Manufacturing Parking Indicator System for UNY Electric Vehicle

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Abstract. The aim of this project is to (1) make parking indicator system in FT UNY electric vehicle using Arduino Uno and ultrasonic sensor is viewed in LCD and buzzer and (2) test the performance of parking indicator system. There were five steps of the project including: (1) analyzing parking indicator system component needed; (2) designing the parking indicator system; (3) preparing tools and components are needed for developing parking indicator system; (4) assembling the parking indicator system components; and (5) testing the product. The result reveals that the parking indicator system work successfully, providing an alert signal to the driver when there are wall or other things around the vehicle.

1. Introduction

Pollution in Indonesia is higher and higher. Environmental health articles that investigate the NO2 content in Jabodetabek, Cianjur, Bandung, and Bandar Lampung give results, one of which is NO2 levels. Among those cities that were most severely affected were Tangerang and Jakarta with the highest levels of 37 and 31 ppb (particle per bilion) (Duki, et.al: 2003). This value is also directly proportional to the ratio of vehicles to residents in these cities, that in Jabodetabek, the ratio of vehicles to people living is 1: 3,3 while in Bandar Lampung and Bandung, respectively, are 1:39 and 1:40. Among that three city, Jabodetabek has more NO2 Then other city. That showing vehicle is significant air pollution contributor. That’s why one of solution is change vehicle with internal combustion engine with electric vehicle.

The electric vehicle is vehicle with electric motor becomes power plant. One of the vehicles that we often encounter is a car, so an electric car is a car driven by an electric motor. Currently, electric cars is a concern for the Indonesian government, because they are considered more environmentally friendly and more efficient in converting energy than the fuel motor that we often encounter on the streets. The number of motorized vehicles in Indonesia totaled 129,281,079 units in 2016 according to BPS. From there, motorized vehicles contribute to air pollution.

Community participation in encouraging the use of environmentally friendly energy is evidenced by many electric vehicle developments carried out at research centers, and in higher education institutions. One of those developing electric vehicles is Yogyakarta State University. Through the Institute for Development and Empowerment of Technology Works (LPPKT) which contains students of the Yogyakarta State University, an electric car with a capacity of 2 passengers was developed using
a BLDC (Brushless Direct Current) electric motor, equipped with 4 batteries, so this electric car can travels a maximum speed of 60-70 KM / hour in 2 hours of travel if fully charged.

The development of the electric car, also developed the safety features of driving an electric car. One of the features developed is the parking assist system, which is called the Parking Indicator System for the FT UNY Electric Car. This car is a small car, so it is suitable for use in urban areas. Urban will often be used in daily activities in short distances and the mobility is very fast, the consequence will often park at the destination of the driver. Therefore, a tool was developed to assist drivers when parking. This tool is a parking indicator system using Arduino as a control system for parking indicators on electric cars. The hope, with this tool, will help drivers in parking their vehicle.

Through the development of this system, the authors want to explain how to manufacture and test the Parking Indicator System for FT UNY Electric Vehicle, as well as explain the performance results and the appropriateness of using the parking indicator system.

2. Methodology

2.1. Component Need Analysis

The results of the analysis of material requirements in the manufacture of the Parking Indicator System for the FT UNY Electric Car are (a) the parking indicator system can inform the driver that there is an object behind the car within the set distance; (b) the parking indicator system can provide information on the distance of objects behind the car; and (c) information is given in the form of distance and nominal.

2.2. Draft Design

A technology should consider what specific areas it will be in. In addition, it is necessary to determine the solution to the problem that becomes the background for the creation of a new technology, whether it significantly affects human work (Braess: 2001). Therefore, a concept is needed to design a new technology that will be implemented. The design concept is the stage after the component needs have been identified. The things that will be done at this stage are as follows. The distance will be set at 40 cm as a benchmark for dangerous distances. Then starting from this distance, the sensor will send a signal to Arduino, then processed with logic, the distance is too close, so the Arduino will give a signal to the buzzer to turn on and send the value to the LCD to be displayed. The work concept of the FT UNY electric car parking indicator system can be seen in the following figure:

![Figure 1. Work Flow System.](image)

Arduino is a microcontroller board, which contains programmable ICs and other supporting components. Because it is programmable, the board can enter the program according to the desired purpose. The basic programming language of Arduino is C language, so the programming language must first be understood by making some adjustments such as, Understanding the code and functions, and knowing the libraries of each component, especially the components to be used in this tool.

The design concept is a stage for designing component positions and designing the cable wiring to be installed on this vehicle.
Figure 2. Component position.

In accordance with the image above, the Arduino is located near the Fuse Box, for easy maintenance. The Arduino is attached using 4 small bolts to the holder using 2 thin plates and then connected to the car frame. Buzzer is placed inside the cabin for clearer warning signs. LCD 16X2 with a length of 70mm is placed on the top dashboard, parallel to the head unit right next to the battery indicator left. Then, the ultrasonic sensor is placed on the rear body, which is most indented backward. There are 3 ultrasonic sensors, located in the middle, left corner and right corner of the vehicle.

2.3. Testing Draft
System testing is a stage to see the performance of the system. The performance of the Parking Indicator System on the FT UNY Electric Car, is carried out with 4 variations of the distance, namely 40cm, 50cm, 60cm, 70cm, with 5 repetitions of the test. This distance is a safe distance recommended by the Director General of Land Transportation, Ministry of Transportation Number: 272/Hk.105/Drjd/96.

3. Result
3.1. System Manufacturing Process
The manufacturing process starts from collecting the necessary items. After all the tools and materials are collected, the next step is to make a holder for each component in an electric car. All electronic components to be installed must have a stand for neat results. The components that need a stand are the HC-SR04 Sensor, LCD, Arduino Uno R3, Buzzer.

The HC-SR04 sensor is an ultrasonic sensor, so its placement should not be obstructed by any vehicle body, it is necessary to drill on the vehicle body so that the sensor placement looks neat, but is not obstructed by the body. Furthermore, after being drilled, the sensor is installed with an acrylic protector. After the sensor is installed properly, the process is continued by making a cable path for the sensor to the Arduino, and the shape of the sensor that has been attached to the electric car body. The HC SR04 sensor is already installed on the electric car body, then then install the LCD, the position of the LCD must be visible to the driver, and the correct position for the LCD on the dashboard above.

3.2. Testing
Ultrasonic sensors make use of ultrasonic waves, which is include sound waves. These waves, propagating through the air. Then the wave propagation speed will be affected by the density of the medium as in the equation below.
\[ v = \sqrt{\frac{\gamma}{\rho}} \]

Where \( \gamma \) is the modulus of young and \( \rho \) is the mass density of volume (Tipler, 1998). So it can be said that the propagation of a sound will depend on the modulus young and the mass density of the volume. The statement above is reinforced from the results of research by the Ikhwan, which made an experiment measuring the speed of sound propagation with air medium with variations in air temperature. The results is below.

From the graph above, it is known that the higher the temperature, the higher the speed of sound propagation, with a linear regression value from the results of the study of \( R^2 = 0.992 \). So this data becomes the benchmark for researchers to test this system in places with different temperatures.

After all the components are finished and the program is inserted, the next step is testing the system. In the implementation of the test, first ensure that all components are in good condition. The test time was carried out at 2 different times with 2 different places too. The place is carried out in a closed and open space. The ultrasonic sensor is a sound sensor that is reflected back, according to the above equation, air is a medium for sound propagation that will have a different density at each different temperature. Researchers assume that the temperature outside the room and in the room is different, so that it will give a different air density, and that will affect the results of the sensor readings.

The test concept above was adopted from the research of Matsui (2019: 344) which tested four different cars and then tested their parking sensor capabilities. The method is almost the same, but the researcher modified it to make it simpler by only measuring the long distance, while in the Matsui study, the height, width and length were measured. This was done because this research was the initial stage for further development in the FT UNY Electric car. The test results of the parking indicator system is shown in table 1.

### 3.3. Testing Result

The indoor test was carried out on the 1st and 2nd repetitions, then for the outdoor experiment it was carried out on the 3rd, 4th, and 5th repetitions. LCD, respectively, at a distance of 70cm, 60cm, 50cm, 40cm, 30cm, and 20cm with actual measurements, average found on the LCD screen to be 717mm, 597mm, 507mm, 417mm, 302.5 mm, 203 mm. Then in outdoor testing, at the same position, the results average on the LCD screen were 700mm, 580mm, 490mm, 400mm, 301 mm, 202.3mm, respectively. Then for the buzzer, it can function properly, the buzzer lights up at a distance of 40cm.
Table 1. Testing result.

| Repetition | Real Distance (cm) | Test Result | Responsibilities |
|------------|-------------------|-------------|-------------------|
|            |                  | Distance in LCD (mm) | buzzer | Soundin | No Sounding |
| 1          | 20                | 206         | v                | 0.48 second |
|            | 30                | 300         | v                | 0.50 second |
|            | 40                | 417         | v                | 0.50 second |
|            | 50                | 507         | v                |            |
|            | 60                | 597         | v                |            |
|            | 70                | 717         | v                |            |
| 2          | 20                | 200         | v                | 0.47 second |
|            | 30                | 305         | v                | 0.49 second |
|            | 40                | 417         | v                | 0.50 second |
|            | 50                | 507         | v                |            |
|            | 60                | 597         | v                |            |
|            | 70                | 717         | v                |            |
| 3          | 20                | 208         | v                | 0.50 second |
|            | 30                | 301         | v                | 0.55 second |
|            | 40                | 400         | v                | 0.50 second |
|            | 50                | 490         | v                |            |
|            | 60                | 580         | v                |            |
|            | 70                | 700         | v                |            |
| 4          | 20                | 199         | v                | 0.51 second |
|            | 30                | 302         | v                | 0.50 second |
|            | 40                | 400         | v                | 0.50 second |
|            | 50                | 490         | v                |            |
|            | 60                | 580         | v                |            |
|            | 70                | 700         | v                |            |
| 5          | 20                | 200         | v                | 0.52 second |
|            | 30                | 300         | v                | 0.50 second |
|            | 40                | 400         | v                | 0.50 second |
|            | 50                | 490         | v                |            |
|            | 60                | 580         | v                |            |
|            | 70                | 700         | v                |            |

4. Discussion

The design of the parking indicator system on the FT UNY Electric Car makes it easy to park the vehicle, especially helping to monitor blind spots or areas that are not visible to the driver. Its manufacture begins with determining the manufacturing plan which consists of identifying the needs for tools and materials and the design concept. The design concept will discuss how the layout and wiring paths will be made, as well as designing the whole place of components to suit driver ergonomics.

After this system is finished, then the next test is carried out with 5 repetitions and 4 variables. Of the 5 repetitions, 2 repetitions are indoors, and the remaining 3 repetitions are outside the room, with such conditions, it is expected to have a significant difference in temperature because outside the room the condition is directly exposed to the sun, assuming the outdoor temperature is higher than indoors. The room temperature at the time of testing was 25°C while the outdoor test was 30°C.

The HC-SR04 sensor is a sensor with a high sensitivity level as evidenced by a slope value of 58.3 µs/cm. Means, every 1 cm increase in distance, will produce an ultrasonic echo pulse (T), amounting to
58.3 µs. This is evidenced by research from Yudha et al. (2017). In addition, Yudha et al also characterized the sensor by using the correlation test method from the true value to the value generated by the sensor, by obtaining a correlation coefficient (r) of 1. Where This figure according to Sugiyono (2013) is included in the range of very strong relationship interval values between 0.8-1.

The results of the system testing show that the system is running well, and even though it is carried out at a different temperature, it is assumed that it represents all the places the car will be, but the system can run properly as indicated by the results shown by the LCD with the actual distance not far away. Buzzer also goes well by showing the results of its response in warning the driver is very fast by 0.50 seconds.

The results of these tests have differences in sensor response. This difference could be due to less precise time measurement. Measurement of time is done manually, so errors may occur. In addition, the sensor readings with a predetermined distance are not significantly affected by the air temperature at the time of testing. So it can be said that the system works well at various temperatures. The difference that occurs in distance measurements is only 1-20 mm apart. This distance will not affect the driver in parking the vehicle, because the distance is too little.

The Parking Indicator System for Electric Cars FT UNY is a breakthrough in helping drivers to park. In a study of the time to find a parking space and park it in the center of Zurich, Switzerland, shows that the worst condition for finding a parking space with a maximum number of 30 cars is an average of 13 minutes of parking space search time (Cao and rashid: 2019, 902- 903). During that long search, it would be a waste of time just to park the vehicle. not yet the process of parking the vehicle which, if the conditions are very dense, namely during the day when the workers have entered the office, it can be ascertained that the parking lot must be full. When the parking lot is full, it will be difficult to park the vehicle, especially if it is not helped by anything.

The obstacles that occur in working on the parking indicator system on the FT UNY Electric Car are components that are not in accordance with the needs so they have to look for something more suitable, errors in programming that cause a long time in making programs for Arduino, errors in stringing cables, lack of power to do processing,. Overall these obstacles, causing the time needed to work on this system, to be longer. This will spread to the costs incurred to be more and become draining.

An article by Matsui & Naruyuki in 2019 from the Tokyo Metropolitan University of Japan discussed ultrasonic sensors to detect objects when the car is moving backwards. The sensor turns out to be used to detect not only objects, but can detect the presence of people, so in the future further research in this article can be developed to be able to detect not only objects, but also to detect humans by utilizing more than one sensor, and with the help of other systems.

5. Conclusion
The conclusion of this article is (a) the parking indicator system is made based on the analysis of the needs of the electric car, FT UNY. This is followed by making the design of the parking indicator system with the wiring diagram, and making the holder of each component. The next step is programming the Arduino UNO R3 program, using the ARDUINO IDE software and assembling the system on the FT UNY electric vehicle; (b) testing the performance of the parking indicator system by entering the reverse gear then moving the car slowly towards a predetermined object, after which the distance will be printed on the LCD. After the distance has been stated, identification can be made with the specifications so that the required results can be obtained, namely the results of the system testing and the specifications still meet the level of safety when parking the FT UNY electric vehicle, at the distance indicated on the LCD the deviation obtained is not more than 2 cm or 200 mm then the buzzer responsiveness reaches 0.50 seconds. So that it can be concluded that the success rate of making the thinking indicator system on the electric vehicle FT UNY with the results obtained is the same as the required specifications.
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7. Ethical Statement
This research was carried out in accordance with the IOP’s ethical policy and was approved by the ethics committee of the Behavioural, Management and Social Sciences Graduate Program of Yogyakarta State University.

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