Image Processing in Automotive Industry

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***Abstract*—** This research paper research paper I would be documenting the role that image processing plays in the automotive sector. And also how image processing is used in this automotive industry where accuracy is what matters the most i.e. how, where and why image processing is used in the automotive industry.

Keywords*— *Image Processing, Automotive Industry, Computer Vision, LiDar, self driving cars, driver assistance.

I. INTRODUCTION

Image recognition will make our cars safer, more efficient and reliable. Learn how image recognition technology is improving.

The image of a self-driving car has been prevalent in sci-fi movies for the last several decades, but the reality is just starting to catch up. There are currently some prototypes from Google, Ford, Tesla, General Motors, and Apple. These companies have invested heavily in the technology for autonomous vehicles so far, with Uber's self-driving cars valued at $7.25 billion.

The success of the product is highly dependent on the automation level achieved. These are the five widely-accepted levels:

- **Driver assistance** includes safety features, which have now become mandatory.
- **Partial automation** is about stability control, blind-spot detection, and collision warning, yet keeping the driver fully engaged.
- **Conditional automation** gives the driver a supervisory role while staying ready to take control at all times.
- **High automation** includes self-parking, lane-keeping, and traffic jam assistance.
- **Full automation** implies that the driver is no longer present; vehicles communicate with each other on their own.

It follows that the evolution from each step to the next one requires substantial innovations and control systems.

Some of these cars rely on LiDaR (Light Detection and Ranging), a laser-based technology to 3D-map the environment in a similar way to sonars. It can detect objects, slope changes, street furniture, and more. However, it has no predictive abilities; it is lagging a bit due to the need for the light to come back to the receiver and the newly created data points to be evaluated.

To solve this problem, Elon Musk suggests focusing more on cameras and AI, an idea also picked up by Apple. This means that there will be more pressure on improving the image recognition aspect of autonomous cars

II. IMAGE PROCESSING

Image processing[1] is the process of transforming an image into a digital form and performing certain operations to get some useful information from it. The image processing system usually treats all images as 2D signals when applying certain predetermined signal processing methods.

There are five main types of image processing:

Visualization - Find objects that are not visible in the image

Recognition - Distinguish or detect objects in the image

Sharpening and restoration - Create an enhanced image from the original image

Pattern recognition - Measure the various patterns around the objects in the image

Retrieval - Browse and search images from a large database of digital images that are similar to the original image.

AUTOMOTIVE INDUSTRY RELIES ON CAMERA SYSTEMS

High-speed cameras enable detailed fault analysis, especially in very fast-moving manufacturing processes. In the case of high-speed processes, the cameras' superiority is obvious. But even in the case of mainstream manufacturing speeds, quality and process control is increasingly being transferred to imaging systems. Image processing ensures brilliant surfaces around the clock, micrometre-accurate assembly tolerances and defect-free circuits on the increasingly prevalent chips & micro controllers.

III. ROLE OF IMAGE PROCESSING IN AUTOMOTIVE INDUSTRY

1) *Computer vision for automotive*

What if we could have a second pair of eyes to help compensate for the driver's mistakes? This is possible through computer vision (CV)[2], a set of algorithms which strive to mimic human understanding of the surroundings and which make uses of image recognition possible in multiple areas.

As the first step, the CV processing unit identifies the objects with a machine learning algorithm (typically a convolutional network), which has been trained on millions of images from the real-life environment. At this point, the computer assigns tags to each object, like "a car," "a pedestrian," "a traffic light," "street furniture," or "a cat" and determines their geometric boundaries.

The problem that could arise is that convolutional networks only know how to classify single objects. This problem is solved by moving a sliding window over the image and breaking it into smaller images. The image gets split into a grid, and each piece of the grid receives a score regarding the object it holds.

The next step is about making predictions about the previously identified objects. For example, are the nearby cars continuing their trajectory at a safe distance, or are they moving dangerously close? Are the pedestrians on the sidewalk or crossing the street? This detection is done through image localization. The difficulty here is that the same object might be split across multiple grid cells, a challenge solved by identifying the cells with the highest probability of having a specific object in adjacent cells.

2) *Accident Prevention*

Until the industry gets to the fully autonomous vehicle stage, there are important safety measures to be implemented along the way to prevent crashes with the help of computer vision.

Lane departure warning (LDW)[3] systems can identify another vehicle entering the current lane without proper preparation (the turn signal or ensuring the road is clear), trigger a warning for the driver, or even activate automatic braking systems and help avoid a collision. It is also helpful if the driver gets distracted.

A CV system can also monitor the driver's reactions and biometrics (vision, pulse, etc.) to ensure that there is no risk of falling asleep while driving and also prevent accidents by blocking the car if the driver seems to be under substances.

CV can also help prevent accidents involving pedestrians. When the car identifies a pedestrian, the vehicle CV system will keep monitoring its behaviour, triggering a warning signal to the driver if the pedestrian does anything unsafe, like crossing the street at a red light or where it's not permitted.

A CV system mounted on a car also enhances the night vision mode, helping the driver avoid imminent danger in the blink of an eye by seeing as good at night as during daytime.

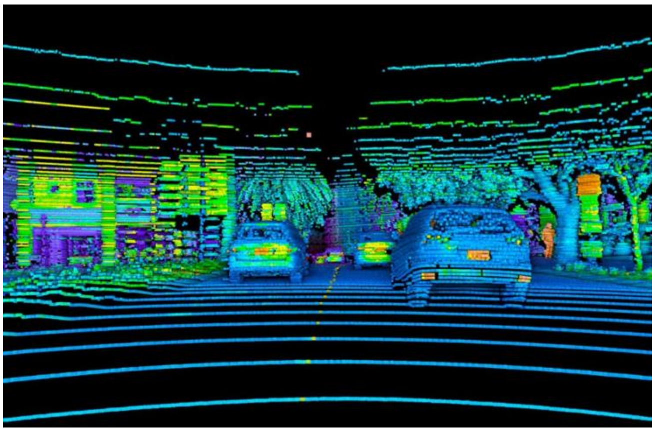
3) Blind spot detection

The basic variant of blind spot detection can be implemented using ultrasonic sensors or corner radar sensors. The function uses the sensors to cover the dangerous blind spot. If another vehicle is situated in the monitored area, the driver is alerted to the potential danger by means of a warning sign in the side mirror. If the driver fails to spot or ignores this warning and activates the turn signal to change lanes, the system can also trigger an additional warning. The system recognizes stationary objects on or alongside the road, such as guardrails, masts or parked vehicles, as well as the driver's own overtaking maneuvers – and does not trigger the warning in this case.*[4]*

The advanced variant of blind spot detection works by using two corner radar sensors that are concealed in the rear bumper – one on the left, one on the right. These two sensors monitor the area alongside and behind the car. Powerful control software collates the sensor information to create a complete picture of all traffic in the area behind the vehicle. The rear corner radar sensors exceed the sensing range of the ultrasonic sensors. In contrast to the ultrasonic-based system, even fast-approaching vehicles can thus be detected at an early stage before a lane change.

4) LiDar

LiDAR, typically used as an acronym for "'light detection and ranging'", is essentially a sonar that uses pulsed laser waves to map the distance to surrounding objects. It is used by a large number of autonomous vehicles to navigate environments in real time. Its advantages include impressively accurate depth perception, which allows LiDAR[5] to know the distance to an object to within a few centimetres, up to 60 metres away. It's also highly suitable for 3D mapping, which means returning vehicles can then navigate the environment predictably —a significant benefit for most self-driving technologies. One of the key strengths of LiDAR is the number of areas that show potential for improvement. These include solid-state sensors, which could reduce its cost tenfold, sensor range increases of up to 200m, and 4-dimensional LiDAR, which senses the velocity of an object as well as its position in 3-D space. However, despite these exciting advances, LiDAR is still hindered by a key factor; its significant cost.



A busy street scene captured by Velodyne's Alpha Puck (a 360-degree horizontal field of view LiDAR)

5) Rear Cross Traffic System

Backing out of a parking space can often be a challenge – especially when the driver's view on the traffic passing behind his own vehicle is obstructed. The rear cross traffic warning increases comfort and safety for the driver when backing out of parking spaces by actively warning of potential hazards of crossing vehicles, cyclists or pedestrians. In critical situation the system can trigger an emergency braking to avoid or mitigate a collision.[6]

6) Adaptive cruise control(acc)

By monitoring other vehicles and objects on the road, adaptive cruise control enables a safe and comfortable driving experience. It does so by helping the driver keep a steady vehicle speed at a given moment. The driver can set their preference regarding certain factors, such as the distance to the car in front, driving mode – for example, economical, sporty or comfortable – and others. Together with information about speed limits, road curvature, accidents data and more, these choices influence the automatically selected speed.[7]

Cruise control has come a long way from its early days in its quest to assist drivers on the road. When first introduced, it was only found in luxury car models due to its high production cost. As less expensive sensors reached the market, adaptive cruise control is steadily becoming a standard feature in new vehicles today.

7) *Automatic parking*

Itis an autonomous car-maneuvering system that moves a vehicle from a traffic lane into a parking spot to perform parallel, perpendicular, or angle parking. The automatic parking system aims to enhance the comfort and safety of driving in constrained environments where much attention and experience is required to steer the car. [8]

In 2003, Toyota began to sell their Japanese Prius hybrid vehicle with an automatic parallel parking capability offered as an option named Intelligent Parking Assist. In 2006, Lexus added a self-parking system to the redesigned Lexus LS sedan; it parallel parks as well as angle parks. In 2009, Ford introduced their Active Park Assist beginning with their Lincoln models; it does parallel parking. In 2010, BMW introduced a system called "parking assistant" on the redesigned 5 Series to perform parallel parking.

Up to 2012, automatic parking systems were being developed by several automobile manufacturers. Ford and Lincoln offered active park assist on Ford Focus, Fusion, Escape, Explorer, and Flex and Lincoln MKS and MKT. Toyota and Lexus had advanced parking assistant on Toyota Prius V Five and Lexus LS460 and LS460 L. BMW all-new sixth-generation 3 Series used a system called parking assistant. Audi had a parking assistance system on the Audi A6. Mercedes-Benz also offered parktronic on their C-Class, CLS-Class Coupe, M-Class SUV, E-Class, S-Class, GL350, GL450 SUV (standard on the GL550), and R-Class in different prices.

Jeep introduced an automatic parallel and perpendicular parking system, called ParkSense, on its 2014 Cherokee model. Chrysler introduced an all new 2015 200 sedan, offering ParkSense as part of a SafetyTec package.

In 2014, the parking assistant of BMW i3 can be activated from a smartwatch.
In 2015, Bosch plans to release a fully automated valet parking system. This driverless system allows the driver to get out of the car and activate an autonomous parking from a smartphone. The system will calculate a parking maneuver and monitor the surroundings.

8) Traffic –sign recognition

Traffic-sign recognition is a safety tech system that recognizes traffic signs and relays the information displayed on the sign to the driver through the instrument cluster, infotainment screen, or head-up display. Most TSR systems can identify speed limit, stop, and “do not enter” signs. More sophisticated systems may be able to recognize other types of signs.

The primary purpose of TSR is to increase driver focus. If a driver misses a sign, TSR can make them aware of it so they can react accordingly. The idea is simple: TSR identifies road signs the driver might have missed and alerts them of their presence.

This technology uses advanced forward-facing cameras positioned high on the windshield, generally adjacent to the rear view mirror housing. Aimed to “see” traffic signs, the cameras scan the side of the road relative to the car.

Once the camera captures a sign, the system’s software processes the image to establish its classification and meaning. The system then relays this information to the driver almost instantaneously in the form of an icon or graphic representation of the sign. However, TSR’s ability to accurately identify a sign depends on the speed of the vehicle and its distance to the sign.

IV. CONCLUSION

Image Processing techniques has played a major role in automotive industry.We learned that AI and Machine Learning rely on Image Processing when in comes for safety.There were many system in automotive industry made using image processing.An attempt was made to study the role of image processing in Automotive industry.

V. References

[1] https://www.simplilearn.com/image-processing-article

[2] https://innovationmanagement.se/2019/10/04/how-image-recognition-is-transforming-the-automobile-industry/

[3] https://onmyside.com/faqs/how-does-lane-departure-warning-work-and-does-it-prevent-accidents/

[4] https://www.bosch-mobility-solutions.com/en/solutions/assistance-systems/blind-spot-detection/

[5] https://www.automotiveworld.com/articles/lidars-for-self-driving-vehicles-a-technological-arms-race/

[6] https://www.bosch-mobility-solutions.com/en/solutions/parking/rear-cross-traffic-warning/

[7] https://www.tomtom.com/blog/automated-driving/what-is-adaptive-cruise-control/

[8] https://en.wikipedia.org/wiki/Automatic_parking

[9] https://www.bosch-mobility-solutions.com/en/solutions/parking/rear-cross-traffic-warning/

[10] https://www.jdpower.com/cars/shopping-guides/what-is-traffic-sign-recognition