Design and Build a Traffic Light Automation System for Ambulance Vehicles in Traffic Light Paal II

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Abstract*—Transportation has become something that is very much needed for the daily life of the Indonesian people, with the growing population in Indonesia, the vehicles used by the people have also developed, especially in the Paal II Horse Statue Area. In this way the Traffic Light Automation System Design for Ambulance Vehicles in Traffic Light Paal II serves to reduce the level of accidents, congestion, and the delay rate of Ambulance vehicles. This system utilizes IoT technology to enable real-time data transmission and can be accessed online by security officers and emergency vehicle drivers. By using Arduino MEGA and KY-037 sound sensor. Arduino MEGA functions as a central controller for LED Traffic Light and KY-037 sound sensor as well as for analyzing data and adjusting traffic light times according to traffic conditions in real time. The KY-037 sound sensor functions to capture the sound of sirens from Ambulance. Once detected, the traffic light will automatically change the light to red so that ambulance vehicles can pass more quickly and safely. This approach is intended to speed up response time in emergency situations and improve public health and safety. In an emergency situation, every second counts and it is a priority for emergency vehicles to help save lives and reduce the risk of death. This system has the potential to save time and money in handling emergencies and improve the quality of life of the community as a whole. In order to ensure the success of this system, it is necessary to carry out continuous trials and evaluations as well as improvements to existing systems

***Keywords*— IoT, Arduino, Arduino MEGA, KY-037, Traffic Light, Ambulance**

I. INTRODUCTION

Iot is a concept that aims to expand the use of internet connectivity that is always connected. On highways, IoT can be used to control Traffic Lights remotely via a computer network or automatically through a program that has been created. This technological advancement must be utilized, studied, and applied in everyday life. For example, with the existence of IoT, Traffic Light can be developed into a Smart Traffic Light, one of the uses of this Smart Traffic Light is that the tool can distinguish emergency vehicles such as ambulances through the sound of sirens produced by ambulances.

The research "Design and Build a Traffic Light Automation System for Ambulance Vehicles on Traffic Light Paal II" will produce a system that will control the Traffic Light light to turn red only by detecting the sound of the Siren from the Ambulance, so that the Ambulance can pass through the intersection safely. This research uses Arduino, an Internet of Things component that can be used as a controller for electronic equipment such as lights. The program on this device has been set to work automatically without human intervention so that it can increase the efficiency of labor and work time for Traffic Light operators.

Based on the explanation above, the researcher aims to design prototypes using Arduino MEGA. This technology is very suitable to be applied in order to facilitate Traffic Light operators in carrying out their duties and increase labor efficiency and work time.

II. RESEARCH METHODS

This section will explain the system design and research methods conducted by researchers.

2.1. System planning

System design is a process of designing and building a system which consists of several stages with the aim of providing a general overview to the user regarding the new information system. In the design process, carried out based on the results of the analysis.

The KY-037 sound sensor has the ability to detect sound waves within a distance of about 5 to 10 meters from the sensor, depending on the intensity of the sound produced by the sound source. The detection distance may vary depending on the environment and surrounding noise, but in general, this sensor can identify sounds within that range quite accurately.

2.2. Research methods

The method used is the experimental method. The Experimental Method is one of the research methods used to test hypotheses and answer research questions by controlling the variables studied. The stages of the Experimental method may vary depending on the research being conducted. However, in general, there are several stages that are often used in this method, among others.

1. Formulation of the Hypothesis: This stage involves the researcher to formulate the hypothesis to be tested.

A. Azizah et al. (eds.), *Proceedings of the International Conference on Applied Science and Technology on Social Science 2023 (iCAST-SS 2023)*, Advances in Social Science, Education and Humanities Research 817,
https://doi.org/10.2991/978-2-38476-202-6_16

2. Experimental Design: This stage involves planning the experimental design that will be used, such as the prototype design that will be used as a research result, materials that will be used during the research and system design.
3. Data Collection: This stage involves collecting data which will be used to test the hypothesis. Data will be collected through road observation and vehicle development data in the city of Manado.
4. Data Analysis: This stage involves researchers to analyze the data that has been collected. This stage is carried out to test the hypothesis and draw conclusions based on the results of the research.
5. Interpretation of Results: This stage will show the results of data collection, data analysis, and prototype designs that have been made.
6. Research Reporting: This stage is the result of research that has been compiled in the form of a report which includes research background, research objectives, methods used, analysis and research results, as well as conclusions and suggestions.

The research method is described in the following flowchart:

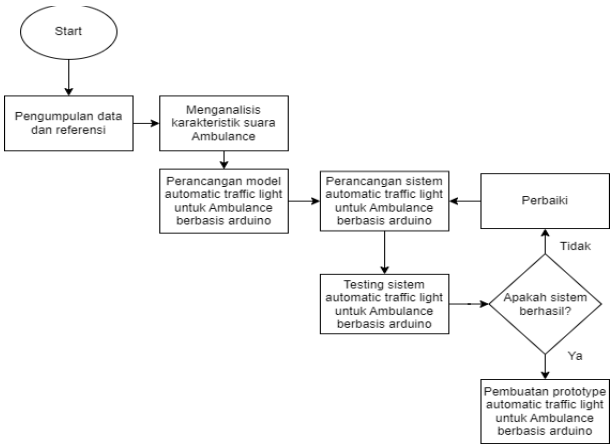

Figure 1. Research Flowchart

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III. RESULTS AND DISCUSSION

The Arduino coding made makes it possible to manufacture a prototype hardware where the hardware can simulate the state of a Traffic Light intersection using LEDs and sound sensors to detect ambulance sirens.

Arduino MEGA is used as the main microcontroller which functions as the brain of the system. Arduino IDE (Integrated Development Environment) and VSCode were chosen to design and edit the program code that will be uploaded to the Arduino hardware.

Testing is done by utilizing software such as Proteus ISIS and Wokwi. The function of this software is to simulate the work of the system that will be created. Proteus ISIS software is used for more complicated hardware designs, Proteus combines the ISIS program to create circuit design schematics with the ARES program to create PCB layouts from the schematic that will be designed. Wokwi was used in the early stages of testing. Wokwi is a web-based simulator with various functions to facilitate the design of electronic devices, due to the lack of components required for designing prototypes in Wokwi. The decision to use software such as Proteus ISIS is needed to analyze the system's response to the sound of sirens by taking into account the response time, system stability and the match of detected sound frequencies.

At the hardware testing stage, the KY-037 sound sensor was installed close to the LED Traffic Light to detect the sound of Ambulance sirens. This sensor works by using ultrasonic waves and measuring the reflection time of the waves to measure the distance to objects. Ambulance sirens can generally reach 700hz or more, hence the decision to calibrate the sound sensor to detect sounds that reach 700hz or more was made. When the sound sensor detects a suitable sound frequency, a signal will be sent to the Arduino microcontroller. Through the program code that has been designed, Arduino will analyze the received signal and will give instructions to the LEDs to change its status to red.

This is done to give priority as well as to signal to road users that an emergency vehicle will pass. During the design of this system, testing and validation is carried out to ensure the reliability and accuracy of the system response.

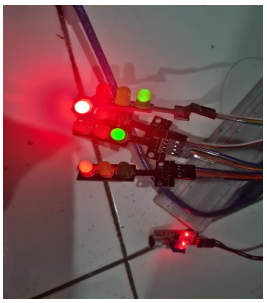

Figure 2. Sensors Don't Detect Sirens

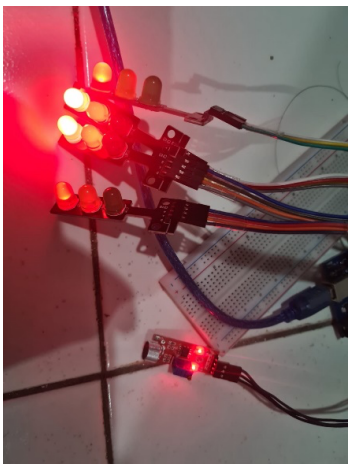

Figure 3. Sensor Detects Sirens

Following is the use of the OLED module as a visual sign for drivers and pedestrians. OLED uses binary array code to form an ambulance logo and a Buzzer to warn that an ambulance will be passing through the traffic light

This system uses RFID technology to recognize the RFID tag attached to the ambulance. When the RFID reader module successfully reads the tag, the module will send instructions to Arduino MEGA to enter standby mode on the KY-037 sound sensor module. When KY-037 detects the sound of a siren and confirms that the detected sound is a siren, it will execute program instructions to change the state of the light to red.

Android Studio is used to create android applications for handling hardware and system problems, programs that are made can detect problems within the hardware, such as programs that don't work, errors in modules, etc. When the program detects a problem, instructions will be sent by Arduino MEGA to the application which will provide a crash notification to the operator. This is possible when the Bluetooth module is connected to the Arduino MEGA with a program that has been designed so that system operations can run automatically

In connection with this research, a system implementation was carried out using Arduino as the main microcontroller. This system includes several main components, such as Sound Detector KY-037 which detects the sound frequency of ambulance sirens, OLED and buzzer as visual and sound signals to warn drivers and pedestrians near traffic lights, and RFID technology which detects RFID TAGs installed on ambulance vehicle.

The system work process begins when the RFID READER successfully detects the RFID TAG on the ambulance. Then the system determines the sound frequency of the siren using the KY-037 sound detector. When the siren's audio frequency meets or exceeds a preset limit of 700 Hz, the LED at the traffic light turns red to alert drivers and pedestrians that an ambulance is crossing the intersection. Additionally, the system is equipped with an OLED display that displays the ambulance logo as an additional visual cue. following BUZZER warns drivers and pedestrians clearly and loudly when an ambulance passes through an intersection. The purpose of all these visual and audible signals is to give priority to emergency vehicles and to increase the awareness and safety of drivers and pedestrians around traffic lights.

To keep system performance optimal, a special Android application has been developed that detects and monitors system performance. This application automatically sends notifications to the operator when a problem is detected in the system. In this way,

the operator receives information about possible malfunctions or damage to the tool or system, so that they can immediately take the necessary corrective action.

This study shows promising results in implementing a system that prioritizes emergency vehicles and improves traffic awareness and safety. However, for this system to be implemented on the road, more testing and improvement must be done to ensure optimal system performance and reliability in various traffic conditions and situations. With appropriate further development and improvement, this system can be an effective and innovative solution for traffic optimization and prioritization for emergency vehicles

IV. SUGGESTED

This article focuses on using Arduino as the main material for system prototyping. Arduino is used as the main microcontroller to provide flexibility and convenience in implementing complex control logic to respond to various inputs and conditions. In addition, using Arduino as a software development platform makes it easy to modify program code that can be uploaded to the microcontroller.

Although the Arduino proved effective in early prototyping, this approach allowed new prototypes to be developed in the future using new materials and techniques. As technology advances, Arduino can be replaced with more sophisticated and efficient platforms to improve overall system performance and accuracy.

In addition, the accuracy of the sound sensor is also a crucial factor in this system. By using a more advanced and more sensitive sound sensor, the system can distinguish between road noise and ambulance sirens. More advanced sound sensors allow the system to more accurately identify siren frequencies and provide a quick response.

Although this research has yielded promising results, several aspects must be considered for further development before it can be used on the road. More experiments are needed to ensure that the system works well under different conditions and environments. In addition, field testing is required to test the effectiveness of the system in real-world situations and identify potential problems or deficiencies that need to be addressed.

By continuing this research, it is hoped that the results can be applied in the real world and have a positive impact on improving road safety and efficiency, especially in emergency situations such as overtaking an ambulance. With the right refinement and development, this system can be an effective and innovative solution for traffic optimization and emergency vehicle priority.

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