Does Spatial Mapping Technology Match Human Recognition Ability?

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Background

Spatial Mapping Technology: *Technology that enables machines to receive information about and interact with a three dimensional real world environment* (1).

With the prominence of autonomous vehicles, augmented reality, and advanced surveillance systems, the technology utilized to sense and map the world around us has become especially important.

In addition, the capabilities of this technology has come into question with 73% of US drivers reporting feeling afraid to drive an autonomous vehicle in 2018 (2).

This brings into question whether spatial mapping technology is more capable than human abilities.

To explore this, this study will explore the primary methods of spatial mapping in relation to adult spatial recognition abilities.

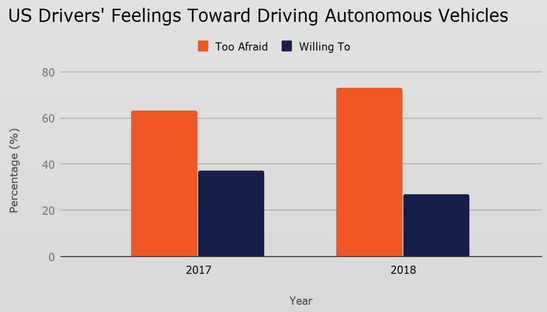


Figure 1.
US drivers' feelings towards driving autonomous vehicles has risen from 63% in 2016 to 73% in 2018 (2).

Methodology

This research project was a combination of both a literature review and scientific study testing the capabilities of computer driven facial detection versus human ability.

The literature portion provides an examination of this difference by analyzing the strengths and weaknesses of both sides (technology and human ability) in the context of vehicles.

The scientific study portion utilizes a live computer facial recognition program developed utilizing OpenCV (Open Source Computer Vision Library) in C++ and student participants on the Orange Coast College campus (8).

Results

Human Recognition Ability
Human spatial awareness, in the context of vehicle operation, is limited by the three dimensional position of the driver. This impacts the ability to both receive peripheral information and respond to it, especially when performing a task (3).

Lighting, weather, age-related eye changes, and visual impairments are all factors that negatively impact human spatial recognition ability (4).

Spatial Mapping Technology
Four dimensional imaging radar allows for a wide 100° field of view with real time moving object detection. Operational even in poor weather, all lighting conditions, and high speeds (with a range of over 300m), 4D radars are a major component of modern autonomous vehicles (6).

LiDAR (Light Detection and Ranging) aids radar by allowing for a complete 360° field of view. Its sensors utilize laser light pulses to map a 3D environment around the vehicle in real time. However, it is unable to sense fine details like road markings and signs. (7).

Video cameras placed around the vehicle allow for high resolution input similar to human vision. Information from camera systems allow for identification of road signs and lanes (7).

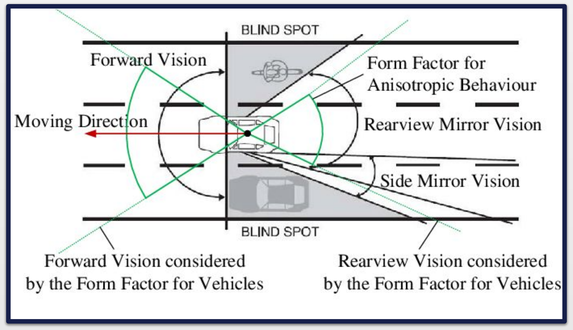


Figure 2.
A driver's effective vision when looking forward is impacted by the three dimensional position and has areas where vision is impaired (5).

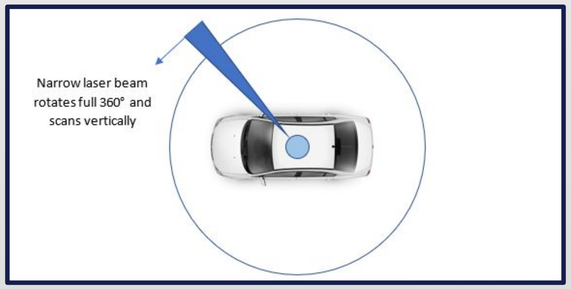
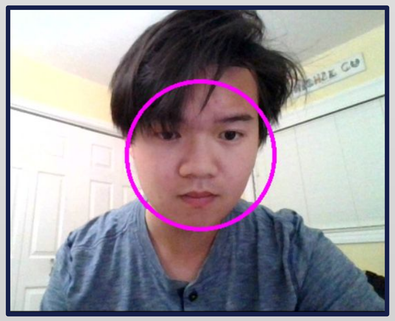


Figure 3.
LiDAR allows for a 360° field of view around the vehicle (6).



With the facial recognition program, the camera vision easily recognized student participant faces with no failure.

35 participants, representing human ability, were able to make out faces similarly.

However, the camera vision program had a higher failure rate when the face was obstructed or lighting changed, and a much higher false positive rate.

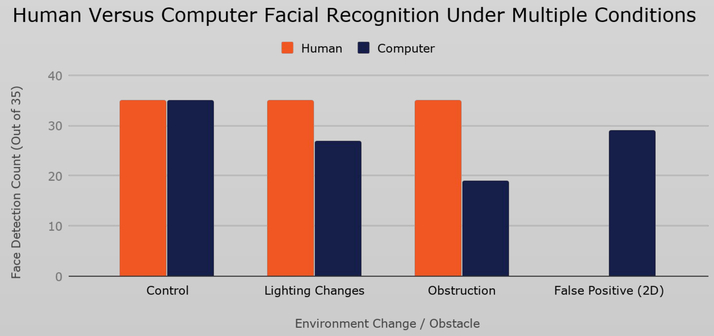


Figure 4.
Between human and computer recognition ability, humans were able to adapt to enviroment changes with a 100% success rate. The computer had a varying degree of success, thought it was always lower than human recongition ability.

Conclusion

Four dimensional imaging radars, LiDAR, and camera systems' combined ability to inform accurate detection of distance, create a 360° three dimensional map of a surrounding, and ability to work in far worse weather conditions than humans amongst the sheer volume of information outperforms human abilities (6,7).

While computer based spatial mapping has a higher intake and accuracy in terms of information, humans, have a higher degree of success in adapting to environment changes.

Based on these factors, spatial mapping technology's weakness lies in its adaptability and independent thinking. This can be improved by enabling computer systems to process information with adaptive reasoning like humans through artificial intelligence.

Improved adaptability in spatial mapping computer systems not only increase safety in autonomous vehicles, but also in disaster relief, surgery, and space travel.

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