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Designing Emergency Vehicle Detection System with Wireless Bluetooth Based on Arduino

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A B S T R A C T

Congestion is a problem that arises because of the many vehicles on the road. One of the bottlenecks that is often encountered is at a crossroads. From several vehicles, there are emergency vehicles that must be prioritized. Therefore, this research develops a system using Bluetooth technology that gives priority to emergency vehicles to cross the junction. This system works is the first Bluetooth module before the junction with a distance of 500 meters detecting it with autopairing and autoconnect on the Android Bluetooth that has been made. This system uses Arduino Mega as its data processor to make the traffic lights output freeze to the green light, then the traffic light will return to normal when the second Bluetooth module after the junction with a distance of 100 meters detects Android Bluetooth. The results of the study are very helpful when the lane is jammed, but for empty lines this system has a maximum limit at speeds not exceeding 81.43 km/h because the detection distance limit of the Bluetooth connection is only 50 meters.

INTRODUCTION

Traffic congestion has been found in many big cities in Indonesia, one of the cities with the worst traffic jams is the city of Jakarta. Congestion arises due to population growth and community needs for transportation equipment, these conditions will cause the volume of vehicles on the streets of the capital city.

Based on data from the Badan Pusat Statistik (BPS), the population of DKI Jakarta in 2016 reached 10.28 million people, and increased to 10.37 million people in 2017 and will continue to grow each year. Which made the capital city streets more crowded with the rapid growth of transportation facilities, it was not accompanied by the growth of road infrastructure, causing traffic congestion on various roads, especially at crossroads.
There are several vehicles on the road, which have very important objectives called emergency vehicles. Emergency vehicles really need the shortest time possible on the way so that emergency help or needs can be immediately fulfilled. Emergency vehicles have interests that must be prioritized. This will be an obstacle if an emergency vehicle that will cross the junction is required to wait while the traffic lights are red (stop).
According to PP, Chapter 65 Paragraph 43/993, the order or prohibition stated by the traffic signal device about stop signals (red lights) is not applied to firefighter that are carrying out their duties, ambulances transporting sick people, vehicles to provide assistance in traffic accidents, vehicles of the Head of State or Foreign Government who are the guests of the state, and hearses. Even though emergency vehicles get more priority compared to other vehicles, but if the conditions of the road is very crowded, then other vehicles cannot give priority space to the emergency vehicle.

Based on that, a research was carried out that could provide an idea or solution by utilizing Arduino the microprocessor. This study uses Bluetooth technology and Android to detect emergency vehicles in the lane before junction. In other words, when an emergency vehicle passes a traffic lights at a certain distance, the traffic lights at the junction will turn green automatically and after the emergency vehicle passes the junction the traffic lights will automatically return to normal. Thus, providing security to other vehicles while still obeying traffic lights, so that emergency vehicles can be prioritized to pass the junction smoothly.

METHOD

The working principle of emergency vehicle response systems at traffic lights at the junction using Arduino Mega as controller and Bluetooth technology as the trigger, it is necessary to use a block diagram to connect several functions that are related between blocks (see Figure 1).

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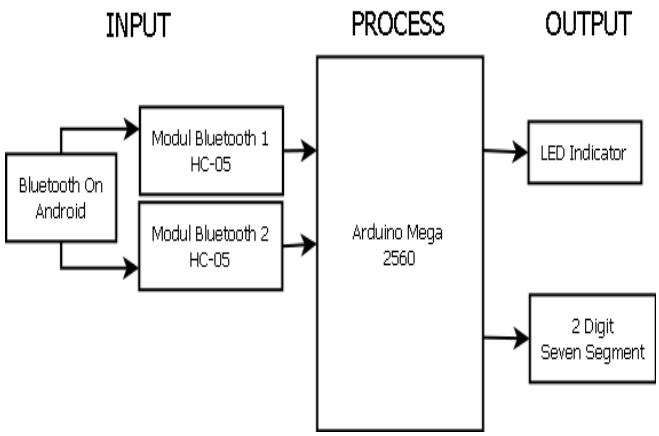

Figure 1. Block Diagram of the System

A. *Block Input*

Block input consist Bluetooth circuits to detect the arrival of emergency vehicles at a distance of ± 500 meters from the junction. The workings of this input block are the Bluetooth on android emits frequency radio waves so the Bluetooth module will receive the input and declare that the emergency vehicle has been detected.

B. *Block Process*

In the block process, after being given input in the form of power supply, emergency pulse detector connection and route of density detection, the input is entered into the processing part which is the main control of this device, namely the Arduino Mega, then the results will be sent to the block output.

C. *Block Output*

After the input is processed on Arduino, the output will be connected by a traffic lights circuit system at the junction by changing the green light (freeze mode) on the path that has been detected by first Bluetooth module and red light on the path that is not passed by emergency vehicles by stopping traffic lights counting, then the next output is when second Bluetooth module detects that an emergency vehicle has passed so that the traffic light will return to normal.

D. *Flowchart*

The design of this system requires a flowchart algorithm, so the system can work regularly and in accordance with the programs that have been made (see Figure 2).

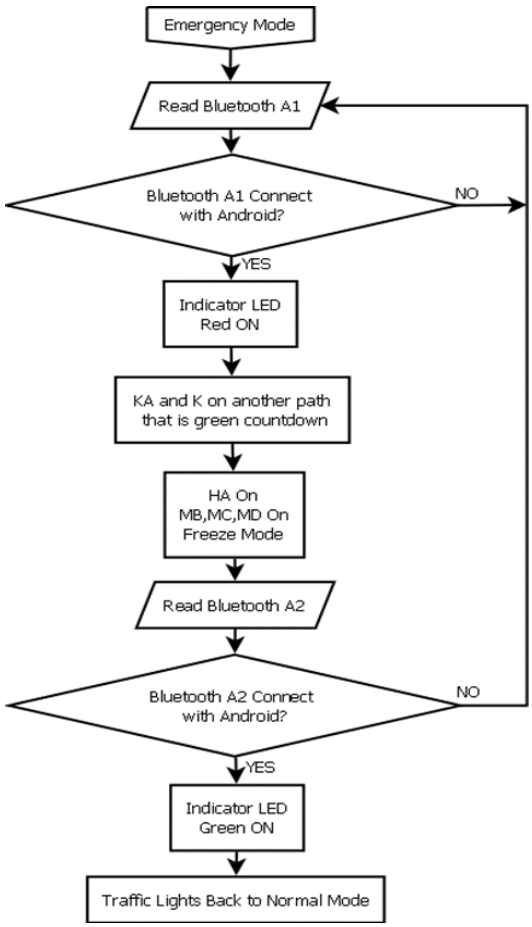

Figure 2. Emergency Vehicle Detection Flowchart

This flowchart describes the emergency vehicle detector system on the path that has been programmed to read Bluetooth, the process will always loop to Bluetooth on android pairing and connect to the Bluetooth module.

E. *Hardware Design*

In the modelling a prototype is made in the form of crossroads with 4 line (see Figure 3).

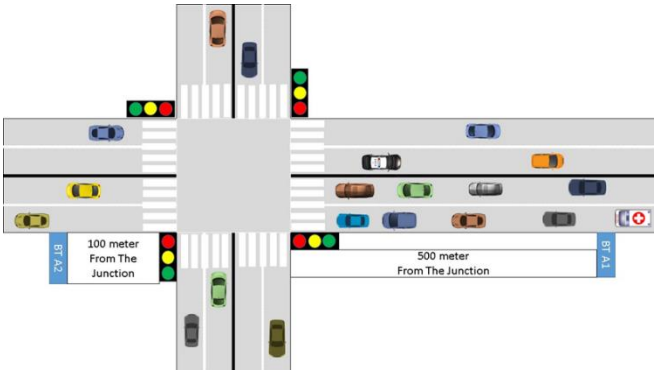

Figure 3. Traffic Lights Design at the Junction

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RESULTS AND DISCUSSION

In this chapter, analysis and testing device. The testing result of this system first, testing synchronization of Bluetooth, second, testing Bluetooth transmission, the last, test of result emergency detection and analysis of all device testing.

A. Testing Synchronization of Bluetooth

The Bluetooth module is tested by changing the name on each Bluetooth to distinguish Bluetooth detected first and after. After that the password must be the same as the program on android and baudrate is set so that Bluetooth on android can adjust it, if both baudrates are different both Bluetooth can only do pairing but cannot exchange data. To change the conditions that you want to determine on the Bluetooth module can be done in AT-Mode (see Figure 4).

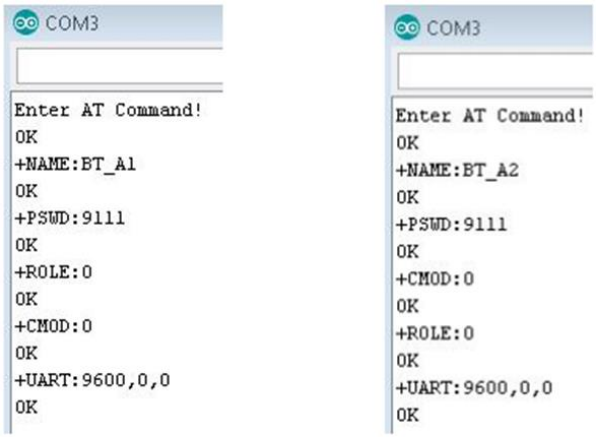

Figure 4. AT-Mode at HC-05 Bluetooth module

The next test is an Android Bluetooth to test automatically. Automatically so there is no need to press the button that is on Android, the way is by giving a timer program (see Figure 5).

```
public void startTimer() {
    timer = new Timer();
    initializeTimerTask();
    timer.schedule(timerTask, 1000, 1000);
}
```

Figure 5. Timer for Automatic Program

In this way Bluetooth Android sends a number 1 message continuously to the Bluetooth module every 1 second. The message given is in the form of data that has been programmed and made in the mobile application (see Figure 6) with the caption "SEND AUTO 1 BTH1 # 0".

Figure 6. Mobile Application

After the message is received, the output displayed on the mobile application will receive a reply that the message has arrived with the caption "#isipesan: X". Then to detect the Bluetooth Module A2 just like BT_A1, the mobile application sends a number 1 message continuously to BT_A2 every 1 second but with a different caption "SEND AUTO 1 BTH2 # 1".

After the message is received, the output displayed on the mobile application will also receive a reply that the message has arrived with the caption "#isipesan: Y.

In its application this mobile application will be placed on the car's dashboard from an emergency vehicle that has been programmed with the aim to make it easier, smoother, and safer when passing a crossroads. Examples the application (see Figure 7).

Figure 7. Emergency Vehicle Dashboard Sample

B. Testing Bluetooth Transmission

In this section the test is carried out to see how much distance and time needed by Bluetooth android can send a message to the Bluetooth module so that it can control the traffic lights without obstacles and with obstacles conditions, such as boards or walls (see Table 1).

Table 1**.** Connectivity Testing on Bluetooth with Xiaomi Redmi 5 Plus

Distance (Meter)	Without Obstacles Pairing and Connection (second)	With Obstacles Pairing and Connection (second)
5	1.53	1.81
10	1.82	1.86
15	1.73	1.83
20	1.73	1.92
25	1.63	1.89
30	1.73	2.12
35	1.78	2.17
40	1.82	2.00
45	1.87	2.10
50	1.94	2.21

The test results in Table 1. explain that:

1. Without Obstacles

The conditions without obstacles with a range of distances between 5-50 meters Bluetooth can be connected optimally.

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While, a distances of more than 50 meters, Bluetooth does not get any connection or the connection is lost.

2. *With Obstacles*

The conditions with obstacles same as without obstacles but with a longer time because there are barrier factors such as walls and human

3. *Field Condition*

Field conditions greatly affect the performance of Bluetooth sending and receiving, making the data transfer time needed longer. Some conditions that can affect the quality of the power of this wireless include: weather, distance, the number of obstacles, and Bluetooth modules that have often been used.

C. Test of result emergency detection

In testing to detect emergency vehicles, the Bluetooth module can work with programs that have been uploaded on Arduino, so that it can detect Bluetooth Android in a state ready to receive a pair from a mobile.

After the Bluetooth module is detected, the traffic lights must also be programmed so that it can change the system from the traffic lights at the crossroads to become a priority route for emergency vehicles by greening the lights on the path they pass (see Figure 8).

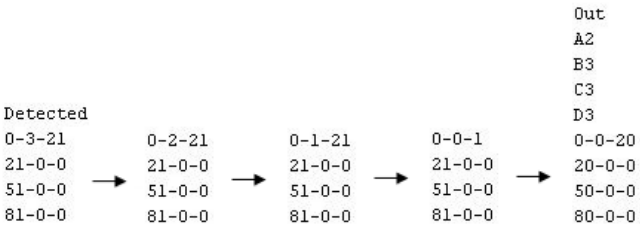

Figure 8. Green Light on Path A Detected in Serial Monitor Display

This paper only focuses on path A that is passed by emergency vehicles, then when line A is green, the path remains green but in a freeze state it is not countdown (see Figure 8). And for other paths if the inside of the green will change but with a delay or yellow light on first to give a signal that line A will be given priority, then after the lamp has turned red then the countdown does not work, or in the freeze mode.

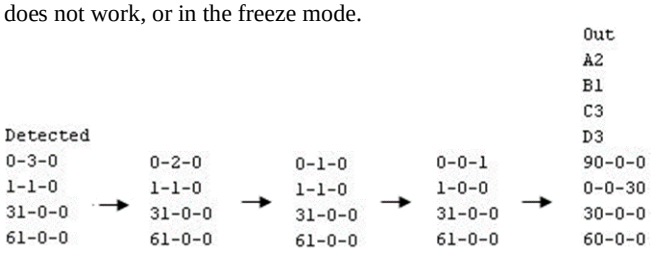

Figure. 9. Yellow Light on Path A Detected in Serial Monitor Display

Not much different from the yellow light conditions on line A like Figure 9 when the A line is yellow then when it is also the yellow B line, the output will calculate the yellow time for 3 seconds to change the path A to green, while the B line returns to red. Unlike the case in Figure 10 when line A is red

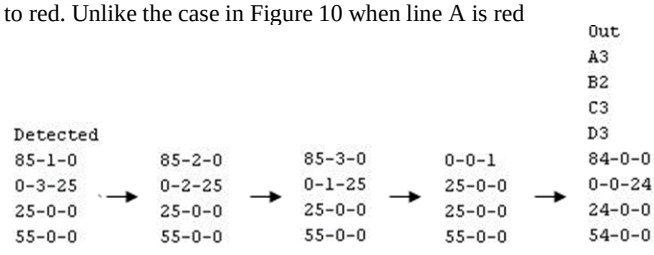

Figure 10. Red Light on Path A Detected in Serial Monitor Display

When line A is red, the first output executed is the yellow light on line A and line B lights up for 3 seconds. After that path A turns green and line B turns red in the freeze mode (see Fig. 10) until second module is detected. After that, the output that can be seen in the serial monitor with the "Out" caption and the traffic countdown is back to normal as in the fifth picture from Figure 10.

D. Analysis of All Device Testing

From the tests that have been carried out there are several results that can be tested into a simple formula, so that it can provide an implementation that is in accordance with the existing theory. Because to detect the Bluetooth module from a mobile application there are a number of problems with range and time, resulting in emergency vehicles must to maximum speed, so the value that must be obtained is:

$$v = \frac{S}{t} \qquad (1)$$

From the data obtained in table 4.1 it is explained that the maximum distance from the auto connection between Bluetooth 50 meters and the time obtained for the pairing process and connection with the longest time and with obstacles is 2.21 second, so maximum speed obtained:

$$v = \frac{50m}{2.21s} \quad (2)$$

$$v = 22.62\ \frac{m}{s} atau\ 81.43 \frac{km}{h} \quad (3)$$

In theory, emergency vehicles will get closer to the Bluetooth module to detect, but it would be better if the maximum speed limit for emergency vehicles is calculated with a speed of 81.43 km/h, so if the speed exceeds the maximum limit, it takes longer distance and time faster for pairing.

CONCLUSIONS

Based on the results of the testing and analysis it can be concluded that this system uses the Bluetooth module as the receiver and Bluetooth Android as the sender of the message with a maximum range limit of 50 meters and this system is very helpful when the path is jammed, but when the path is empty, the sensitivity is detected only when the vehicle speed 22.62 m/s or 81.43 km/h the system can work to detect optimally.

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