light prototype device.

RESULTS

This device is designed for a traffic light malfunction monitoring system using the IoT-based Blynk application on ESP32. The device will operate and monitor the condition of the traffic lights using the Blynk application connected to the internet. If one of the traffic lights—red, yellow, or green— is either off or on, the ADC (Analog to Digital Converter) signal will send the status of the red, yellow, and green traffic lights to the Blynk application indicator.

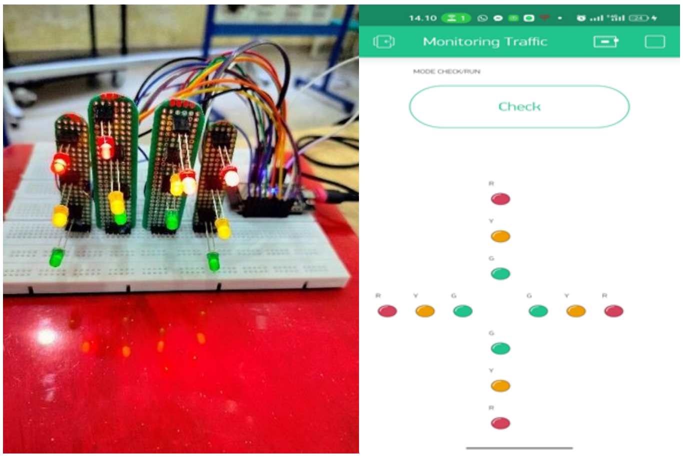


Figure 3. All lamps on

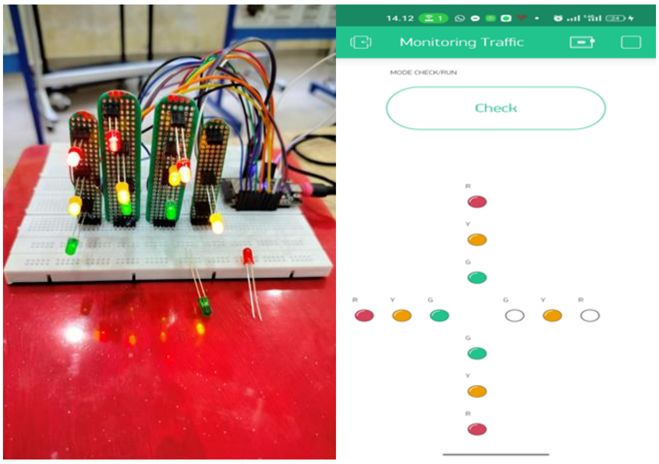


Figure 4. Condition: 2 lights on lane 1 are off

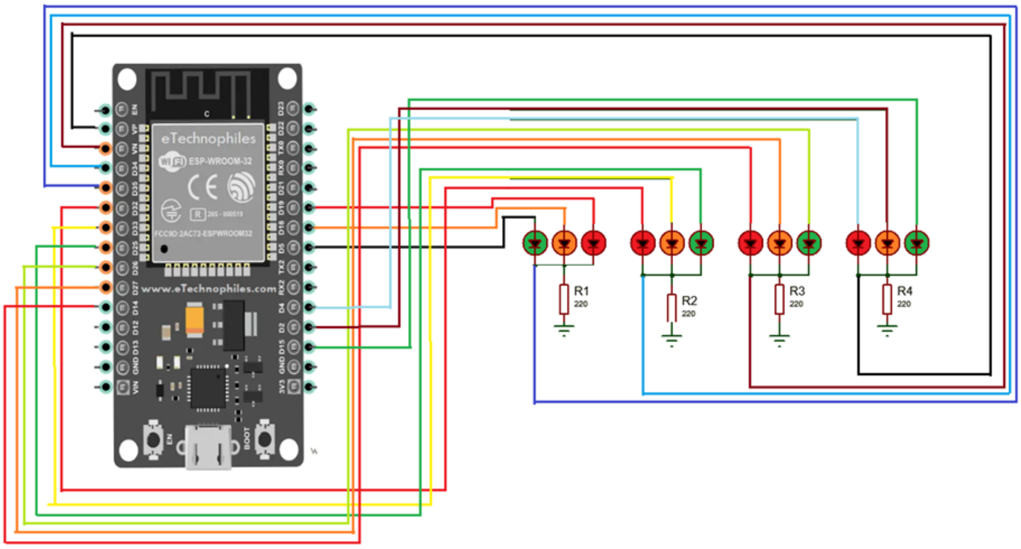


Figure 5. Wiring diagram

The wiring diagram in Figure 5 uses the ESP32 microcontroller, where the output on the ESP32 microcontroller for lane 1 is as follows: Pin D5 to the green LED, D18 to the yellow LED, and D19 to the red LED. For lane 2, Pin D32 to the red LED, D33 to the yellow LED, and D25 to the green LED. For lane 3, Pin D14 to the red LED, D27 to the yellow LED, and D26 to the green LED. For lane 4, Pin D4 to the red LED, D2 to the yellow LED, and D15 to the green LED. The microcontroller input uses ADC (Analog to Digital Converter) pins connected to ground and a resistor, with lane 1 connected to Pin ADC D35, lane 2 to Pin D34, lane 3 to Pin VN, and lane 4 to Pin VP.

Table 1.
Pin Input and Output Connections

Pin Device		Pin Controller	
Traffic Light	LED	Hw	Sw
Post 1	Led Red	D19	19
	Led Yellow	D18	18
	Led Green	D5	5
	Resistor Converter (I/V)	D35	11 (ADC1_7)
Post 2	Led Red	D32	32
	Led Yellow	D33	33
	Led Green	D25	25
	Resistor Converter (I/V)	D34	10 (ADC1_6)
Post 3	Led Red	D26	26
	Led Yellow	D27	27
	Led Gren	D14	14
	Resistor Converter (I/V)	VN	8 (ADC1_3)
Post 4	Led Red	D4	4
	Led Yellow	D2	2
	Led Green	D15	15
	Resistor Converter (I/V)	VP	5 (ADC1_0)

DISCUSSIONS

In testing the traffic light malfunction monitoring system using the IoT-based Blynk application on ESP32, the performance of traffic lights during operation is monitored using the Blynk application connected to the internet, and the condition of LED traffic lights in all lanes is monitored using the Blynk application connected to the internet. The monitoring process is conducted in two stages: Check Mode and Run Mode.

Check Mode:

- This mode is used for monitoring the malfunction of LED traffic lights in all lanes.
- A resistor connected to Ground is used as the input to the ADC (Analog to Digital Converter) to obtain data or ADC values on the serial monitor.
- The data from the serial monitor will be taken, with the maximum ADC value (4095) indicating that the LED light is on, and an ADC value below 100 indicating that the LED light is off.
- These ADC values will be incorporated into the program to operate the traffic light monitoring system in Check Mode.
- If the LED traffic lights in all lanes are on, the ADC signal will send the status of the LED traffic lights to the monitoring indicator on the Blynk application.
- If any LED traffic light in any lane is off, the ADC signal will send the status of the LED traffic light to the monitoring indicator on the Blynk application.

Run Mode:

- This mode is used for monitoring the performance of traffic lights using the Blynk application connected to the internet.
- In Run Mode, the system does not check for LED malfunctions as in Check Mode.

Table 2.
The response time of the Blynk application when receiving information about traffic light malfunctions from the prototype device.

Blynk Display	Device Display	Time
Lane A	Lane A	2.23 second
Lane B	Lane B	2.58 second
Lane C	Lane C	2.29 second
Lane D	Lane D	2.23 second

Table 2 shows the traffic light monitoring system's duration of time for the Blynk application to receive information from the prototype device. The times recorded are as follows: Lane A for the prototype device and Blynk is 2.23 seconds, Lane B for the prototype device and Blynk is 2.58 seconds, Lane C for the prototype device and Blynk is 2.29 seconds, and Lane D for the prototype device and Blynk is 2.23 seconds.

CONCLUSION

Based on the results of testing the prototype device for monitoring traffic light malfunctions using the IoT-based Blynk application on ESP32, it can be concluded that this prototype system effectively monitors the performance of traffic lights across all lanes connected to the Blynk application via the internet. The prototype device is capable of monitoring malfunctions in red, yellow, and green traffic lights across all lanes using the internet-connected Blynk application. The monitoring process involves two stages: Check Mode and Run Mode.In Check Mode, the system monitors the status of LED traffic lights across all lanes using the ADC (Analog to Digital Converter) inputs. If all LED traffic lights in all lanes are on, the ADC signal sends the status of the LED traffic lights to the monitoring indicator on the Blynk application. If any LED traffic light in any lane is off, the ADC signal sends the status of the LED traffic light to the monitoring indicator on the Blynk application.

From the testing results of the traffic light malfunction monitoring system, the average ADC values, voltage (Volts), and current (mA) for each lane are as follows:

- **Lane 1:**
  - Red LED: ADC 1411, Voltage 1.14V, Current 5.17mA
  - Yellow LED: ADC 1269, Voltage 1.02V, Current 4.65mA
  - Green LED: ADC 1275, Voltage 1.03V, Current 4.67mA
- **Lane 2:**
  - Red LED: ADC 1405, Voltage 1.13V, Current 5.15mA
  - Yellow LED: ADC 1238, Voltage 1.00V, Current 4.53mA
  - Green LED: ADC 1278, Voltage 1.03V, Current 4.67mA
- **Lane 3:**
  - Red LED: ADC 1282, Voltage 1.03V, Current 4.70mA
  - Yellow LED: ADC 1280, Voltage 1.03V, Current 4.69mA
  - Green LED: ADC 1306, Voltage 1.05V, Current 4.78mA
- **Lane 4:**
  - Red LED: ADC 1370, Voltage 1.10V, Current 5.02mA
  - Yellow LED: ADC 1272, Voltage 1.03V, Current 4.66mA
  - Green LED: ADC 1275, Voltage 1.03V, Current 4.67mA

Run Mode is used to monitor the performance of traffic lights or to determine which lanes are currently showing red or green lights using the internet-connected Blynk application

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