# Performance Parameter Study of Signal Warning Detector (SWAD) and Circuit System

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*Abstract:* - Safety is a factor that needs to be prioritised at the workplace. Every worker in the sector values a safe and secure work environment, so workplace safety is important for all of them. Highway maintenance workers' safety is critical since they are placed in the highway's work zone to perform maintenance tasks. There are many incidents involving maintenance workers when working on the highway since there is a poor danger detection system in place to alert workers during the working process. The goal of this research is to build an improved safety system for maintenance workers on the job. There are two objectives in this study, which are to study the parameters effect of applying a distance sensor in finding the best safety vehicle detection at an emergency lane and the reliability test of a signal warning detector (SWAD) casing for the best installation at a road maintenance vehicle. The SWAD set up and experimental performance field test have been done. The study was conducted by setting up the SWAD at Padang Kawad, UTHM, and testing its ability to detect the presence of a vehicle at different distances and sensor heights. The vibration test for SWAD circuit casing has be done using a vibration shaker. The results showed that the SWAD was able to detect the presence of a vehicle at 90 metres and at a sensor height of 0.7 metres. From the vibration testing for the long pane, we know that the maximum vibration of SWAD's circuit casing can absorb, which is 13.074 Hz, and the speed of the vibration is 3.8319 *m/s.* The system can increase the level of safety among highway workers if it is implemented on highways for safety purposes involving highway workers and users of highways.

*Key-Words:* - Highway workers, Circuit Casing, Signal Warning Detector, Transmitter, Receiver

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## 1 Introduction

The Royal Malaysian Police received 548,598 reports of traffic accidents in 2018, although just 1.1% of those incidents resulted in deaths. With 1046 cases, Selangor had the largest number of deaths from traffic accidents, while Kelantan had the most injuries, 1626 cases, from such incidents. The fewest number of deaths and injuries were reported in Wilayah Persekutuan Putrajaya, at 10 [1]. There are three dangers that might cause accidents, including underproduction or lack of protection, poor visibility issues, and rushing through work zones. Most roadway accidents involved user and worker vehicles while doing the job [2]. This study is done to upgrade the Signal Warning Detector (SWAD) system by developing the laser sensor, which is the HSLD-01

laser distance sensor and to do the vibration test for reliability on the Signal Warning Detector (SWAD) circuit system.

To compute the distance determined by ultrasonic sensors and record information onto a memory card in a data logging shield, the Arduino functions as a processing unit is one of the research example. To make an Arduino operate, a data recording shield may simply be placed on top of it [3]. Laser sensors may be used to detect object distances and related attributes such as displacements, locations, surface profiles, and velocities. Previous researcher proposed that the time-of-flight sensor detects distance by directing a focused laser beam at the target and capturing the signal that is reflected [4].

Nowadays, there are several construction worker injuries on the roadside. Road safety was a primary issue for expert traffic engineers, and it was extensively investigated. The degree of safety while working is one factor that contributes to the increase in the number of injuries on a daily basis [5]. The safety of road workers cannot be guaranteed simply by putting up a safety cone and a hazard light to keep them safe in the event of an accident. By designing a safety system that improves their safety, the safety mechanism must be enhanced.

The primary method of actively monitoring the vehicle's surroundings is infrared laser radar active obstacle detection. Laser radar has advantages over microwave and millimetre-wave radar, including a compact size, a narrow beam, a cheap cost, the absence of electromagnetic interference, and high accuracy of distance and position [6]. The relative speed determined by deducting the previous and subsequent distances. The time between the two frames is then divided based on the outcome.

Product reliability must be better to obtain a longer life cycle. Based on enough failure data, conventional reliability analysis methodologies may often be used. As a result, typical reliability analysis techniques are inappropriate when there is little or no failure data [7].

The primary location for work zone accidents, regardless of road type, is the activity area, and the most common type of accident is a rear-end collision [8]. As a result, highway concessionaires enable researchers to assess and implement a work zone protection policy to improve the safety of work zones at construction sites.

Early warning may prevent three common collision scenarios which are frontal vehicle deceleration, sudden lane changes of another vehicle and intrusion by a vehicle travelling in the opposite or cross direction. The system's design requirements may be divided into three categories which are establishing the maximum stopping distance, identifying an object's motion, and calculating its relative speed [9].

The performance study describes how to utilise these statistical characteristics to generate vibration simulation plans that are tailored to the vehicle type and route. The research demonstrates how statistical models may be used with ordinary random vibration controllers to provide a practical but upgraded way for providing more realistic simulations of road-related vibrations in the laboratory for package performance evaluation [10].

## 2 Methodology

Signal Warning Detector (SWAD) was designed as part of a safety system to provide early warning to highway workers. The traffic accidents among highway workers have become an important concern. By reviewing previous researches, it is understood that the reliability evaluation of SWAD transmitter casing with the circuit system needed to be done [11].

The experimental test was conducted by setting up the SWAD at Padang Kawad, UTHM and testing its ability to detect the presence of a vehicle at different distances and sensor heights. The actual scenario was used to find the distance references to the HDSL-01, the height references at the PLUS vehicles and the velocity of the vehicles that be detect by HDSL-01 sensor as shown in Fig. 1.

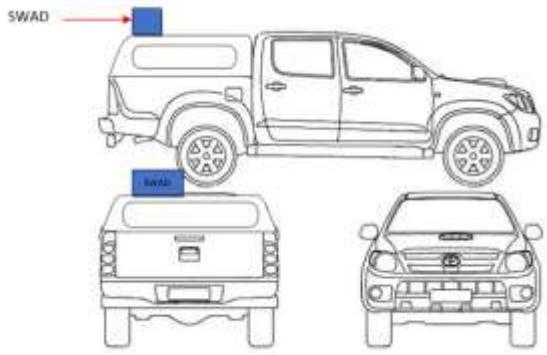


Fig. 1: SWAD placement on PLUS Ronda vehicle

The vibration shaker was used in the reliability vibration test to obtain data on acceleration and velocity. The SWAD system's circuit casing be attached to the vibration shaker before the machine was put into operation liked showing in Fig. 2. After that, the frequency setup was done to obtain the results of the acceleration and velocity. The vibration test of Signal Warning Detector (SWAD) circuit casing was done to find the best installation at road maintenance vehicle.

Fig. 2: Vibration test of Signal Warning Detector (SWAD) circuit casing

Reliability is defined as the calculation that can be repeated is consistency [12]. This test can be considered to be the indicator for calculating a reliable outcome. In other words, if the test is done to get any data, the next test will get identical data. There are some potential explanations for this if the reliability test does not have consistent results, one of which is environmental. Differences in types of environments, such as distance, velocity, presence and sound pressure levels, can affect test output due to the time of testing. In this study, there is an alarm and a vibrator as a warning to save or alert the maintenance worker before the crash occurs. In certain situations, warning systems may be unreliable even though they do not emit signals where those emissions are justified. The data transmitted are the basis for optimizing the structure and reliability of the vehicle [13]. Electronic devices application in SWAD system are the important thing to be considered for the best performance [14].

## 3 Results and Discussion

There are a several discussions that can be taken into consideration for the study. This includes a detail study and analysis on the Signal Warning Detector System (SWAD) concept. The Signal Warning Detector System concept is still fresh and not many research and study on it. Most of study is about signal or sensor concept for simple uses not for highway safety user, but the SWAD system was an innovation as a device for the maintenance worker at the highway site for upgraded their safety level. The efficiency and performance of SWAD has been studied in details. By verifying the material usage, the research study uses different types of material that is applied to the design such as stainless steel and other non-metal materials. Lastly, the fabrication of SWAD was take place. Reliability and simulation process is done to suggest fabricate process flow and it will be easier to observe the design operability on the real application.

The parameter effect of applying distance sensor results shown in Fig. 3. The graph shows the detected distance against the sensor height at the vehicle. The range of measured distances for a 0.7 m sensor height at the vehicle was 10.22 m to 96.05 m. The range of measured distances for a 0.8 m sensor height at the vehicle was 10.0 m to 90.03 m. The range of measured distances for a 0.9 m sensor height at the vehicle was 10.03 m to 70.2 m. The 10 m to 60.05 m range was the range of distances that the vehicle's 1.0 m sensor height could detect. Finally, a 1.1 meter sensor height at the vehicle measured a distance between 20.41 metres and 30.05 metres. The best detection was at a sensor height of 0.7 metres at the vehicle, the sensor's maximum detectable distance was 96.05 metres.

The Fig. 4 shows the maximum distance of detection against sensor height at the vehicle that summarized from the overall experimental result testing. The maximum distance of detection is at 0.7 metres height which was 90 metres.

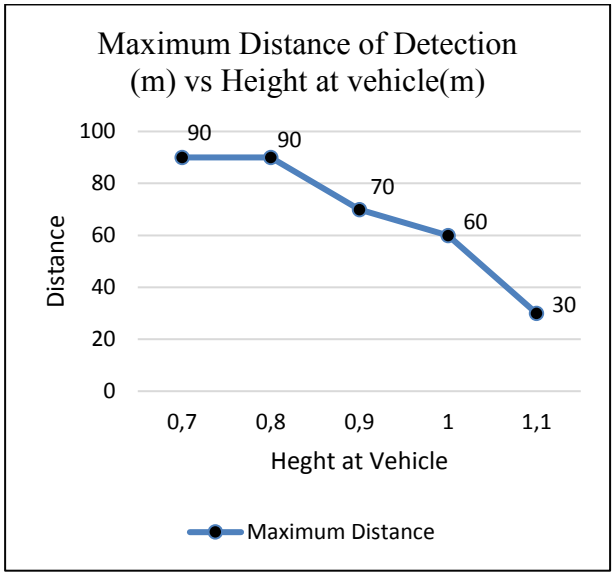


Fig. 4: Maximum distance of detection

The vibration test of Signal Warning Detector (SWAD) circuit casing had been done in laboratory. Fig. 5 showed the vibrate distance at 1 mm pane and the parameter was set at 20 km/h speeds. The SWAD circuit casing vibrates at a peak point of 13.074 Hz and 3.8319 $m/s^2$.

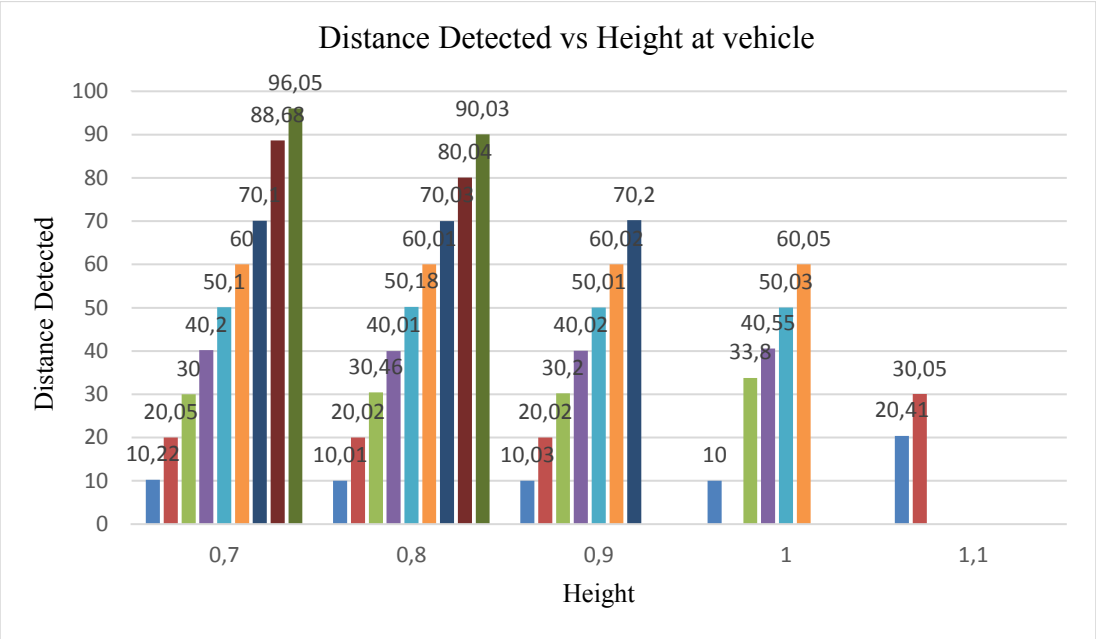


Fig. 3: The maximum distance detected data

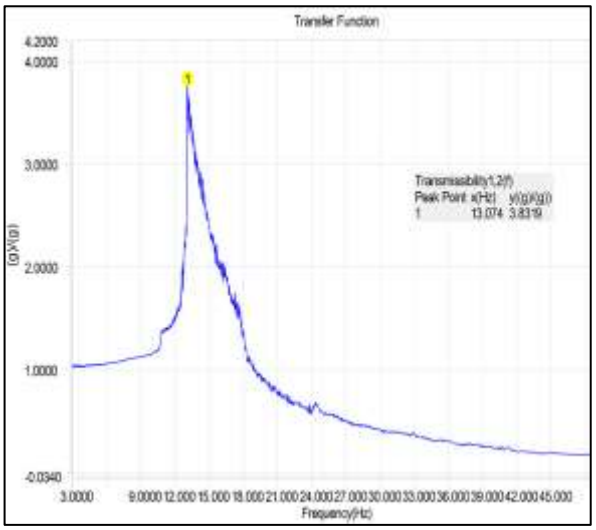


Fig. 5: Graph of vibrate distance for 1mm pane with 20km/h speeds

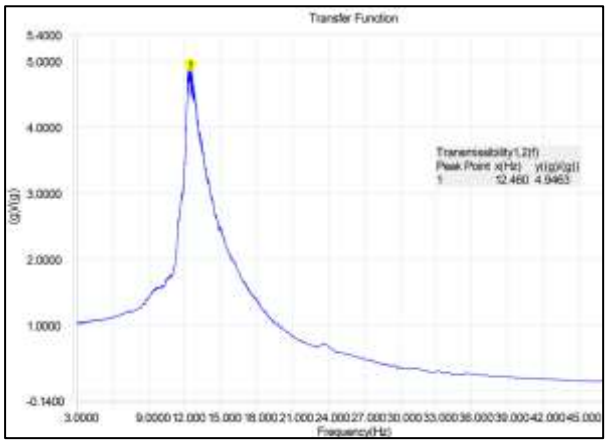


Fig. 6: Graph of vibrate distance for 1mm pane with 30km/h speeds

Second vibration test was done for 1 mm pane and parameter speed was set at 30 km/h. Fig. 6 showed the vibrate distance at 1 mm pane testing result. The SWAD circuit casing vibrates at a peak point of 12.460 Hz and 4.9463 $m/s^2$.

Third vibration test was done for 1 mm pane and parameter speed was set at 40 km/h. Fig. 7 showed the vibrate distance at 1 mm pane testing result. The SWAD circuit casing vibrates at a peak point of 11.178 Hz and 4.9288 $m/s^2$.

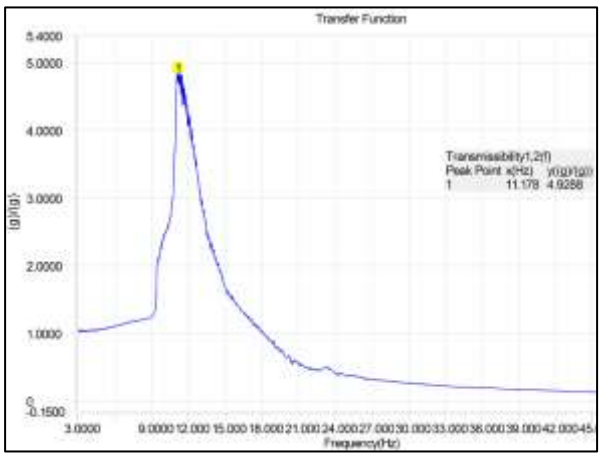


Fig. 7: Graph of vibrate distance for 1mm pane with 40km/h speeds

From all the vibration test result for SWAD circuit casing, when vibration speed was increased, the frequency will decrease while the acceleration parameter will increase. All the results was discussed in detail for SWAD system performance.

# 4 Conclusion

The performance parameter study of the Signal Warning Detector (SWAD) and circuit system had ability to handle the issue that has arisen among highway workers at highway The objective of the project has also been accomplished, which was to study the parameters and effects of applying a distance sensor to find the best safety vehicle detection in the emergency lane. The study was conducted by setting up the SWAD at Padang Kawad, UTHM, and testing its ability to detect the presence of a vehicle at different distances and sensor heights. The results showed that the SWAD was able to detect the presence of a vehicle at 90 metres and at a sensor height of 0.7 metres. The second objective is to study the performance test of the Signal Warning Detector (SWAD) circuit casing for the best installation on road maintenance vehicles. Three experiments had been done on vibration testing for SWAD circuit casings. From the vibration testing for the long pane, we know the maximum vibration that the SWAD's casing can absorb, which is 13.074Hz and the acceleration of the vibration is 3.8319 $m/s^2$. The performance study of SWAD able to solve the problem that leads to reduce the accident rate among highway maintenance workers. The application of SWAD system can lead the automation system with Artificial Intelligence in the safety working environment at highway and roadside. The frequency of accidents can be reduced in developing Internet of Things (IoT) technology that can aid in the solution of this issue [15].

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**Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)**

The authors equally contributed in the present research, at all stages from the formulation of the problem to the final findings and solution.

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**Conflict of Interest**

The authors have no conflicts of interest to declare that are relevant to the content of this article.