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# Prototype Blind-Spot Area Object Detection for Dump-Truck Vehicles

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**ABSTRACT**

*A dump truck is a heavy vehicle designed to transport large quantities of materials. However, the vehicle's large size and unique structure create a significant blind spot area, increasing the risk of accidents. Based on data and opinions of experts, blind spots around dump trucks are often the main cause of accidents, especially those involving pedestrians or small vehicles. In response to this problem, a prototype blind spot detection system has been developed to improve driver awareness and reduce the risk of accidents. The prototype uses an Arduino Uno as a microcontroller, an ultrasonic sensor to detect objects, as well as additional components such as buzzers, LEDs, and LCDs to provide alerts. When an object is detected at a dangerous distance, i.e. between 1 cm and 8 cm, the system will provide an audio-visual warning: the buzzer emits a warning sound, the LED lights up, and the LCD displays the status of "DANGER". The test results prove that this prototype successfully demonstrates the effective ability to detect objects on both sides of the vehicle and distinguish between safe and dangerous zones.*

***Keywords***: *Dump Truck, Traffic Accident, Alarm, Arduino uno*

## 1. INTRODUCTION

Dump trucks are heavy vehicles designed to transport large quantities of materials, such as soil, sand, stones, gravel, and construction waste. These vehicles have a liftable tailgate that allows unloading at the destination, facilitating the process of moving materials. Dump trucks are often used in the construction and mining industries to move materials from one place to another (Kusuma et al., 2020).

According to Jusri Pulubuhu, founder and Training Director of Jakarta Defensive Driving Consulting (JDDC), a blind spot is an area around the vehicle that is invisible to the driver (Fhadeli, 2024). The larger the vehicle, such as a dump truck, the wider the blind spot area. This is due to the construction of the vehicle and the load that obstructs the view through the rearview mirror (Azizah, 2014). Based on accident data, many incidents occur around dump trucks when passengers or pedestrians are not visible to the driver. For example, accidents often occur when children run onto the road without the driver realizing it (Kompas Otomotif, 2018). This shows the need for a system that can detect objects in blind spot areas to improve

safety. In response to this problem, modern technology offers a solution in the form of an object detection system that can be integrated into dump trucks (Kevin, Prayudha, & Syaifuddin, 201x). One of the latest innovations is the pedestrian detection system introduced by Thomas Built Buses. This system uses buzzer, LCD, and LED lights to provide information to drivers about the presence of pedestrians around the dump truck, including in blind spot areas. The buzzer operates at a high frequency (77 GHz) to detect objects in close proximity and provide warnings to the driver through an in-cab display as well as warning lights on cross-view mirrors.

This detection system not only helps to reduce the risk of accidents but also increases the driver's situational awareness of the surrounding environment. By using ultrasonic sensors and buzzers, these systems can provide real-time information about the presence of objects around the vehicle. The implementation of the blind spot detection system on dump trucks involves various electronic components such as Arduino or other microcontrollers, ultrasonic sensors, LCDs, buzzers, and LEDs. The system's working process begins with object detection by sensors, which are then processed to provide output in the form of visual and audio warnings to the driver. Thus, this system is designed to improve the operational safety of dump trucks and reduce the possibility of accidents due to blind spots. With the development of a blind spot detection system on the prototype dump truck, it is expected to make a significant contribution to improving public transportation safety and protecting pedestrians and other road users from potential dangers posed by blind spots.

## 2. METHODOLOGY

This study utilizes an Arduino Uno, ultrasonic sensors, a relay, a buzzer, LEDs, and an LCD as the main components of the blind spot detection system. This study uses a qualitative approach to evaluate the effectiveness of the blind spot detection system prototype. Figure 1 shows the block diagram of the proposed system.

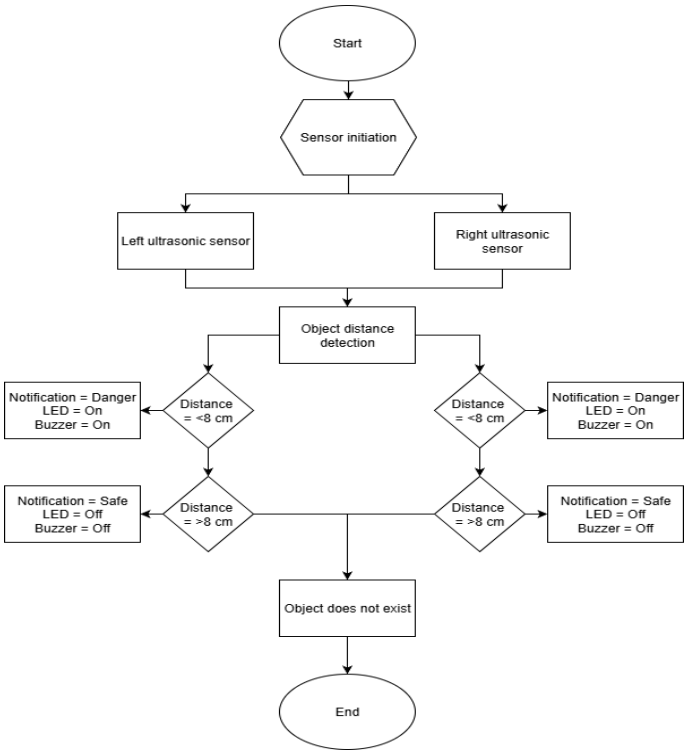


**Figure 1. Proposed System**

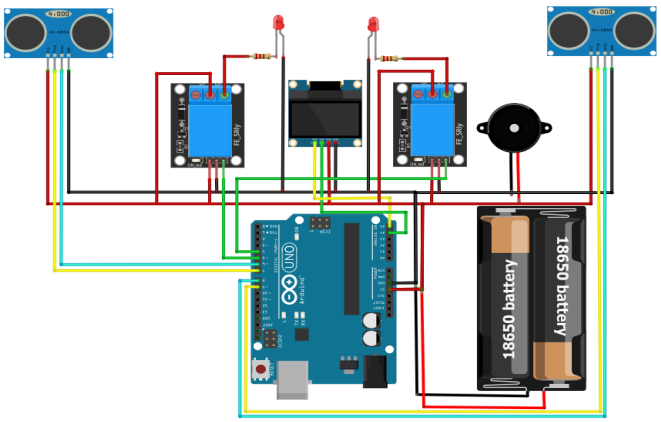


**Figure 2. Proposed Tool**

Figure 2 shows the proposed tool. The tool is made by stringing electronic components such as ultrasonic sensors, Arduino microcontrollers, buzzers, LED indicators, and LCDs according to the design of the electronic circuit. The Arduino microcontroller is programmed to detect the distance of objects using ultrasonic sensors and provide notifications via buzzers and LED indicators, as well as display the status of whether the condition is dangerous or safe via an LCD display.

## 3. RESULTS AND DISCUSSIONS

This chapter describes the results of various tests conducted on blind spot area object detection devices for dump trucks. Testing includes object detection in the blind spot area, system response in providing warnings through buzzers and LEDs, information display through LCD, and overall system performance evaluation.

Testing of the Blind Spot Area Object Detection System for Dump Truck Vehicles is carried out to evaluate the effectiveness of the system in detecting objects in the blind spot area and providing warnings to the driver. The system consists of several main components, namely Arduino Uno, ultrasonic sensor, buzzer, LED, and LCD. Here are the test results of each component and the entire system:

1. **Arduino Uno**: The Arduino Uno serves as the main microcontroller that controls the operation of the system. Tests show that the Arduino Uno is able to receive input from ultrasonic sensors and provide outputs to buzzers, LEDs, and LCDs with a fast response.

2. **Ultrasonic Sensors**: Ultrasonic sensors are used to detect the distance of objects in the vehicle's blind spot area. Testing is carried out at a distance of between 1 cm to 12 cm from the sensor. The results show that ultrasonic sensors can detect the presence of objects with high accuracy. At a distance of 1 cm to 8 cm, the sensor triggers an alert in the form of a buzzer sound, LED flame, and a "DANGER" warning display on the LCD. While at a distance of more than 8 cm, the system displays the status "SAFE" and the output device remains off.

3. **Buzzer**: The buzzer is used to give a sound warning to the driver if there is an object in the blind spot area. The test results showed that the buzzer was active when the ultrasonic sensor detected an object at a distance of 1 cm to 8 cm. The sound produced is sufficiently loud to provide an early warning to the driver.

4. **LEDs**: LEDs serve as additional visual indicators to provide warnings to drivers. Testing shows that the LED lights up when the sensor detects an object between 1 cm to 8 cm away, along with a buzzer sounding. At a distance of more than 8 cm, the LED turns off, indicating the absence of danger in the blind spot area.

5. **LCD**: LCD is used to display the status of the blind spot area in the form of easy-to-read text. The test results showed that the LCD was able to display a "DANGER" warning when the ultrasonic sensor detected an object at a distance of 1 cm to 8 cm. If the distance of the object is more than 8 cm, the LCD displays the status of "SAFE", providing clear and easy-to-understand information for the driver.

In Table 1, we obtained data from the data collection method in the form of direct observation carried out during the testing process of the tool as follow. Based on the results of the data obtained, it can be concluded that this prototype was successfully designed and functioned according to the specifications that had been determined. At a distance of 1 cm to 8 cm, the ultrasonic sensor successfully detects the presence of objects around the blind spot area. The output generated from this detection indicates that the buzzer is on (ON) to provide an audible alert, the LED is illuminated (ON) as a visual indication, and the display shows a "DANGER" status. This confirms that the system is capable of providing early warning when objects are at a dangerous distance.

**Table 1. Results**

| It | Left Ultrasonic Sensor | Right Ultrasonics | Output | | Display |
|---|---|---|---|---|---|
| | Distance | | LED | BUZZER | |
| 1 | 1.3 cm | | ON | ON | DANGER |
| 2 | 2.5 cm | | ON | ON | DANGER |
| 3 | 3.1 cm | | ON | ON | DANGER |
| 4 | 4.4 cm | | ON | ON | DANGER |
| 5 | 5.7 cm | | ON | ON | DANGER |
| 6 | 6.3 cm | | ON | ON | DANGER |
| 7 | 7.9 cm | | ON | ON | DANGER |
| 8 | 8.3 cm | | OFF | OFF | SAFE |
| 9 | 9.1 cm | | OFF | OFF | SAFE |
| 10 | 11.4 cm | | OFF | 0FF | SAFE |

Meanwhile, at a distance above 8 cm, the system does not detect the presence of objects in the hazardous area. The output indicates that the buzzer is off (OFF), the LED is off (OFF), and the display shows a "SAFE" status. This proves that the system can distinguish between safe and dangerous distances well, thus minimizing the possibility of detection errors. In addition, with two ultrasonic sensors mounted on the left and right sides, the system is able to identify the position of the detected object, both on the left and right sides of the vehicle.

This ability is very important to help drivers know the exact location of the object that caused the blind spot, thereby increasing vigilance and reducing the risk of accidents.

## 4. CONCLUSION

After conducting distance detection experiments using ultrasonic sensors to address dump truck blind spot problems, it can be concluded that this prototype is effective in improving safety by providing accurate object detection at various distances. The system successfully provides warnings to the driver through buzzers, LED lights, and a "DANGER" status on the screen when objects are detected within a range of 1 cm to 8 cm. The system also accurately recognizes distances above 8 cm by turning off the buzzer, turning off the LED, and displaying a "SAFE" status.

These results show that the prototype provides reliable feedback regarding the proximity of objects, helps drivers identify hazards, and makes them more aware of their surroundings. The experiments prove that the device works as expected, clearly distinguishing between dangerous and safe distances, thus creating a safer driving environment.

## LIST OF REFERENCES

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