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Object Detection for Autonomous Vehicles

Abhinav Choudhary[1], Amrendra Singh Yadav[2], Rahul Kumar Sharma[3]

Student, Computer Science and Engineering, Noida Institute of Engineering and Technology, Greater Noida, India[1]

Asst Professor, Computer Science and Engg, Noida Institute of Engineering and Technology, Greater Noida, India[2,3]

Abstract: This paper explains an alternative technology for automation, increased use and safety of vehicles. The concept of Thermography aided with Associative memory can be used to provide an object detection technique. The use of RADAR along with this method can provide a better driving experience.

Keywords: Autonomous vehicles, RADAR, LIDAR, Thermography, Associative Memory.

I. INTRODUCTION

An autonomous vehicle is a machine equipped with computers that is capable of sensing its environment and navigating without human input.
With the rise in dependence of human race on automobiles, it seems nearly impossible to imagine the world without them.
With the dawn of artificial intelligence into the real world, it is now possible to design a vehicle which does not need a human controller. Such vehicles can adjust their speed and direction according to the need.
A Vehicle changing lanes, adjusting it gears, even honking would appear unnatural to anyone of us. As the advancement in computer science, it is been made possible to design such Vehicles.
Although the safety and economic viability of such Vehicles are an issue of great concern. Even greater is the deal to make the concept of self governed moving objects a reality.
If the autonomous Vehicles becomes a real thing, as of which the technologies have made as sure it would decrease human caused error.

II. OVERVIEW OF AUTONOMOUS VEHICLES

Vehicles, distinctly cars can be broadly divided into four categories based on automation:

- No automation
- Driver assistance
- Partially automated
- Fully automated

Cars without automation requires each input from the driver. All the cars prior to 1996 can be termed as “dumb cars”. Even today most of the cars rely completely on a human controller to execute the simplest operations.
But with advances in technology, driver assistance is now available in many cars. Driver assistance generally has no control over any mechanical aspects, they just provide help for better driving experience such as information of shortest path, traffic jams and condition of vehicle’s components such as engine and fuel capacity in an advanced manner such as speech and interactive display. Although these features never contribute to greater extent of a vehicle’s performance.
Whereas with the introduction of automation in cars, a computer can even perform mechanical operations such as adjusting the speed and direction.
Partially automated cars are inefficient in every condition and can only be programmed for specific or a set of environment. Many necessary reactions still require the input from the driver.

Whereas in the case of fully automated cars, they do not need a driver, every operation including start is controlled by a computer. It works in almost every conditions and adapts the parts of the vehicle accordingly.

III. WORKING

The present day autonomous vehicles require one or combined form of these technologies:

- LIDAR
- Long-range RADAR
- Cameras
- Short/medium range RADAR
- Ultrasound

Usually a self-driving vehicle includes a combination of these to determine the path. The extent of usage of each technology varies upon its precision.
In the specified technologies, RADAR and LIDAR are specifically used for purpose of detection of objects around the vehicle.
Ultrasound being incapable of gaining such precise information is generally used for parking assistance.
Cameras detect the signals and visible traffic signs to help the computer system of the car.

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The collective information of these aids help to determine the car of possible interventions.

The computer processes the information from all the system, assigning variable degrees of relevance as of the software it is working on. RADAR and LIDAR are the two most efficient methods to judge interventions in the path of autonomous vehicles. They have huge differences and gross similarities between them.

A. LIDAR

LIDAR is the acronym for Light Detection And Ranging, it uses Laser to detect the distance of objects.

It fires a laser beam, then receives the reflected ones to construct a three dimensional map of the surrounding.

LIDAR was primarily used for detection of matter present below earth's surface including the measurement of depth of the seabed. In present LIDAR technology has been transcended into navigation, like in helicopters.

LIDAR systems allow scientists to examine both natural and manmade environments with accuracy, precision, and flexibility due to which it is the primary research work for automated navigation.

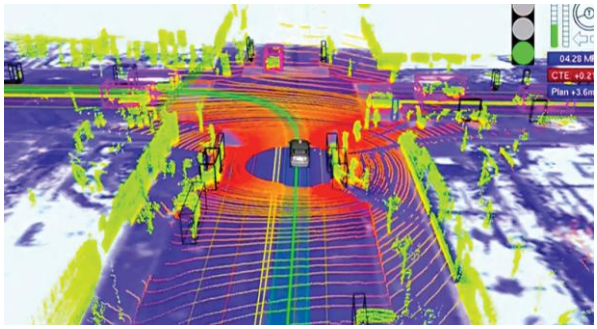

Fig.1 LIDAR generated map

LIDAR is not economically viable for personal mode of transportation as it cost around $75000-100000.

B. RADAR

RADAR stands for Radio Detection And Ranging, it uses radio waves to determine range and velocity of objects.

The RADAR system transmits an intermittent radar beam, for some time and, for some time it receives out for any reflections of that beam from nearby objects. If reflections are detected, the vehicle knows about any interference and adjusts according to the speed and position of the object.

TABLE 1 Comparison between Technologies

Technology	Method	Precision	Cost
LIDAR	Laser	High	High
RADAR	Radio Waves	Moderate	Low
Camera	Visual	Low	Low

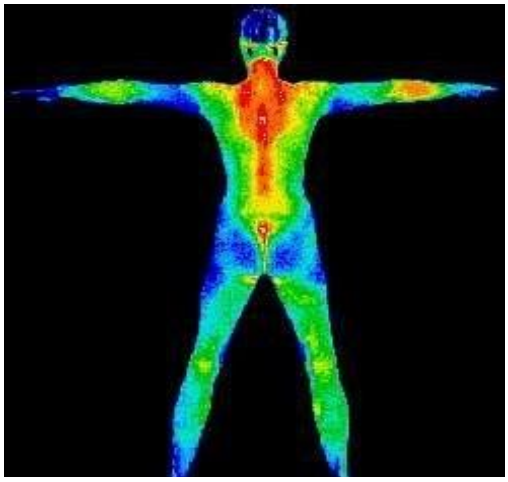

Fig. 3 Thermal Image of a Human Body

IV. THERMOGRAPHY

Infrared thermography (IRT) uses thermal camera which detects radiation in the long-infrared range of the electromagnetic spectrum, roughly 9,000–14,000 nanometers and produce images of that radiation which is called thermograms.

Infrared radiation is emitted by every object above the temperature of 0 Kelvin according to black body radiation law, every object can be captured in thermal camera.

The bodies occurring in real life show very diverse radiation properties. Therefore, it has proved worthwhile to initially consider the laws of a model body of ideal radiation properties to be, then applied to actually occurring objects. This model body is known as the "black body". It distinguishes itself by the fact that, of all bodies of equal temperature, it shows the largest possible emitted radiation.

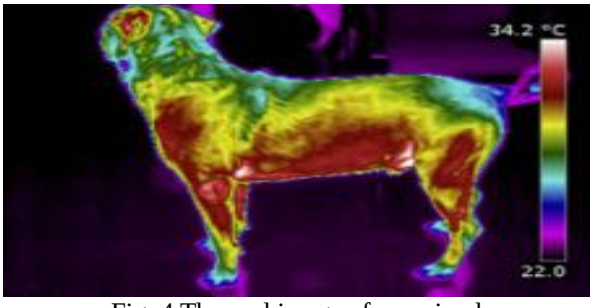

Fig. 4 Thermal image of an animal

V. SYNCHRONISATION OF THERMOGRAPHY AND ASSOCIATIVE MEMORY

Everybody has a general body heat pattern under specific conditions. For example human have high temperature around heart and spine which is shown by red colour in the figure above with a vertical alignment, whereas that of an animal walking on four legs would be horizontal.

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To detect a car the infrared radiation emitted by the engine and tires is calculated to form an image.

Fig. 5 Thermal Image of a Car

A set of such heat patterns of various objects is stored in the memory of the computer controlling the automation. Associative memory is the memory is accessed through content rather than through a specific address.

Associative memory is found on a computer hard drive and used only in specific high-speed searching applications. Most computer memory known as random access memory works through the computer user providing a memory address and then the RAM will return whatever data is stored at that memory address. However, associative memory works through the computer user providing a data word and then searching throughout the entire computer memory to see if the word is there. If the computer finds the data word then it offers a list of all of the storage addresses where the word was found for the user objects in front of the vehicle can be identified by matching the content of storage to the image captured through the thermal camera.

VI. ADVANTAGES

Thermographic cameras can capture objects even behind an opaque object (of visible spectrum by human eye).

This helps to detect a series of objects. In real world this can help to identify vehicles and also to calculate the number of vehicles around the controller. The thermographic technology is economically viable compared other technologies, yet effective in many aspects.

VII. DISADVANTAGES

Thermography solely is incapable to give a precise result upto an appreciable extent. It needs to be combined with an alternative possibly such as RADAR to give a dually calculated and better detection quality.

VIII. CONCLUSION

Thermography should be used along with RADAR to provide an cost effective yet safe automation of vehicles. RADAR should be the primary detection system, but with the contribution of thermal camera a better judgement of the condition around the vehicle can be formed.

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