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# ROADSIDE WORKER DETECTION AND ALERT SYSTEM USING RFID

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## ABSTRACT

The project proposes a prototype system to alert drivers of the existence of roadside workers in order to reduce road accident rate involving roadside workers. High fatality rate involving roadside workers can be reduced by pre-alerting the drivers at a safe distance. A distance alert system is proposed to meet the need of alerting the drivers earlier to prevent accidents. Radio Frequency Identification (RFID) technology is used to indicate the existence of roadside workers and alert the drivers. The prototype system had been developed to clearly show and demonstrate the idea of giving alert to the driver on the existence of the roadside worker. In order for the prototype system to work effectively, RFID reader has to detect RFID tag and transfer the signal to a buzzer. The buzzer informs to the driver of the existence of nearby roadside workers for them to stay alert, and slows down, or change path if necessary. The objectives of this project are to study the implementation of Radio Frequency Identification (RFID) as a simulator in detecting workers at the roadside of a highway and to develop a prototype system that can notify the driver on the presence of the worker at the highway. The significance this project; is to save lives by providing sufficient reaction time for drivers to safely avoid roadside workers.

**Keywords:** RFID tag, alert system, roadside, simulator

## INTRODUCTION

As reported by Malaysian Institute of Road Safety Research (MIROS), the number of road traffic deaths in Malaysia in the year of 2014 was 6,674 [1]. The number shows an alarming rate of death caused by accidents that requires a serious solution. The fatality caused by the accidents did not only involve the vehicle passengers, but the roadside workers as well. As such, The National Institute for Occupational Safety and Health (NIOSH) has expressed growing concern about the safety of the roadside workers on the highway and roadside [2]. The safety of the roadside worker should be of high priority to the authorities or the employer of the road workers [3]. Research in highly motorized countries reported that 1-2% of fatal cases occurred at work roads [4] and the crashes at work roads were normally more severe than other crashes [5]. It was also reported that there were more accidents and fatalities occurred during roadworks than the pre-works periods [6]. Additionally, research made by [7] stated that drivers tend to choose significantly lower speeds in work zones where they detect the presence of workers than in those where there is no apparent activity.

Therefore, based on the cases and statistic presented, there is a dire need for a mechanism to minimize the risk of the roadside workers while they are performing their jobs and indirectly prevent accidents from happening. This has motivated us to propose a prototype system that can alert drivers of the presence of roadside workers. The proposed prototype system uses Radio Frequency Identification (RFID) technology. RFID is used to identify and track objects through wireless communication [8]. RFID consists of the reader and the tag. The RFID Tag is the item to be detected by the reader. This prototype system is only for simulation purpose to give a better understanding of how the idea of this system will work in the future. Therefore, the RFID Tag will be assumed as the one with the roadside worker and being detected by the RFID Reader embedded with the car. To validate our approach, we have carried out lab scale experiments of roadside worker detection and alert system as a method of precaution with what is currently happening on the highway. Drivers can respond by slowing down their speed and change their path.

The objective of this project is to perform a comparative study and analysis of wireless technologies, microcontrollers and sensors that are feasible to detect roadside workers and to develop a prototype system that can alert the driver on the presence of the roadside workers at the highway. In this paper, we are planning to make a simulation of the distance warning system. Therefore the data and all its measurements will be scaled to a lab scale environment. Since the road traffic accident could happen anywhere, so we are narrowing the scope for the use of Malaysia highway and as proof of concept only for straight highway. The main device that will be used to be implemented in this prototype system is Radio Frequency Identification (RFID). Meanwhile, for the microcontroller, Arduino UNO will be used in this project to be linked with the buzzer.

This paper will proceed with the other five main sections which are Related Work, System Model, Results and Discussion, Conclusion, Recommendation and lastly Acknowledgement.

**Table-1.** Table of comparison between technologies.

| Features | RFID [9] | Ultrasonic sensor [10] | Infrared Proximity sensor [11] |
|---|---|---|---|
| Communication range (tracking or detection) | Long range: 1 to 6m for the card (RFID tag) reading distance | Medium range: Up to 2.5m (sensing range) | Small range: 10 to 80cm |
| Frequency range | High | Nominal frequency | High |
| Accuracy | Very accurate | Very accurate | Very accurate |
| Detected Item | Roadside worker with the RFID tag | Detect variety of applications (clear glass, plastic, metal, wood and many more) | Depends on proximity sensor type (metal, plastic) |

## RELATED WORK

### Comparison between technologies

In order to determine the existence of the roadside worker at the roadside, we need to use a technology that has the functionality to be able to detect the worker. All the technologies compared in Table 1, namely RFID, Ultrasonic Sensor and Proximity Sensor can be used for detection purpose. Radio-frequency identification (RFID) uses electromagnetic fields to transfer data wirelessly and it can automatically identify and track tags attached to objects to be identified. The tags contain electronically stored information and RFID can be categorized into two types depending on how they are powered. Passive RFID are powered by electromagnetic induction from magnetic fields produced near the reader or collect energy from the interrogating radio waves. Active RFID tags have a local power source such as a battery and may operate at hundreds of meters from the reader. Unlike a barcode, the tag does not necessarily need to be within line of sight of the reader and may be embedded in the tracked object [12]. Ultrasonic Sensor emits short, high frequency sound waves at regular intervals. The time interval between the sent signal and received echo is determined to measure the distance from an object [13-14]. Infrared proximity sensors work by generating beams of invisible infrared light. A photodetector on the proximity sensor detects any reflections of this light [15-16]. These reflections allow infrared proximity sensors to determine whether there is an object nearby.

Based on Table-1, three features have been identified as the main features and were used to compare the three technologies. The following paragraphs provide thorough analysis of the comparative study.

### Communication range

Communication range can be referred as the distance from where the tracked item will be detected. The proposed system is to detect worker at the highway and sending alerts to the driver to notify them with the presence of the worker. Thus, a large communication range is needed because the alert is sent to the driver from their safe distance depending on the car speed.

As for this prototype, the one with the longest communication range are RFID. It covers up to 6 meters and the communication range of RFID is depending on the frequency type selected to be used. The other two sensors which are ultrasonic and infrared proximity sensor, their communication range covered is not that wide, making them not very suitable for this project. This is simply because, to give an alert to the driver, we need some distance between the driver's vehicle and the roadside worker which is called as safe distance. It has been explained earlier that safe distance is important for every driver will require thinking time before they start to slow down their car. The actual distance will be scaled for this prototyping purposes.

### Frequency range

Comparisons that have been made shows that RFID and Infrared Proximity Sensor, offered with high frequency. Frequency is the desired detection range of the desired object. The frequency range of the RFID will not influence the operation of the components. However, the speed, range as well as accuracy do affected from the frequency range being used in the system.

### Detected item

Among all, RFID is the only one that has the specific detected item which is the RFID tag. The tag is the one attached to the desired detected item. As for this project, RFID tag will be with the worker at the roadside for them to wear. RFID Tag can also be embedded in the cloth. Thus, it makes RFID having a specific thing to be detected as compared to the other two technologies. Ultrasonic sensor and Infrared Proximity sensor will detect any obstacle in front of them. In addition, each RFID tag has unique codes embedded in it. Thus, makes the RFID tag more precise and specific compared to others.

On the other hand, ultrasonic sensor covers almost all items that can be detected like glass, plastic, metal and wood. An infrared proximity sensor is depending on the type of sensor that is being used, whether it is used for metal or plastic. It has its own specific task according to specific proximity sensor type used. Overall all have the same function which is for

detection. However, the difference between RFID and the other sensor is that RFID is able to detect targeted item via the RFID tag.

Lastly, based on the comparison that have been done between the three technologies, we decided to use RFID in this proposed project as it is the only detection technologies that comes with the specific detection item. Furthermore, RFID is the one that provides the furthest distance among all.

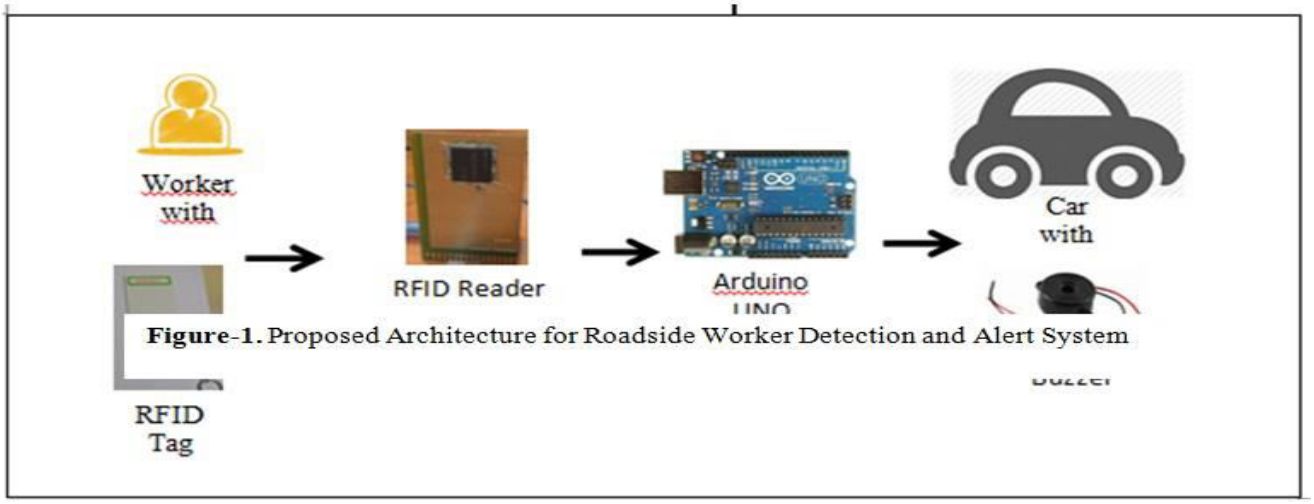


**Figure-1.** Proposed Architecture for Roadside Worker Detection and Alert System

**Figure-1.** Proposed architecture for roadside worker detection and alert system.

## SYSTEM MODEL

### System architecture

Figure-1 is the proposed architecture for this project. It is the overview on how those devices and tools be linked together.

There are four main devices that will be used for this project, which are the RFID tag, RFID Reader, Arduino UNO and the buzzer. All items to be tracked need RFID tag to be attached to them. In this project the one that will be tracked is the roadside worker. Thus, the RFID tag should be with them. The tag is made up of tiny tag-chip or also being called as integrated circuit (IC). Each tag has their own specific, unique tracking identifier. Also known as an electronic product code (EPC). Unique tracking code is the one that is vital for this system to identify whether there is any worker at the roadside.

Signal or data from the RFID tag is being transmitted to RFID reader through Radio Frequency energy. The reader must be placed far from metal based item as it can absorb the Radio Frequency which will make the reading range shorter.

Next, data from RFID reader, also known as interrogator will be passed to Arduino UNO to be processed. Before that, the speed of the car was set in Arduino in order to determine the time when should the buzzer give an alert to the driver. The RFID reader is holding a role as a middle man between the tag and Arduino.

As the input data from the reader reached Arduino, the data will be processed before it gives an instruction or command to ring the buzzer. The buzzer will ring as a sign to notify the driver that they need to slow down the speed of their car or to change the path taken on the highway as the roadside worker is in front of them. We are hoping with the implementation of this system in the future the number of death and accident at the highway can be reduced.

### System flow

In this section, we designed the system flow by using a data flow diagram as shown in Figure-2. The flow in Figure-2 represents the flow of processes of the proposed system, starting from the vehicle speed input until the process end with detection of roadside workers.

The process of the system start by first setting the speed of the car in Serial Monitor of the Arduino. The speed of the car will determine the safety distance for the driver to start pressing the brake pedal. This action is called Total Stopping Distance which is the summation of Thinking Distance and Braking Distance. Next, determine the presence of the roadside worker at the highway by simulating it with detecting the existence of the RFID tag.

This RFID tag is the one that will act as a tracker for this distance alert system. Once the condition of whether there is the presence of the roadside worker is fulfill, then the system can proceed to send the input data to the RFID Reader. However, if there is no roadside worker at the site of the highway, then the system will continue searching for the roadside worker.

## RESULTS AND DISCUSSIONS

### Interview

An interview session has been conducted with representatives from the Traffic Safety Department of

PLUS Highway to get some overview and opinion from their perspective as the one who control the flow of the highway as well as the one that manage the contractor at the road side. Several questions had been asked and before the interview session end, we did make a short demonstration with the prototype. Overall, we got a good response from them regarding the proposed idea and they are also willing to invest in this system if it is available in the future.

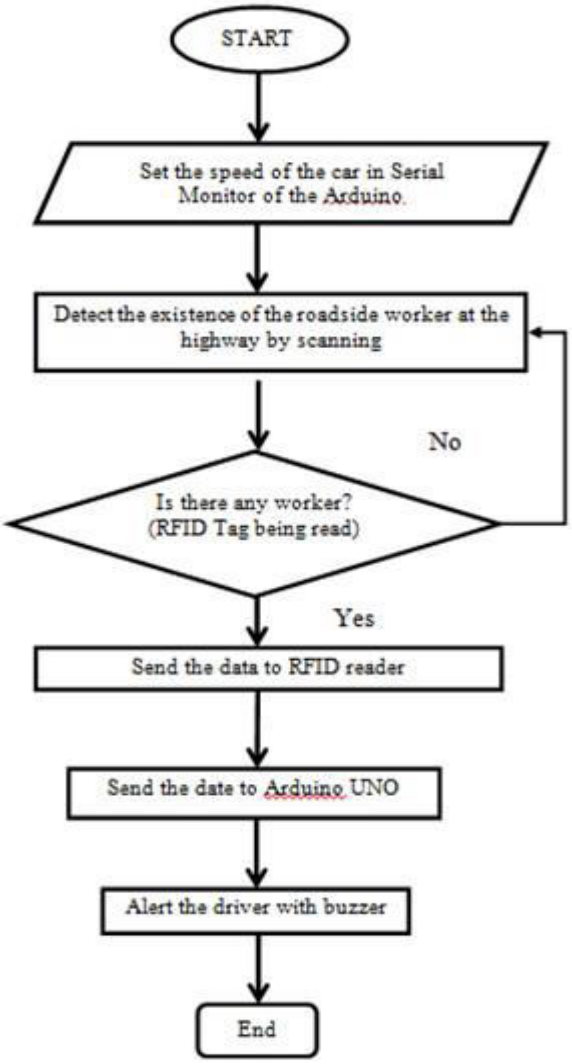


**Figure-2.** Proposed data flow of roadside worker detection and alert system.

## Project testing

### Testing for reading RFID tag

The purpose of this testing is to study alertness of the prototype system when the distance between RFID Tag and the RFID reader is being manipulated. Speed inserted in the serial monitor has been set fixed to 110km/h as this is the maximum speed limit on the normal highway in Malaysia and the output of this testing is to record the time taken for the prototype system to give alert in seconds. Based on Figure-3, it can be concluded that distance does affect the time needed for the system to give an alert. As the distance become shorter, it will give alert even faster. A distance of 3cm needs less time for the system to give an alert.

### Consistency testing

This second testing is about the consistency of the prototype system to give an alert. The purpose of the testing is to study the consistency of the delay time before the prototype system starts to give alert depending on the value of speed being keyed in. The speed being keyed in had been made as the manipulated variable while the distance between the tag and the reader had been set fixed to 7cm. The value recorded in this testing is the delay time based on the speed inserted. Based on the result, it shows that the prototype system manages to get consistent value after thirty trials.

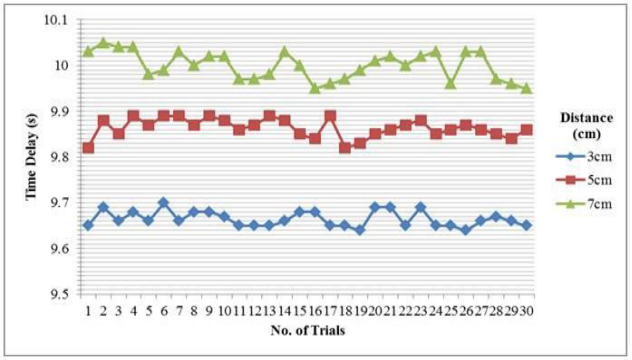


**Figure-3.** Result for reading RFID tag testing.

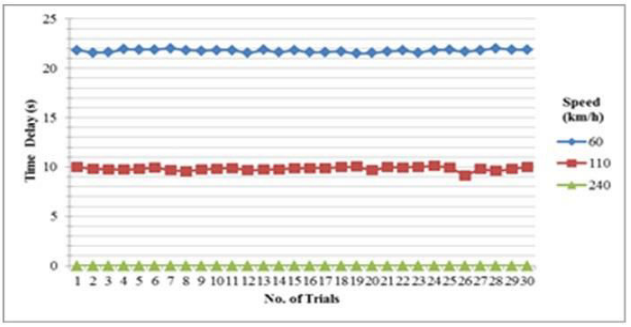


**Figure-4.** Result for consistency testing.

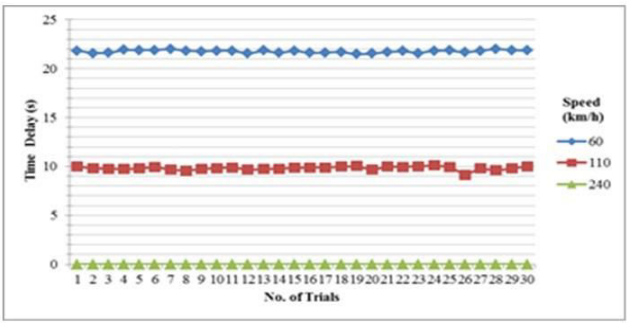


**Figure-5.** Result for verification of RFID tag.

**Verification of RFID tag**

The purpose of this last testing is to validate the RFID Tag that has been scanned. In this testing, two RFID tag was used, each with a different ID. For this testing the distance between the RFID tag to the reader is being fixed to 7cm and the output monitored is the verification message appeared on the serial monitor.

Figure-5 displays the result for verification of RFID Tag on the serial monitor of the Arduino UNO. If the tag identifier is an authentication tag, it will display a message "Identification verified" on the serial monitor. The 5-byte code is the unique id of the RFID tag.

This testing has shown that only verified RFID Tag will trigger this prototype system to give an alert.

## CONCLUSIONS

This system is proposed to reduce the rate of road accident, especially involving roadside workers. The system provides a pre-alert notification for drivers to stay alert with the roadside workers so that drivers have more reaction time avoiding them. The proposed solution of this prototype system has been shown in the software architecture to show how RFID could help in simulating the detection of the roadside worker as mentioned in the first objective.

Next, the implementation part is where the prototype is being developed and it has been tested based on the three testing conducted. This phase will need us to link all the four main devices which are RFID tag, RFID Reader, Arduino UNO and the buzzer. The input data gather must be sent correctly to trigger the buzzer. Since we are just developing a prototype system, the distance is being scaled and the speed of the moving car has then been key in from the Serial Monitor of Arduino UNO.

Overall, we manage to accomplish both objectives of this project. First, we have done a comparative study on technology that should be used in developing this prototype system.. Second, we developed the prototype system and had successfully done three testing on the prototype system. All the three testings are important to test the functionality of the prototype system.

## RECOMMENDATION

The basic idea of this project is to enhance the safety aspect of the roadside worker. Based on the news reported, there is a serious need for us to improve the current safety aspect. Thus we came out with the idea of proposing this project. However, this project only manages to come out with a prototype system and still a lot more improvement need to be done. We had to go through several technologies currently being used in the real implementation, but still we did not find any technologies or sensor that can be used to specifically detect the roadside worker. Besides, those technologies that are currently available have their own limitation.

Based on the detection technologies that we found, radar had been the innovator choice of creating detection sensor with a long range. Some of the car companies like Honda and BMW had use Far Detection Sensor (FDS) in cars that they produced. In Volvo, they are now using radar sensors to avoid collision with the front vehicle [17]. However, both sensors are still having some limitations. FDS is a high accuracy of target range, but the maximum range is not that far. It only covers up to 180m. Meanwhile, for radar sensor used by Volvo, one of the limitations is that radar sensor cannot detect when it is raining. The detection will be blocked. In addition, both technologies mentioned, are not having specific item to be detected.

In Korea, they already have a system which they name it as a Smart Incident Detecting System [18]. This detecting system is using radar for the detection. The detect range can cover up till 1km which is far enough if we compared to the Total Stopping Distance that we have calculated in Table 6. This might be a good choice to be improved in the future. Just that it needs to be embedded in the car and the detection is made specifically for the roadside worker.

Lastly, we hope that this idea can be further improved to be used in the next future.

## ACKNOWLEDGEMENTS

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