

Determination Of Traffic Lights Duration By Identification Of Vehicle Numbers Using IoT

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Abstract— This research aimed to reduce the duration of time for quiet roads. Each motorized vehicle installed a WeMos chip as a client that contained each vehicle's license plate data. In the middle of the intersection, WeMos chip was installed as a traffic light controller to determine the duration and connect with cloud internet as a database server. It was installed at a distance of 50 meters as a scanner. It also detected the direction of arrival of motorized vehicles. Then, it would send the data to the cloud. It regulated the duration of the traffic light based on the data received and processed by the database server in each lane at the intersection. Determining the duration of traffic lights was based on sample time of motorcycles and cars, 1 second for motorcycles and 3 seconds for cars. This determination depended on the number of road junctions installed by this system. It was made standard, namely the total duration of time divided by the number of intersections. This time duration would run in a fixed order. If the number of vehicles on each track was as dense, it would skip certain paths. If one of the lanes did not have a vehicle, it would reduce the crowded of motorized vehicles from the other lanes because it would get a green light turn again without waiting for the time from the empty lane. In conclusion, it would be able to break down traffic density by giving priority time duration scale based on the calculation of the number of motorized vehicles by identifying the SSID of the vehicle license plate.

Keywords— *Traffic Light, Identification of License Plate,IOT, Wemos D1, WiFi*

I. INTRODUCTION

This Activities of human cause the production of facilities to help their activities. One of them is land transportation facilities. For instance, they are cars, motorbikes, and other land transportation. This condition causes traffic jam especially crossroad of urban areas because it has a number of dense vehicles. Traffic lights regulate the flow of vehicles in order to break down congestion. It makes the drivers drive orderly and follow the duration of the lights. [1]

The problem emerges when there is no vehicle on one road but the green light is on. It causes the other drivers on the other road must wait their green light. It can cause the long traffic jam on the other side.

In this case, it will apply a technology, which can detect vehicle license plates to find out the number of vehicles passing on each road in order to be a reference for the duration of crossing lights and reduce vehicle density. [2] For data control and processing systems, it consists of a microcontroller as a vehicle identity chip that has been filled with vehicle number license plate data. It is as a chip scanner that is used to receive and process data from the vehicle's identity chip. It is the center of the Traffic Light Controller that is used to determine the number of vehicles passing on each road section and determine the duration of the traffic lights. It expects that it can realize a technology that can be an alternative to reduce the density of vehicles on each road at the intersection.

Traffic Conditions at Four Intersections

The following figure shows the traffic condition at four intersection. [3] Two road sections look crowded and two more roads look quiet. They must have the different duration setting.



Fig. 1. Traffic condition at four intersection

Of course the denser current will get a longer duration compared to the rather quiet path.



Fig 2. The chaotic situation at the intersection

This condition requires structuring and setting the exact duration of the traffic lights so that there is no clutter at the intersection.

II. LITERATURE REVIEW

Previous Research

The researchers will mention some previous researches as follows. It intends to improve and compare the production of hardware and software in order to it can run smoothly and in accordance with the expectations of the authors.

The first is "Internet of Things (IoT) as Green City Economic Development Smart Transportation System" (Slamet Winardi, et.al 2017). This study discusses the installation of chips in every vehicle with the IoT method as a development of smart transportation to create an environmentally friendly city and energy savings. With themem chip, each vehicle will be easily recognized or identified on every road in the city. [8]

The second is "Utilization of the Internet of Things (IoT) as a Management Solution for Transportation of Motorcycle Vehicles" (Wiwoho et.al 2017). It used ESP8266 Chip WeMos which functions as a client and router that contains an identity (SSID) in the motorized vehicles. Then, the ESP8266 chip is installed on the vehicle and functions as a client that transmits data. If it finds an access point, this chip will be connected and send an SSID to the access point which is then forwarded to the server to be recorded into the database. Each client will have an IP address obtained from the configuration after connecting to the WiFi signal on the access point. The computer and ESP8266 chip must be connected to the same access point. [5]

The third is "Analysis of Traffic Light Cycle Time with Agent-Based Modeling" (Yestica, 2014). The result showed that it could not detect time accurately. The disadvantage is that the vehicle cycle cannot determine how long the traffic light duration is based on the number

of vehicle densities, which results in the buildup of a vehicle's lane

The fourth is "Traffic Light Regulator Simulator Based on time and vehicle density AT89S52 Microcontroller based" (Agung, 2009). The vehicle density and types of vehicles that pass. [1]

The fifth h is "Introduction to Motorized Plate" (Mellolo, 2012). It identifies the plate with image processing which is only used to recognize the character and base color of the plate.

The sixth is "Simulation of Traffic Light at the Intersection with the Atmega 328 Microcotroler System" (Faujiyah and Tri, 2017). The result showed about design and data collection during busy traffic light conditions. [6]

III. RESEARCH METHODS

The design of a traffic light system device has a long and related process sequence between one data and another systematically. [7] To determine the duration of traffic lights by calculating the number of vehicles using vehicle number plate identification based on the Internet of Things (IoT).

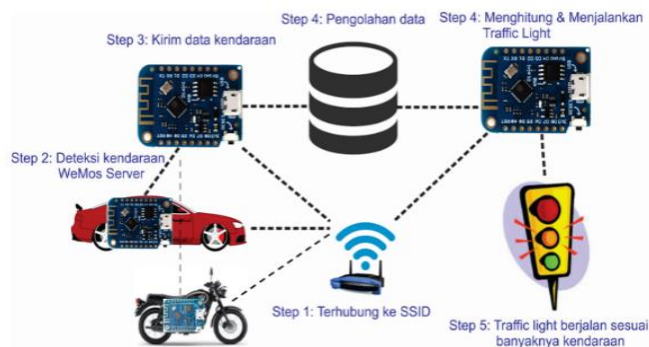


Fig. 3. System Working Principles

Based on figure above, it can be explained the function as follows:

- **Wemos D1**
 - a. Vehicle Identity Chip, it is used to send motorized vehicle license plate data signals to ScannerChip1.
 - b. Wemos D1 (Traffic1), it as a Chip Scanner 1 which is used to receive and process vehicle identity data or license plate from the vehicle identity chip. Data is sent to the database. It functions as a result of the number of vehicles on each track.
 - c. Wemos D1, it as a central traffic light that is used to run a traffic light based on a predetermined duration with the number of vehicles passing on the Wemos D1 Scanner
- **Database Server**

It is used to store data information that has been produced by each device. Data is processed to be used as a process for the duration of traffic lights. Then, it will be sent to Web Monitoring or Web Server.

- **Web Server**

It is used to display data information that has been processed by the database to be used as information on the number of vehicles in each traffic. Then, it can provide information on the duration of traffic lights for each traffic generated.

- **Wifi Access Point**

It is used to connect the Wemos D1 device to communicate with each device.

- **Traffic Light**

It is used as a traffic light for each intersection line.

TABLE I. JUNCTION PATH DATA

No	Street Name	The width of the road	Distance of Wemos Traffic Placement from Wemos Center
1	Manyar	6 meters	50 meters
2	Klampis	8 meters	50 meters
3	Arief Rachman Hakim	8 meters	50 meters

Based on table I it can be seen the width of the road that serves to determine the duration of the duration of each phase. Then, wemos placement distance is used to calculate how many vehicles pass on each intersection line. For phase values, it can be seen in table II

Determination of the Phase Time of Traffic Lights

In determining the time phase of traffic lights, it has been determined the normal time between green, yellow and red of the traffic lights as follows:

TABLE II. GREEN LIGHT NORMAL TIME [4]

Junction Size	Average Road Width	Normal Time of Green Light
Small	6-9 meters	4 seconds/ fase
Medium	10-14 meters	5 seconds/ fase
Big	> 14 meters	>5 seconds/ fase

Analysis of table II is the time duration for the green light that will be applied for the calculation of the traffic light duration per motorized vehicle based on the width of the road. To determine the count of traffic lights is as follows:

$$H1 = (JK * FW) + 5 \dots\dots\dots (1)$$

Where as H1 = First Green Crossing Time
 JK = Number of vehicles crossing
 FW = Time Phase

H1 is a green light count time at a crossroads 1. It is based on the number of vehicles that cross the intersection line 1, so that the number of vehicles is multiplied by the time phase on

the width of the road shown in table 1. Then, it is added with 5 seconds. This 5-second time serves as a time delay for the vehicle at the time of the green light. Then, it can be generated count on each path as follows:

TABLE III. RED LIGHT NORMAL TIME

Jl. A.R. Hakim	Jl. Klampis	Jl. Manyar
Green (H1)	Red (M2)	Red (M3)
Red (M1)	Green (H2)	Red (M3)
Red (M1)	Red (M2)	Green (H3)

Analysis of table III is the duration of the red light. It determines the red light count on each crossing so that it can form as follows:

$$M1 = (H2 + H3 + LK) \dots\dots\dots (2)$$

$$M2 = (H1 + H3 + LK) \dots\dots\dots (3)$$

$$M3 = (H1 + H2 + LK) \dots\dots\dots (4)$$

Where as H1 = Green Time at the First Intersection (sec.)
 H2 = Green Time at the Second Intersection (sec.)
 H3 = Green Time at the Third Intersection (sec.)
 LK = Yellow light 3 (sec.) (international standard)
 M1 = Red Time at the First Intersection (sec.)
 M2 = Red Time at the Second Intersection (sec.)
 M3 = Red Time at the Third Intersection (sec.)

When the Arief Rahman Hakim Street lights up red light, then automatically the red light count based on the duration of the green light on the Klampis Street is added to the duration of the green light on the Manyar Street. If the Klampis Street lights up red, then automatically the red light count is based on the green light duration on the Arief Rahman Hakim Street plus the green light duration on the Manyar Street. Furthermore, if the Manyar Street lights up red then automatically the red light count is based on the green light duration on the Arief Rahman Hakim Street plus the green light duration on the Klampis Street.

Methods and Design Stages

At this stage, analysis of system requirements which includes hardware and software specifications are needed for making the device. The need is as follows:

1. **Hardware**Spesifiacion:
 - WeMos D1 is a vehicle identity chip. The amount used is two (2) units.

- WeMos D1 is a scanner or traffic that is used to retrieve motor vehicle identity data. The number used is three (3) units.
 - Wemos D1 is a central traffic light that is used to run a traffic light based on a predetermined duration with the number of vehicles passing on the Wemos D1 Scanner
 - LED and acrylic lights or cardboard. They are as miniature replacements for traffic lights. The number of LEDs is nine (9) units and acrylic or cardboard is one (1) unit.
 - Laptop with Windows OS 10, 64 bits. It is as the server system for the duration of the traffic lights.
2. *Software*Spesification:
- Arduino IDE. It is as a text editor for a microcontroller program.
 - XAMPP – phpMyAdmin. It is as *web server*.
 - HeidiSQL, it is as regulator of Host IP and IP Server in the database.

TABLE IV. VEHICLE DATA OF HARDWARE DESIGN

No	License Plate	Owner	Transportation type
1	K2125YQ	ZainuriArifin	Honda Vario
2	L4148 CA	JuliKawendar	Honda Supra
3	K 2684 PQ	SandiIfanMaulana	Honda Beat
4	L 4795 GQ	Mohamad Hapi	Yamaha Vixion
5	W 2759 QW	Mochamad Soleh	Vespa Piaggio
6	AG2446WZ	Sulastri	Honda Supra
7	L 6664 KR	Madfandi	Honda Vario
8	L 2063 GZ	Eko Hariyanto	Yamaha Mio
9	L 5873 SU	Sumarjianto	Honda Vario
10	L 2015 HZ	Sukamto	Honda Supra
11	L 4009 RT	Muhammad Hamzah	Honda Vario

Before conducting research, the author first conducts studies related to the design of hardware for traffic light control. The following is the overall block diagram of the traffic light control system simulator. It consists of 4 parts function as figure 4.

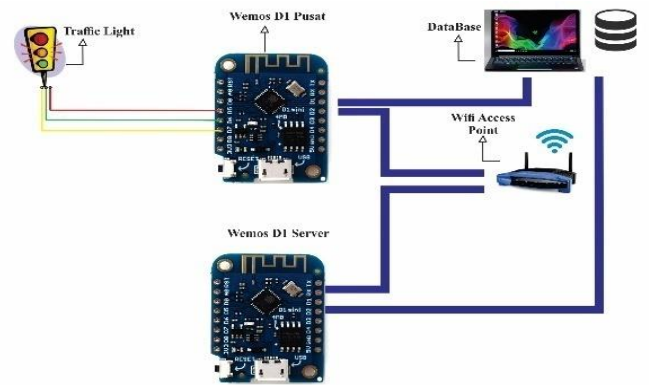


Fig. 4. Hardware Design of a Traffic Light System

This Traffic Light series scheme consists of WeMos D1, LED Lights, Laptop PCs and Smartphones.

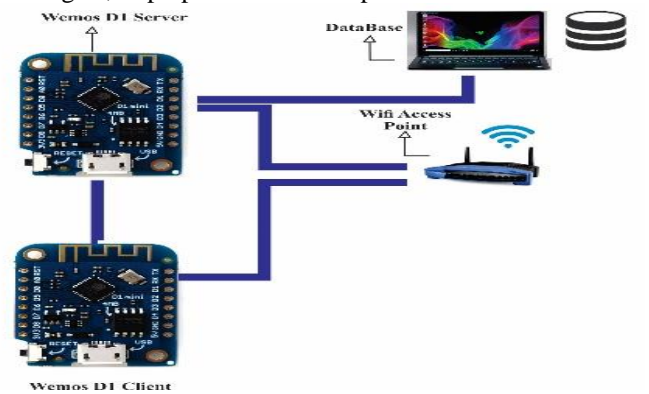


Fig. 5. WeMos Server scheme (Traffic1)

The scheme of the Traffic Light Scanner consists of WeMos D1, PC Laptop and Smartphone.

Wemos is used as a data processing microcontroller and other component controllers. LED lights are used as traffic lights on crossings. Laptop PC is used as servers and databases. Smartphone is used as SSID for WeMos and PC Laptop devices.

Design of Software

At this stage, it will be discussed about testing system devices consisting of testing software and hardware. The program uses C Language which is using Arduino IDE. In this software, routines have been provided for communication between the microcontroller and Wemos D1 so programming becomes shorter and easier. After the program is created and compiled into Wemos D1, the file generated is the extension .ino.

The flowchart of the stages of designing software to create a program or source code for each Hardware is as follows:

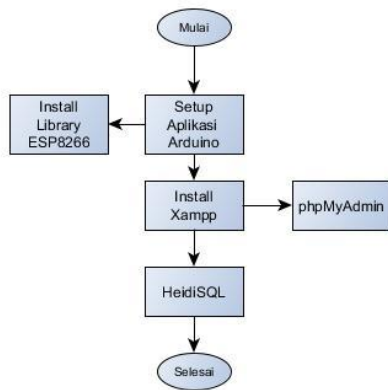


Fig. 6. Flowchart of Flow Installation Software of Traffic Light Applications

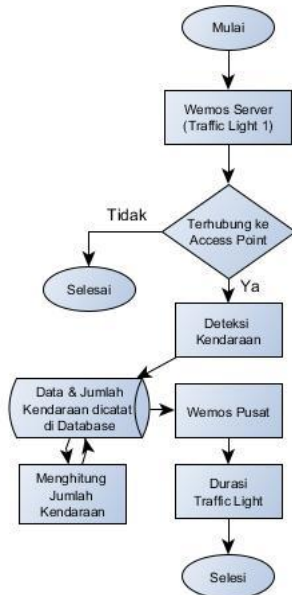


Fig.7. Flowchart of Traffic Light Systems

In Figure 7, it explains the workflow of the system that works to calculate the duration of time in one of the Traffic Light 1, because the system of the flow of each Traffic Light is the same. If there is a passing vehicle, the WeMos server will detect the vehicle, then the data will be calculated and sent to the database, with all WeMos server and WeMos Client devices previously connected to a WiFi access point. The WeMos client has been loaded with a program that contains vehicle license plates. After all counts, the data will be sent automatically to Wemos, the central traffic light and the duration of the traffic light or traffic lights running according to the number of vehicles in each traffic light that is crossed by the vehicle.

IV. RESULT AND DISCUSSION

Phase testing of the chip number ID of the vehicle license plate and vehicle ID scanner. The number of test vehicles is as many as eleven motorcycle units that will cross at each intersection. Each motorcycle is installed with a chip that has been injected with a vehicle number plate. Every road that is

about 100 meters away is installed by a scanner ID number plate to calculate the number of vehicles passing each road, then scanned by a scanner at a crossroads to determine the duration of the traffic lights.

Device Design Results

In the testing phase, the device is divided into several different circuit schemes, namely a series of traffic devices 1, traffic 2, and traffic 3. All hardware components are assembled on a PCB board. The results of the design of miniature devices are as follows:

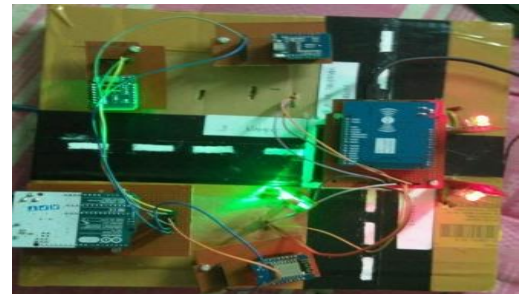


Fig. 8. Miniature Traffic Light Device

Device, the traffic light device consists of WeMos D1 and LED.



Fig. 9. Miniatures of WeMos server devices

The WeMos Server device consists of WeMos D1.

Results of Web Design Monitoring and Database Design

At the design stage of the device, the vehicle data that passes through is displayed in the database traffic. The data displayed is a vehicle license plate. This data will calculate the number of vehicles passing by each crossing that WeMos server has installed. Display database traffic is as follows.

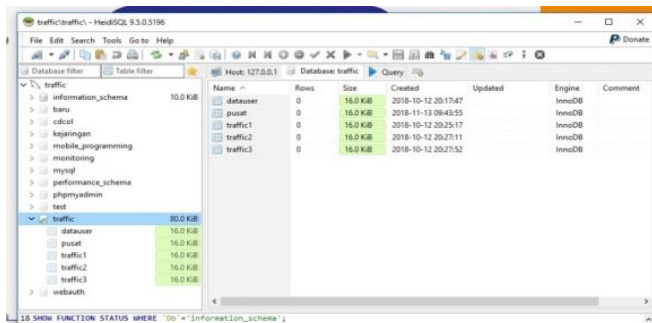


Fig. 10. Database of *Traffic Light*

Figure 10. Database of traffic Light consists of data users, centers, traffic1, traffic 2, and traffic 3. Then, this traffic light system only uses traffic1, traffic2 and traffic3.

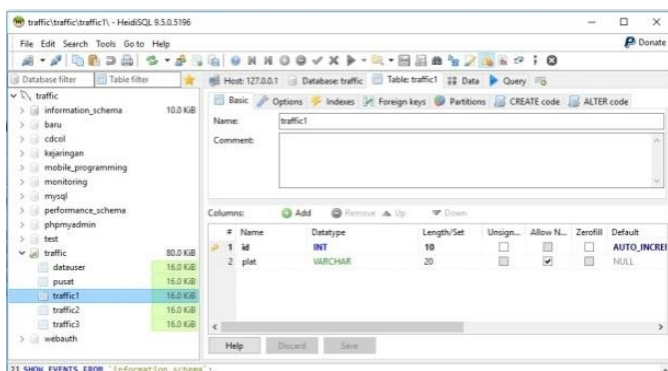


Fig. 11. Database of *Traffic Light1*

Figure 11. Database of Traffic Light1 consists of license plate tables. This data determines the number of vehicles that cross the crossing lane Arief Rahman Hakim Street. Then, it will be sent to the central WeMos and made the duration of the traffic light.

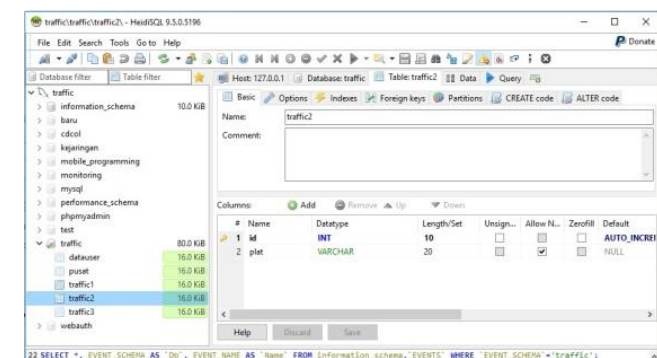


Fig. 12. Database of *Traffic Light2*

Figure 12. Database Traffic of Light 2 consists of license plate tables. This data determines the number of vehicles that cross the crossing lane Klampis Street. Then, it will be sent to the central WeMos and made the duration of the traffic light.

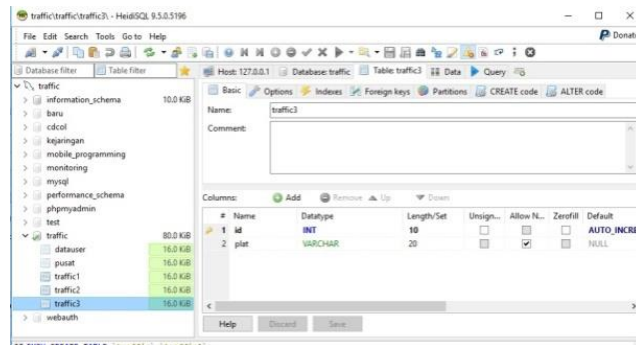


Fig. 13. Database of *Traffic Light3*

Figure 13. Database of Traffic Light3 consists of license plate tables. This data determines the number of vehicles that cross the crossing lane Manyar Street. Then, it will be sent to the central WeMos and made the duration of the traffic light.

Analysis and Discussion

The testing step is to conduct a traffic light test normally with the duration of time based on the path. After the intersection sample on the traffic goes well, it starts counting the duration based on the number of vehicles on each traffic lane by multiplying the phase time based on the width of the road. Next, it is added to the time of the vehicle delay for 5 (five) seconds. Finally, the duration count is used as a formula for the source code of each traffic light. Then, it creates the WeMos Client source code with data on each vehicle. Next, the WeMos Client and traffic light are connected to the smartphone WiFi SSID provided.

TABLE V. TIME DURATION OF GREEN CROSS LIGHTS

	Duration (units)		
	<i>Jl. Arief Rahman Hakim (2)</i>	<i>Jl. Klampis (4)</i>	<i>Jl. Manyar (5)</i>
Time H1	13 sec. (H1)	16 sec. (M2)	40 sec. (M3)
Time H2	52 sec. (M1)	21 sec. (H2)	24 sec. (M3)
Time H3	28 sec. (M1)	44 sec. (H2)	25 sec. (H3)

Table V is a traffic light test to calculate the green light time of each crossing. If there is no vehicle, the duration of the traffic light duration will count for 5 seconds. This time is the time of the vehicle delay. If WeMos scanning detects a vehicle with a number of 2 units, it produces a green cross light count time on the traffic light is 13 seconds. If WeMos scanning detects a vehicle with a number of 4 units, it generates a green cross light count time on the traffic light is 21 seconds. If WeMos scanning detects a vehicle with a number of 5 units, it produces a cross-green light count time on the traffic light that is 25 seconds.

TABLE VI. TIME DURATION OF CROSS RED LIGHTS

Number of vehicles crossing	Jl. Arief Rahman Hakim	Jl. Klampis	Jl. Manyar
0	5 sec. (H1)	5 sec. (H2)	5 sec. (H3)
2	13 sec. (H1)	13 sec. (H2)	13 sec. (H3)
4	21 sec. (H1)	21 sec. (H2)	21 sec. (H3)
5	25 sec. (H1)	25 sec. (H2)	25 sec. (H3)

Table VI is a traffic light test to calculate the red light time of each crossing. When the green light of each traffic light can determine how long the traffic lights will be on each crossing line. From table VI, it can be seen the time value of each red light. If the vehicle passes on Arief Rahman Hakim Street 2 motorcycles, Klampis Street 4 motorcycles and Manyar Road 5 motorcycles, then the green light count value starts from Arief Rahman Hakim Street 13 seconds (H1), 16 seconds (M2) and 40 seconds (M3). Klampis Street 21 seconds (H2), 24 seconds (M3) and 52 seconds (M1). Manyar Street 25 seconds (H3), 24 seconds (M1) and 44 seconds (M2). It is the result of calculating each of the red traffic lights at the junction Arief Rahman Hakim Street, Klampis Street and Manyar Street. So the duration of the green light from Arief Rahman Hakim Street is 13 seconds and the red light is 56 seconds, from Klampis Street green lights for 21 seconds and red lights 76 seconds, and for Manyar Street the duration of the green light is 16 seconds and the red light is 56 seconds. The move from the green light to the red light plus 3 seconds for the duration of the yellow light.

V. CONCLUSION

Based on above result, the conclusion is as follows:

1. Vehicle data sent by WeMos is successfully matched and stored in the database. Then, it is displayed in the light arduino traffic monitoring series.
2. The farthest distance that can be reached by WeMos to be able to connect with an Android phone as a hotspot is 50 meters without any obstacles.
3. Pins 5V and 3.3V of WeMos cannot be used simultaneously to be a source of voltage (Vcc) for other components.
4. The database is able to recognize vehicle data that is case-insensitive. However, it cannot recognize vehicle data whose number of characters is not the same as data stored in the database such as added or reduced text characters (spaces, etc.).

5. WeMos data that was sent simultaneously was successfully read with a difference of 1 second in the passing vehicle.
6. If there are no vehicles passing then the duration of the traffic lights is red for 5 seconds, if there are 2 vehicles passing on the road then the duration is 13 seconds, for 4 vehicles the duration of the traffic lights is 21 seconds, and for 5 vehicles it lasts for 25 seconds .

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