Infrared for Obstacle Avoidance on Self-Driving Cars

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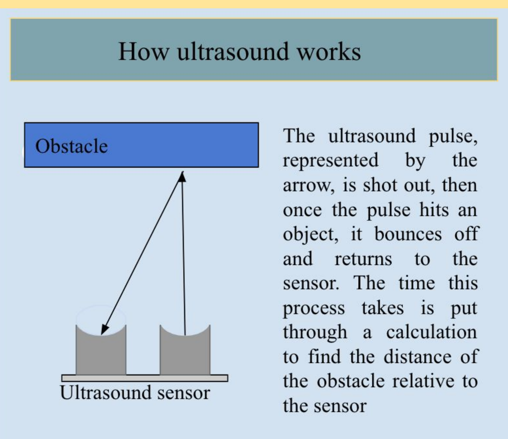
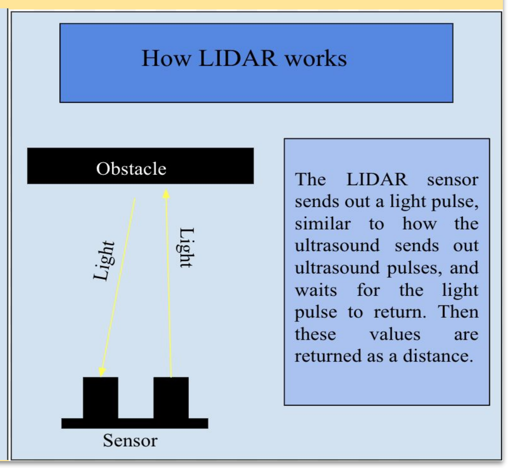
INTRODUCTION

In this modern age, many people choose to commute by automobile. However, every year, thousands of people are hurt or killed in car accidents. “Each year, nearly 400,000 people under 25 die on the world’s roads, on average over 1,000 a day” (Association for Safe and International Travel). However, new technology for cars, specifically the combination of artificial intelligence and automobiles to create autonomous vehicles, would help make roads safer. The sensors that allow the car to avoid obstacles is crucial for self-driving cars. Self-driving cars use sensors to gather data to input into the algorithm. Some of these sensors include RADAR, optical, LIDAR, and ultrasound. Each of these sensors has a specific role in obstacle detection. For example, optical sensors gather information on environmental stimuli, like the color of a traffic light, while LIDAR and RADAR are used to map the environment around the car. This research project will focus on a sensor that is not widely used in this field: infrared. Infrared sensors would be able to detect the heat produced by living organisms. The goal of this research is to observe whether or not an infrared sensor would be beneficial for obstacle avoidance in self-driving cars.



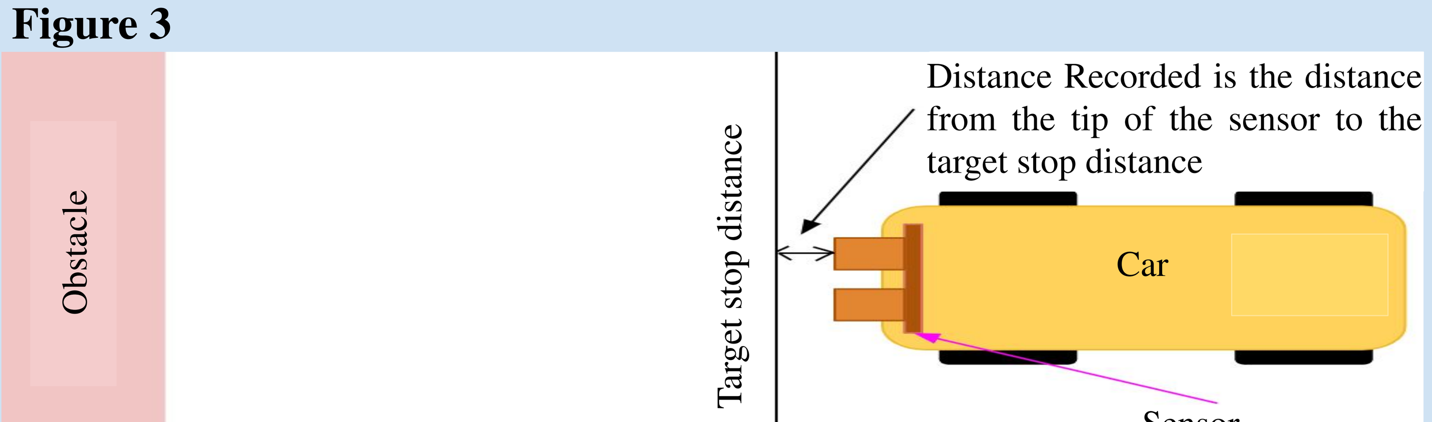


RESEARCH METHODOLOGIES

A set procedure was used to test how well the sensor can collect data and use it to detect and avoid obstacles.

1. Set the car 100 cm away from the obstacle, set the candle on top, and light it.
2. Mark a line where the car is supposed to stop (e.g., if the test is at 30 cm, a mark is placed 30 cm away from the obstacle).
3. Turn on the car.
4. When the car stops, measure the distance from the tip of the sensor to the actual distance and record the value to the nearest 0.01 cm.
5. Repeat these steps for other trials.

Figure 3



DATA AND FINDINGS

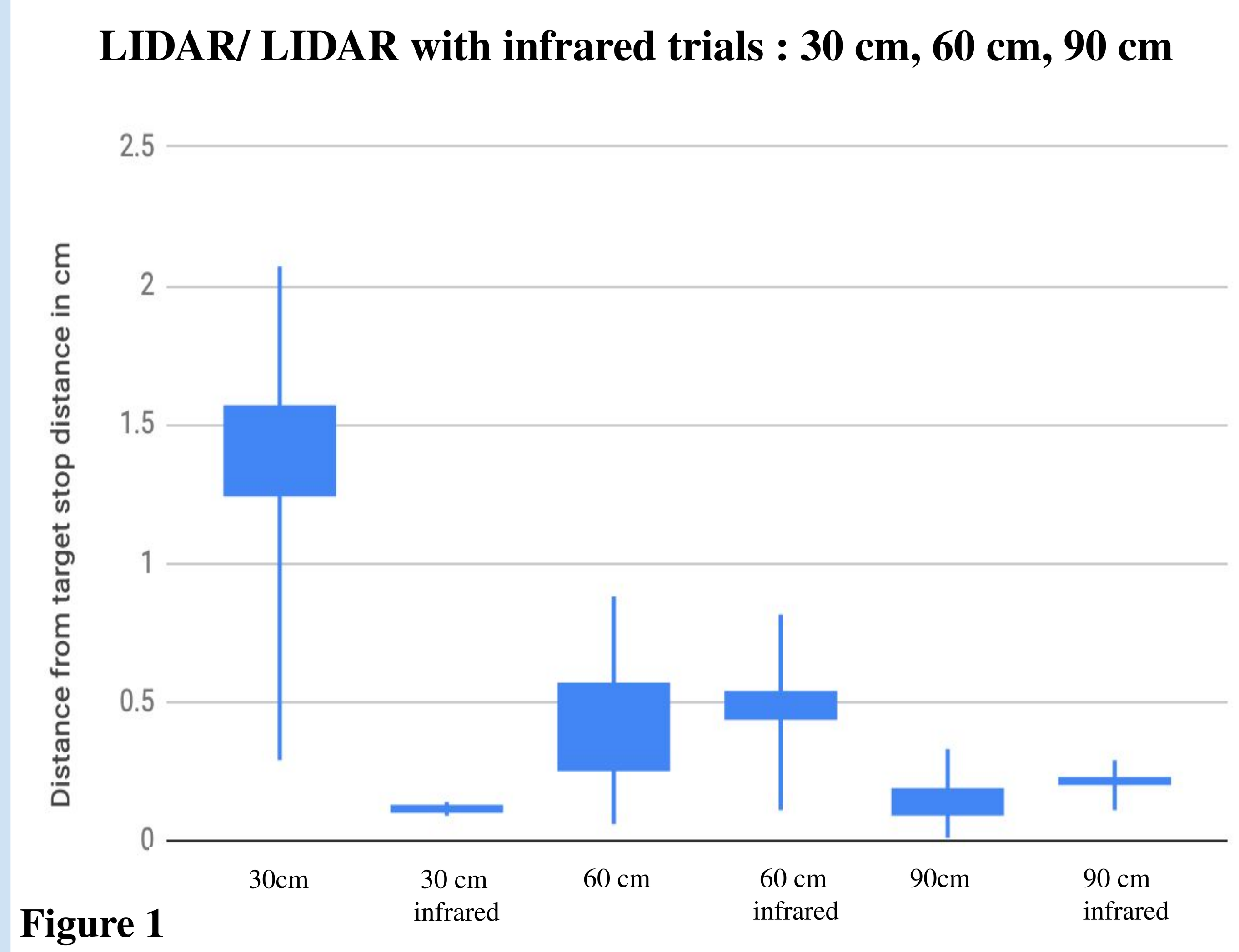


Figure 1

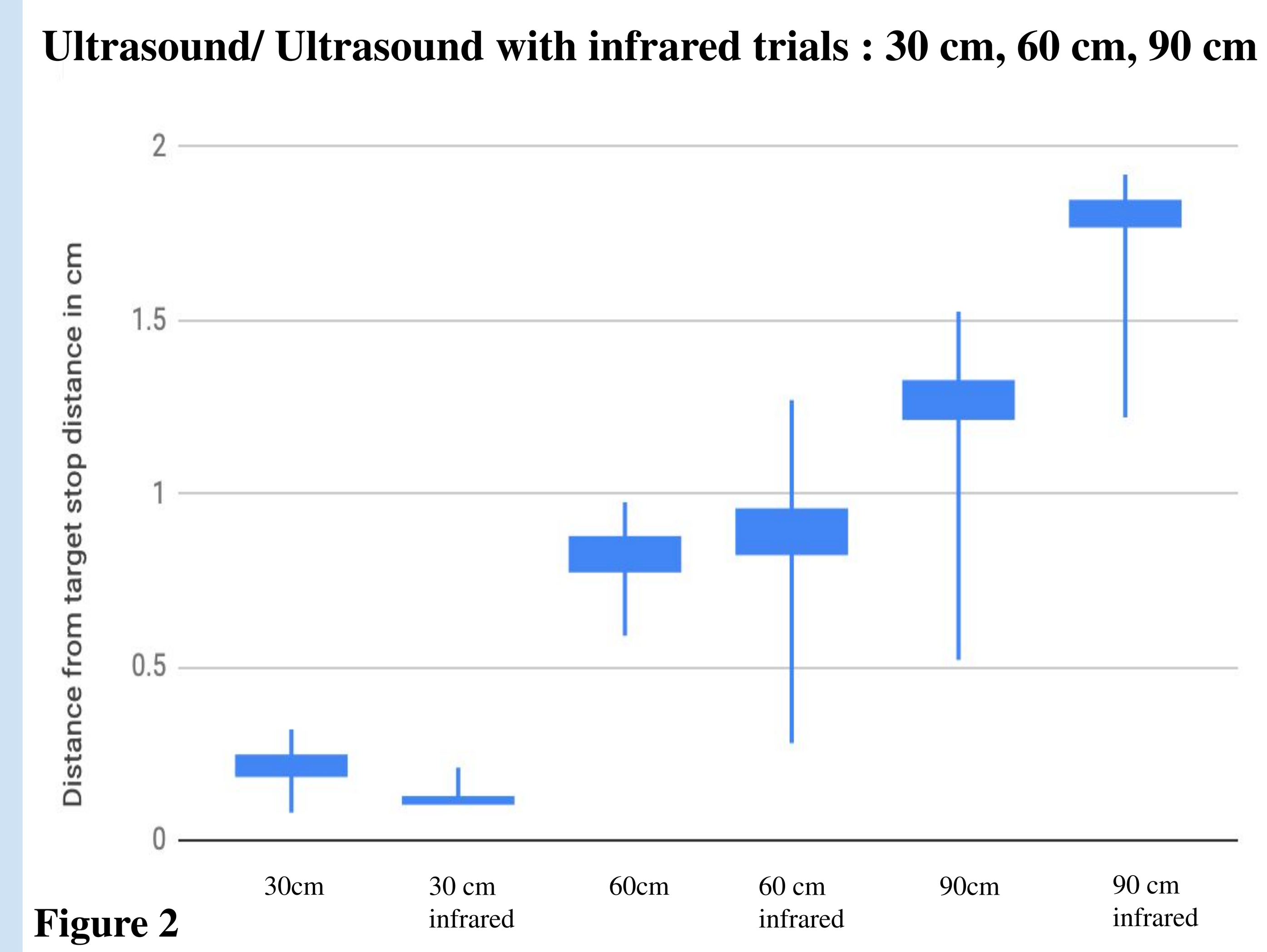


Figure 2

The data collected for the LIDAR trials strongly suggest that infrared has a positive impact on the LIDAR sensor performance. For example, the trial LIDAR thirty centimeters had data that was both dispersed and inaccurate. With the addition of the infrared sensor for the 30 cm trial, both the accuracy and the precision of the data set were increased. The data above suggest that the LIDAR sensor is more accurate at longer ranges, as the data sets became increasingly accurate and precise as the testing distance increases. However, there is a limit to how far the LIDAR sensor can accurately detect an obstacle and for the LIDAR sensor that was used in this experiment, the distance was around four thousand five hundred centimeters. However, when observing data trends for 60 cm and 90 cm trials, the infrared does not seem to have a significant negative impact on the LIDAR sensor’s ability to detect the obstacle. A large portion of the data is clustered, with most of the data being similar in precision and accuracy.

The data collected for the ultrasound sensors suggest that the addition of infrared technologies to assist this sensor has a negative impact on the ultrasound sensor’s ability to detect an obstacle. Although the addition of the infrared sensor in the 30 cm trial allowed the data to be more concentrated and accurate, the other trials show that the infrared sensor causes the data to decrease in accuracy. For example, while comparing the 60 cm trials, the ultrasound by itself had higher overall accuracy and a tighter spread of data whereas the addition of the infrared sensor introduced more variance in the data, decreasing the precision of the overall dataset. Additionally, the 90 cm trials show how the addition of the infrared sensor has a negative impact on how well the ultrasound sensor can detect an obstacle. Although the cluster of the data was tighter, there was a decrease of accuracy showing that the car was reliably stopping much closer to the obstacle which is undesirable.

CONCLUSIONS AND ANALYSIS

In conclusion, one can see both the positive and negative effects of infrared technologies on sensors used on self-driving cars. The addition of the infrared sensors to assist the LIDAR sensor benefits the performance of the LIDAR sensor, as the infrared sensors used in this experiment excel in short-distance readings, have very high accuracy, and are very consistent when dealing with readings that are less than 60 cm away. The LIDAR sensor capitalizes on the strengths of the infrared sensor in order to compensate for its own weaknesses, showing that the infrared sensor does have potential in the field of self-driving cars and obstacle detection. However, for the ultrasound sensor, the addition of the infrared sensor causes more variance, making the overall data less accurate. The ultrasound sensor has many disadvantages when paired with an infrared sensor, with the largest issue being the fact that the accuracy of the ultrasound drastically decreases when the infrared sensor is added. This drastic decrease in accuracy could be due to an increase in time required to complete the entire program. The increase of time is due to the additional segment of code added in order to use the infrared sensor. If there is only one sensor being tested, the program goes straight from sending out an ultrasound pulse to a distance reading, then it uses the distance obtained and checks if it is less than the set distance, and then another ultrasound pulse is outputted and this process repeats. However, with the addition of the infrared sensor, the process becomes send an ultrasound pulse, obtain a distance reading, use the infrared sensor to determine if there is a heat source, check if the car crossed the set distance or if there is a heat source, and then this process repeats and sends another ultrasound pulse. This extra element prolongs the time it takes to the get to the conditional, allowing the car to travel farther before stopping when the conditional is met. This decrease of accuracy did not occur when the LIDAR sensor was paired with the infrared sensor as the rate at which the obstacle detection process is refreshed is much shorter due to a small amount of lag time. Ultimately, using the data collected throughout the experiment, one can see that the benefits of using infrared on self-driving cars are balanced by the disadvantages.

IMPLICATIONS/NEXT STEPS

In summary, the data collected suggest that there would be both benefits and disadvantages when one adds the infrared sensor to assist the sensor’s on the self-driving car. The infrared sensor improves the accuracy of the LIDAR sensor, whereas it causes the ultrasound sensor to lose accuracy and consistency when the car is programmed to stop farther away.

This research is significant because it highlights the capabilities of infrared sensors on self-driving technologies. Although this sensor has proven to have benefits for self-driving cars, these benefits should be weighed against the disadvantages that are present when this sensor is added to the aid in obstacle detection. However, this amount of data is not enough to make an accurate decision on whether an infrared sensor would be beneficial or harmful for self-driving cars.

Further research in this area could focus on weighing the exact benefits and disadvantages of the infrared sensor on self-driving cars. Additionally, the research could be done on the hardware of the infrared sensor. By further examining the hardware of the infrared sensor and improving its design, the accuracy, range, and efficiency of the sensor could be improved upon, minimizing the disadvantages this sensor has when implemented on an autonomous vehicle.

ACKNOWLEDGEMENTS and REFERENCES

Special thanks to the AAR program and Mr. Cormia for their support in making this project possible

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