

An Investigation into Distance Measuring Technologies to Augment Driving Experience

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1. Introduction

Globally over 1.3 million fatalities occur from traffic collisions with 90% due to human error [1]. Advanced Driver Assistance Systems (ADAS) are a group of safety technologies relating to motor vehicles, with their main purpose to minimise human error. This project outlines an investigation into ADAS which adopt distance measuring technologies.

2. Aim & Objectives

Aim:

To investigate distance measuring technologies within ADAS and develop an electronic system to test a selected technology.

Objectives:

- Research and investigate Advanced Driver-Assistance Systems which adopt distance measuring technologies.
- Write a design specification for a system to test a selected technology.
- To design and build a system based on the design specification.
- Perform tests on the overall system and the technology, recording all results achieved.
- Analyse and evaluate the test results, comparing collected results with relevant studies.

3. Research Overview

ADAS which adopt distance measuring sensors include parking sensors, lane departure warnings, blind spot monitors, collision avoidance systems, adaptive cruise control and autonomous vehicles. Technologies used:

- RADAR:** excellent range and reliability, however suffer line of sight issues.
- Camera:** excellent object detection and accuracy despite being unreliable in adverse weather conditions.
- LiDAR:** high response times and reliability however the technology is costly and requires higher computational power.
- Ultrasonic:** low cost and accurate however have a limited range and surface and angle reflectivity issues [2].

Due to budget constraints ultrasound was the adopted technology. There are many related studies which use ultrasound. Jiménez et al provide a study of the suitability of ultrasound in vehicle tracking and detection. They believe ultrasound is strongest for short range ADAS due to low cost and accuracy [3].

4. Design and Implementation

The final system uses eight HC SR04 ultrasonic sensors which are fitted around a buggy to simulate the workings of a short range collision avoidance system. A PIC16F887 is used to control the buggy and perform two software algorithms, being free roam and self park modes. These algorithms use 'if' statement thresholds where a change in distance changes the speed or direction of the motors. The speed is controlled using PWM and the distance is calculated using the time of flight principle:

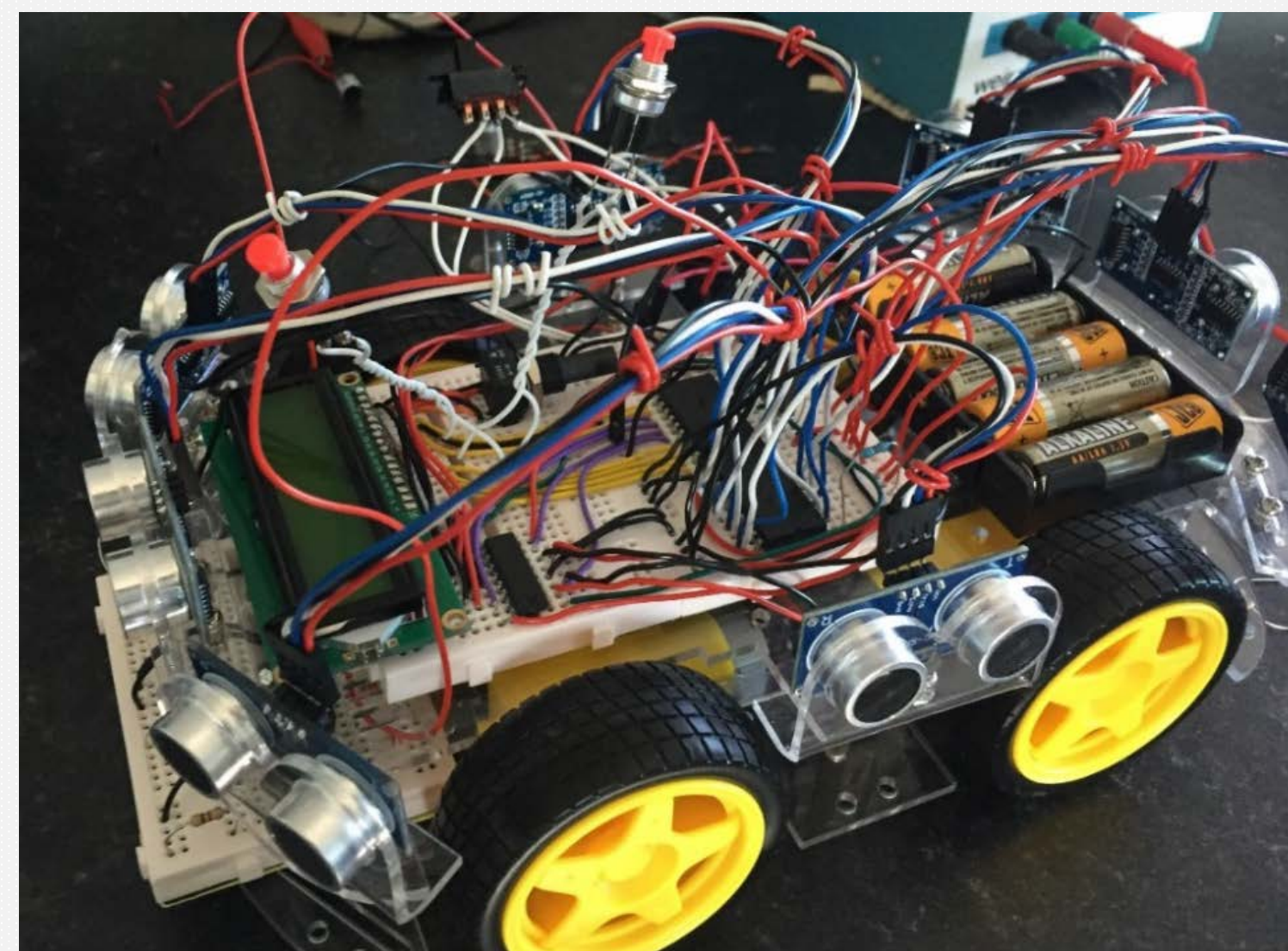
$$Distance = \frac{time\ of\ pulse \times speed\ of\ sound}{2}$$


Figure 1: Final Hardware Implementation

5. Testing & Results

Many tests were performed on the final system:

- Surface Reflection:** The accuracy of the system was tested against a variety of materials. Results showed paper to produce the most errors with errors occurring throughout the measurement range (fig 2). These results are as expected from research with a study by Adarsh et al showing similar errors. This is due to paper's transmission property [4].
- Angle Effect:** The accuracy of the system was checked against a varying angle. Results showed that the sensor performs poorly with large errors occurring at just 20° (fig 3). This compares with research as a similar experimental study by Gamarra-Diezma et al show errors occurring at 20° also [5].
- Algorithm Response:** The algorithm responded as intended and reacted well to a variety of materials. However, paper provided false starts due to reflection issues.
- Interference Effect:** A transducer was used to direct a varying frequency at the sensors. No interference was found, future tests considered using larger transducer.

Surface Reflectivity Accuracy

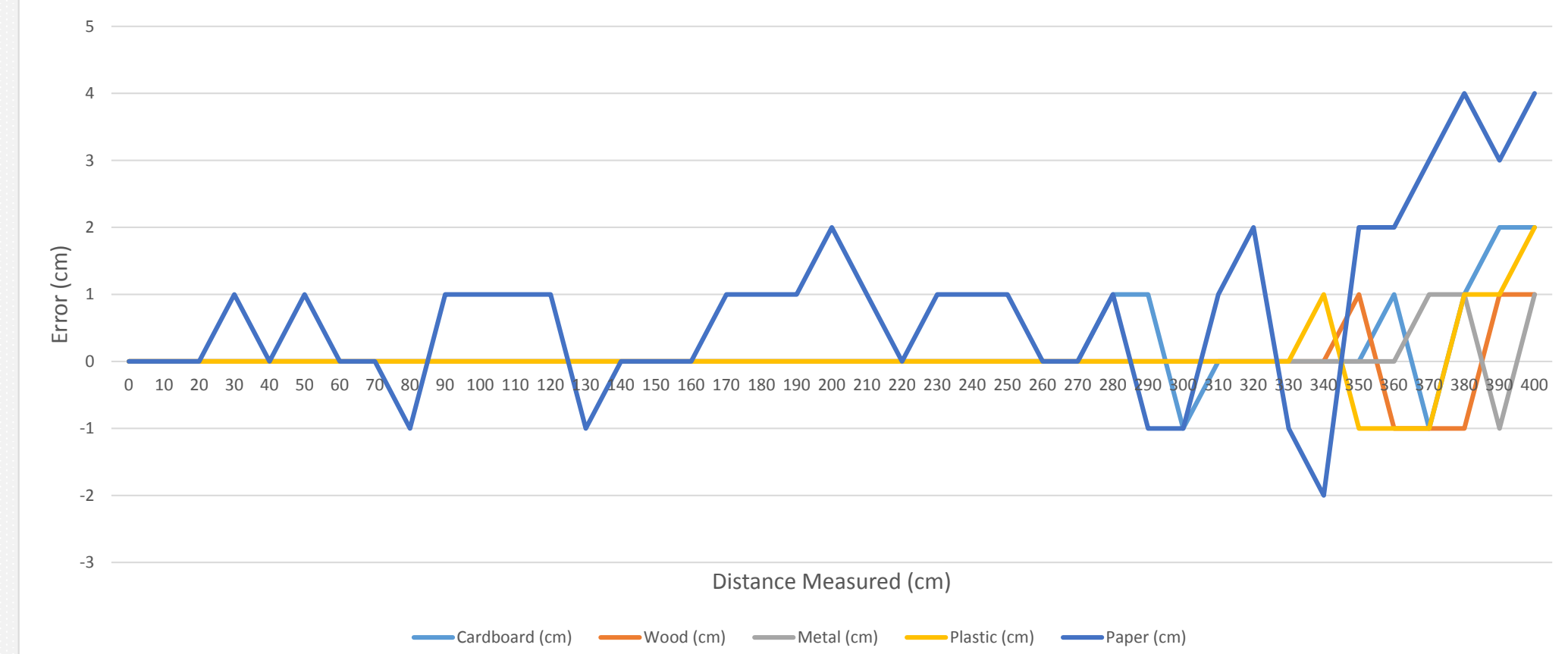


Figure 2: Surface Accuracy Results

Angle vs Measurement Error (Wood)

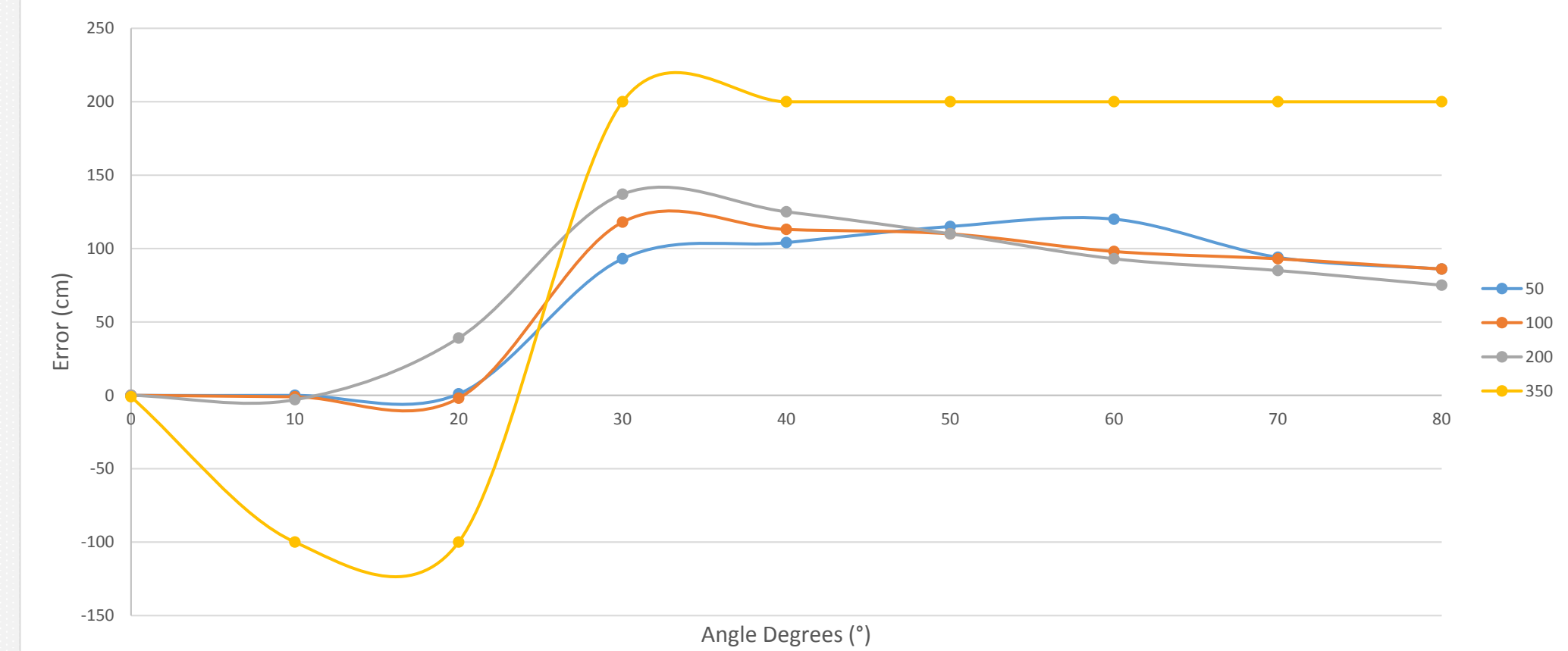


Figure 3: Angle Effect Results

6. Conclusion

Ultrasonic sensors are regarded as a low cost and accurate option for short range ADAS. However, limitations include surface and angle reflectivity issues. Due to these limitations for ultrasonic systems to be applied to a self drive car, a large number of transducers are required to overcome these issues. In terms of system design the system functions according to the specification, with minor improvements including temperature compensation and algorithm improvements. The project has led to potential future work including investigations into other technologies (e.g. RADAR) and further testing on the current system. Overall the project is regarded a success with all objectives met.

References

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