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ENHANCING DRIVING SAFETY USING ARTIFICIAL INTELLIGENCE TECHNOLOGY

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ABSTRACT

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Abstract

The first thought that comes to mind when using AI in the automotive industry is self-driving cars but in reality AI can do more than drive. Artificial intelligence (AI) has a lot of potential for improving driving safety and overall driving pleasure. This thesis work investigates how artificial intelligence (AI) technology may be used to make driving safer, such as accident avoidance, lane departure alerts, and driver behaviour forecasts. Furthermore, the thesis investigates the advantages of using AI in electric cars, which are gaining popularity due to their eco-friendliness and innovative features. Every vehicle using AI technology has the ability to deliver a variety of aiding functions, such as driving assistance, parking assistance, and speed limit support. The paper also addresses ethical concerns about AI for driving safety, such as privacy and prejudice. The analysis suggests that the adoption of AI technology in the automotive industry has the potential to greatly improve driving safety and reduce the number of car crashes and human casualties.

Keywords

Electric Vehicle (EV), Artificial Intelligence (AI), A vehicular ad hoc network (VANET)**,** Vehicle Stability Control (VSC), Electronic Stability Program (ESP), Dynamic Stability Control (DSC)

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1 INTRODUCTION

Artificial Intelligence (AI) refers to a programmed simulation that can think like humans and mimic the action of humans. The term AI can be applied to any machine which can learn like a human mind for problem-solving. Artificial intelligence has acted as the main foundation and driver of developing technologies like big data, robots, and the Internet of Things and has continued to do so. It has a significant effect on the automobile sector as well.

Many individuals depend on their ability to drive to get to work, school, and other key locations as part of their everyday lives. However, there are serious hazards associated with this convenience. The World Health Organization reports that road traffic accidents are the ninth greatest cause of death worldwide and the top cause of mortality among young people aged 15 to 29 each year, inflicting millions of injuries or fatalities. In addition, a total of 32,675 people died in collisions that were deemed fatal in 2019, according to the National Safety Council. The given figure is for a single year, and to lower it in the upcoming years, we must prioritize road safety. Apart from the considerable negative effects on the lives of those directly impacted, accidents can result in large financial losses due to medical expenditures, lost productivity, and property damage. Consequently, increasing driving safety is a vital objective that has the potential to benefit people personally, communities, and society at large by potentially saving lives, lowering expenses, and generally improving quality of life.

Technology based on artificial intelligence (AI) has the potential to greatly increase driving safety and enhance the whole driving experience. Artificial intelligence (AI) powered systems integrate cameras, sensors, and other technology to identify possible road dangers, such as other cars or pedestrians, and then either warn the driver or swerve to avoid a collision. Collision avoidance technology has the potential to significantly lower the number of accidents on the road.

Lane departure alerts are another way that AI may improve driving safety. Lane departure incidents can be avoided with the use of artificial intelligence (AI), which can identify when a car is drifting out of its lane and warn the driver. Another way where AI might help increase driving safety is by predicting driver behaviour. To predict a driver's style and warn them of potential threats, AI can evaluate data on a driver's behaviour, such as their speed and how they operate the car. To improve driving safety and relieve traffic congestion, AI may be used to develop smart vehicle systems. The increasing use of electric vehicles (EVs) opens up new opportunities for AI integration in the automotive sector. For instance, AI may improve the performance and security of EVs by providing speed limit warnings, parking assistance, and driving assistance.

While AI technology has enormous potential to boost driving safety, it also poses significant ethical questions about prejudice and privacy. To guarantee that AI is applied in the automobile sector safely and successfully, several issues must be taken into account. As a result of its ability to enable cutting-edge features and systems that can significantly improve driving safety, artificial intelligence technology has the potential to alter the way we think about driving and transportation. To ensure that AI is utilized responsibly and securely, it is crucial to thoroughly assess the ethical ramifications of its application in the automobile sector.

2 RESEARCH AND LITERATURE REVIEW

Many studies have focused on the problem of road accidents. There is plenty of research which are focused on the safety of automobiles using Artificial Intelligence. Kannan & A. T. R. K (2010) proposed an ontology approach for assisting vehicle driving through the warning message during critical situations. During the research, Kannan & A. T. R. K(2010) simulate test bed development using the Java framework which generates alerts during urgent situations. The approach was useful, and the research has included graphs showing response time graph. The studies were taken in different scenarios in various modes like day and night for the single, 2-way, and 4-way roads. The system operates in a VANET scenario, which requires adaptation to environmental changes and contextual variation. The method that is being provided demonstrates simulation that can be used for all vehicles in a real-world setting with positive outcomes. (Kannan & A. T. R. K 2010.)

Along with road accidents, many researchers focused on the improvement of safety and efficiency for the road environment. Jiménez (2016) has done research on road safety improvement and efficiency. Given the complexity of these environments compared to motorways and a large number of serious and deadly incidents on them, the article primarily concentrates on single-carriageways roads. The suggested system is based on sophisticated perception techniques, automated cars, vehicle-to-vehicle (V2V), and infrastructure connections (V2I). Based on laser scanners and computer vision technologies, a sensor fusion architecture is created. Real-time obstacle detection, categorization, and danger identification are all made possible by this. The driver receives this information as well as certain system-generated warnings. The applications include adaptive cruise control with fuel efficiency optimization, an overtaking assistance system on single-carriageway roads that considers appropriate speed evolution and identifies the best road segments for the maneuver, an assistance system at intersections with speed control during approximation maneuvers, and a collision avoidance system with the option of evasive maneuvers. Propulsion system models are utilized to create effective patterns, and mathematical vehicle dynamics models are adopted by Jiménez (2016) to guarantee stability. Artificial intelligence and simulation are used for testing and assessment of the algorithms that will be used in the control unit. Additionally, Jiménez (2016) planned for the car to alert the driver if a risk was found and to take control if required. The technology has been put into use on a passenger vehicle and successfully tested in particular circumstances on a test track. (Felipe Jiménez 2016.)

Article by Mohn (2022) in the New York Times, 1.35 million individuals each year pass away in auto accidents. Another 50 million individuals, according to the World Health Organization, have significant injuries. The COVID-19 epidemic caused a startling surge that the National Highway Traffic Safety Administration (NHTSA) saw in just six months. As reported by Mohn (2022), automobiles currently use artificial intelligence to keep drivers safe. Different applications, safety features, and algorithms keep track of driving patterns and connect with other cars. Without human assistance, cars may change lanes and stop abruptly if the algorithm deems it should. David Ward is the president of the Global New Car Assessment Program, according to the New York Times. According to Ward, there is "too much hoopla around artificial intelligence, traffic safety, and self-driving cars," He claims that intelligent speed aid is a more readily available and helpful technology (ISA). This employs in-car cameras and maps along with artificial intelligence to monitor speeds. After July 2022, this ISA technology will be required in Europe, but not in the United States. Acusensus, a business in Australia, is utilizing artificial intelligence to assist keep drivers safe. Acusensus referred to the system as "intelligent eyes," which learn various driving styles with the use of cameras and high-resolution images. The Heads-Up technology can assist identify risky driving practices and other actions. Vice President of Acusensus Sales for North America is Mark Etzbach. The device, according to him, "can observe and record conduct within the car." For instance, the "intelligent eyes" technology is unaffected by low visibility or fast speeds. The cameras may be mounted on billboards, overpasses, or other buildings. According to Etzbach, this artificial intelligence technology can identify driver attention, vehicle speed, and whether or not the driver is engaging in "risky conduct." During testing, the system reduced road fatalities by 22% in Queensland and New South Wales. Studies have indicated that people are more likely to drive carefully when there is evident traffic enforcement taking place. This artificial intelligence's main goal is to make driving safer by acting as a police officer on the road. Acusensus's technology can assist in identifying places that can benefit from increased enforcement or infrastructural modifications. (Mohn 2022.)

Article by Fu (2022), provides a comprehensive survey of the current research on collision avoidance systems, focusing on the application of artificial intelligence, sensing, and vehicular communications. It provides a background of CAVs, a systematic understanding of the major steps of CA, and a detailed discussion of the enabling techniques and individual methods. It also discusses the opportunities and challenges of the existing technology and emerging directions in the CA application scenario. Finally, it identifies and analyzes the importance of AI technology in CA and provides an extensive survey of the implementation of popular algorithms in different functions of CA systems.

3 CURRENT STATE OF AI TECHNOLOGY IN THE AUTOMOTIVE INDUSTRY

The automobile sector has successfully incorporated artificial intelligence (AI) across the value chain, including systems for "driving assistance," "driver risk assessment," and supply chain management. AI is employed in component manufacture, and design, and to help people create AI-enabled autos. AI streamlines decision-making for automakers and assures a high-quality consumer experience by mimicking human decision-making and cognitive abilities. Anti-lock braking systems (ABS) and adaptive cruise control are two examples of AI tools and technology that are currently present in contemporary vehicles. The car industry's next major achievement is self-driving technology, which mainly depends on AI.

The rise in research and development (R&D) in the automotive sector is the key factor driving the growth of the global market for automotive artificial intelligence. Data science and machine learning technologies have helped automobile companies become more competitive by improving their research, design, production, marketing, and data analytics operations. Moreover, the use of AI in vehicles that have cameras, sensors, radars, and lidar enables improved route planning and a thorough awareness of the environment, both of which support market expansion. To lessen their reliance on fossil fuels, automakers are concentrating on developing alternative fuels and switching to clean, plentiful, renewable sources of energy. Over the anticipated time, these variables will substantially enhance the worldwide automotive artificial intelligence market. (Research 2022.)

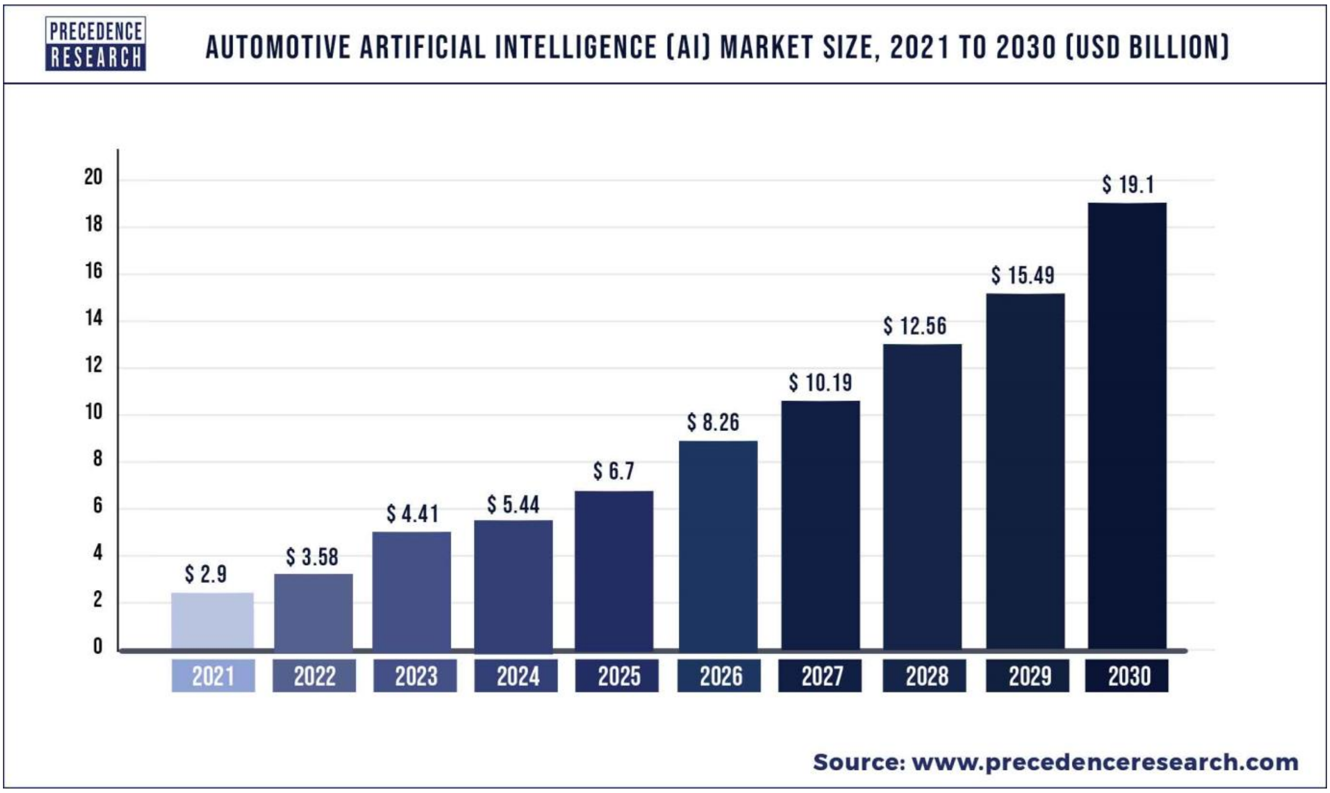

Figure 1. Bar Graph showing Automotive Artificial Intelligence market size 2021 to 2030 (Research 2022)

The above figure shows the market size of automotive AI from 2021 to 2030. As per the figure, the market size from 2021 increasing sharply from 2.9 billion dollars to 19.1 billion dollars. The market for automotive artificial intelligence (AI) was assessed at USD 2.9 billion in 2021; from 2022 to 2030, it is anticipated to increase at a CAGR of 23.3%, reaching an estimated market size of USD 19.1 billion.

4 DATA COLLECTION AND ANALYSIS

Accurate data is essential for designing effective road safety strategies and conducting high-quality studies. Without good data, it is impossible to gain a clear understanding of road safety issues, which is necessary to develop policies that can reduce the consequences of crashes. Good data not only help to identify the main problems and risk factors but also provide insight into why crashes occur and how they can be prevented. Proper data analysis is crucial to making informed decisions and taking specific interventions that can help reduce casualties. Therefore, the availability of good data and the expertise to analyse it correctly is essential.

A road safety plan may be created that defines specific goals and initiatives to pursue them using the knowledge gathered through data analysis. These decisions must be supported by solid facts, and it is important to routinely assess progress to see whether the approach is bearing fruit or whether further action is required. Studies on traffic safety also rely largely on precise data, particularly when analysing the effects of risk variables. To guarantee accuracy and dependability, research findings from computer simulations or driving simulators must be verified against actual crash data.

The road safety data collection from OECD report (2014) is used for data collection and analysis in Finland. In Finland, information on traffic collisions is collected in two ways: through police reports and insurance company reports. Statistical data Finland obtains information on traffic accidents from the police, which are then supplemented with information from several registries, including details on fatalities, collision sites, resources used, and crashes, as well as data on coercive measures and fatal drunken driving accidents. Accidents that result in death are covered entirely, whereas accidents that result in bodily injuries are only covered to a degree of about 20%. Data gaps mostly relate to information that cannot be validated. Although hospitals and health facilities maintain information on road accidents, they are unreliable for enhancing traffic safety. Statistics on accidents for which compensation has been paid from traffic insurance are compiled by the Traffic Safety Committee of Insurance Companies (VALT). All fatal road traffic accidents in Finland are investigated by the Road Accident Investigation Teams, and their results are used in specialized research. Although information on major injuries is not compiled into official statistics, PRONTO database of the emergency services is used to track unofficial figures. (OECD 2014.)

Finland reported 223 fatalities in 2020, an increase of 5.2% over the previous year. Finland did not see a decrease in traffic fatalities from Covid-19, in contrast to many other nations. The revised Road Traffic Act was passed by the Finnish government on June 1st, 2020. The Act intends to increase the efficiency and security of transportation. Moreover, it advances deregulation while setting the stage for digitalization and safe traffic automation. (ITF 2022.)

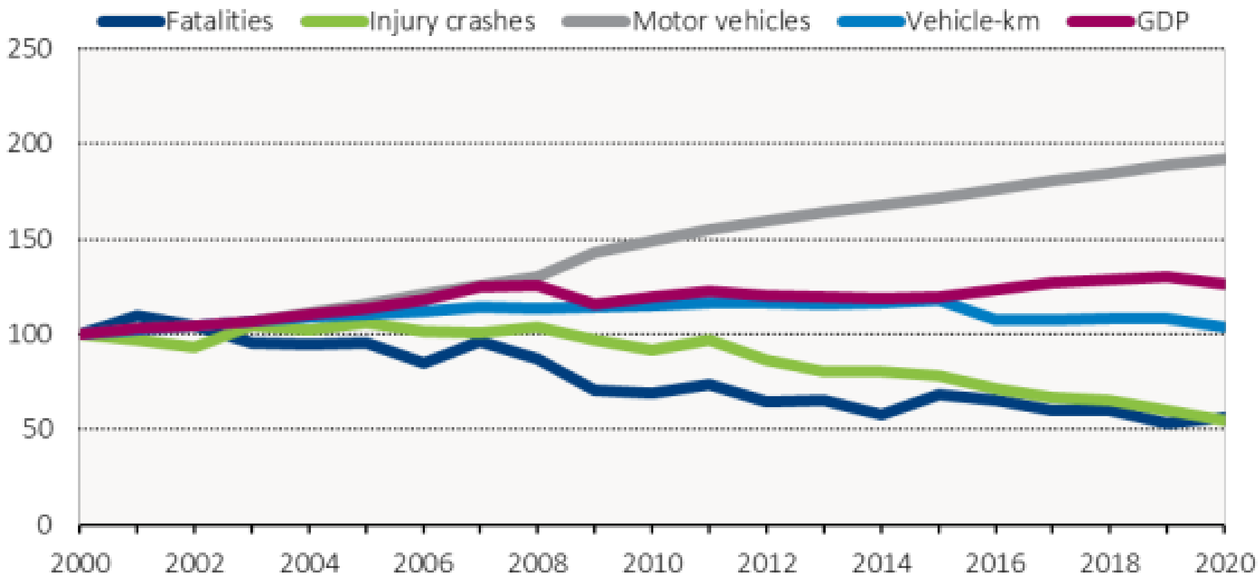

Figure 2. Evolution of road fatalities, injury crashes, motorisation, traffic and GDP in finland, 2000-2020 (ITF, 2022)

Figure 2 above clearly shows that the fatalities and injury crashes has been decreasing which is result of important measure since 2000 carried out by Finland to improve road safety. Those important measures include lower speed limits, construction of pedestrian and bicycle path, installation of automatic speed cameras, reform of driver education, and many more.

According to the report from road crash data collected by investigation team speeding and drink-driving contribute about 30% and 26% of all fatal crashes respectively. Throughout the previous 10 years, the mean speed has not significantly changed. On road stretches where speed cameras have been deployed, a mean speed reduction of 1-3 km/h has been seen. Although many drivers go over the speed limit, particularly in the winter when the speed limit is decreased, the number of drivers going 10 km/h over the limit is quite small. On major routes, 11% of drivers in the summer and 14% in the winter of 2020–

21 went beyond the posted speed limits by more than 10 km/h. Almost 3000 km of major roads are covered by speed cameras, which were mostly put into place throughout the 2000s. In police speed camera locations, there are less speeding violations. (ITF 2022.)

Furthermore, 500 people were hurt and 57 people died as a result of drunk driving-related incidents in 2020. These numbers make up 26% and 11% of the corresponding totals, respectively. Most frequently, the drivers themselves are the ones who pass away in drunk driving accidents. Of the 57 fatalities from drink-driving-related instances in 2020, 39 (68%) were the drivers of the cars involved, 11 (16.2%) were the passengers, and 7 (10.8%) were not occupants of the cars. (ITF 2022.)

5 APPROACH TO MAKE AUTOMOBILE SAFE USING AI

Artificial intelligence is now being used to address more immediate issues that fleet operators encounter, such as safety and security, and is no longer just limited to tracking fleet performance. Challenges relating to the driver, vehicle, material or goods, and passenger safety are typically included while addressing safety. (Young 2022.)

By adopting techniques that can be used to learn from the varying driving situations on roads, climatic conditions, and providing challenging chances in the range of automated systems with a goal to aid drivers, artificial intelligence has the potential to make driving safer. Simple safety systems have advanced, grown intelligent, and now give drivers and fleet management more precise, valuable data. AI is utilized to keep both passengers inside and outside the vehicle safe, from accident warnings to vehicle monitoring.

5.1 Advance Driving Assistance System (ADAS)

Advanced driver-assistance systems (ADAS) increase auto safety by enhancing the driver's reaction time to potential road dangers through automated systems and early warning signals. When ADAS are properly developed, they take use of human-machine interaction to improve driver safety. These systems can be included in cars as standard components by manufacturers or can be customized by aftermarket additions. ADAS can avoid accidents and lessen their severity because human error is the primary factor in most car crashes. (BasuMallick 2022.)

The main objective of ADAS is to lessen the frequency and severity of automobile collisions in order to decrease casualties and injuries. These systems offer useful data on traffic, road closures, degrees of congestion, and suggested routes to avoid traffic. In order to enhance driving performance and offer advice, ADAS may also identify driver weariness and distraction. It can then send out warning signals. (BasuMallick 2022.)

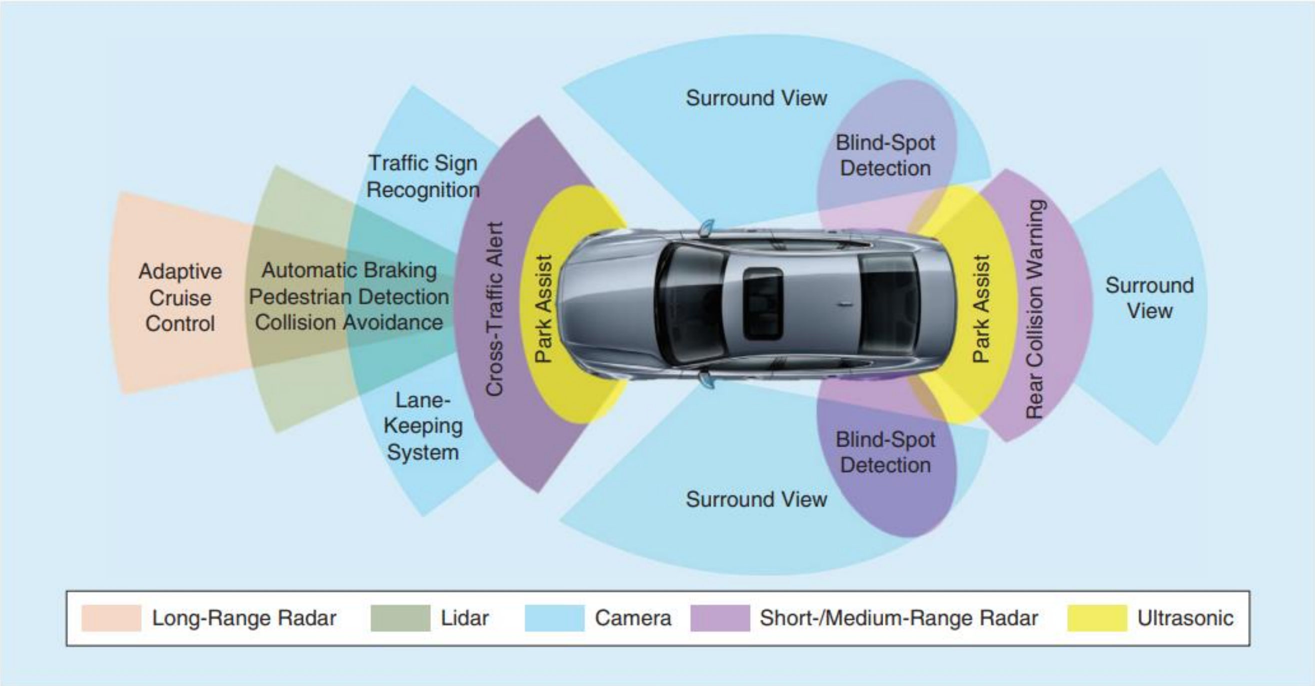

Figure 3. The state-of-the-art ADAS sensors used. (Kukkala 2018)

The above figure shows the start-of-the-art ADAS sensors used in automobile. The sensor attached in automobile cover all the surrounding of automobile and each feature or different sensors are categorized according to the colour in the figure. Pink colour indicate long-range radar, grey colour indicates Lidar function, light blue colour indicates camera view, dark blue colour indicate short/medium range radar and yellow colour indicate ultrasonic feature.

According to recent World Health Organization estimates, 1.25 million people die as a result of traffic accidents every year (Organization. 2015). However, in recent years, such incidents have had a global cost of US$518 billion annually, depleting 1% to 2% of the gross domestic product of all nations worldwide (Travel 2018).

The automobile industry has prioritized safety as a top priority since the invention of on-road vehicles. Some original equipment manufacturers (OEMs) have created a range of safety devices to protect car occupants and stop harm to those outside the vehicle. Because of high mortality rates, financial losses, and rising customer demand for intelligent safety systems, manufacturers are developing ADASs. Also, the integration of numerous types of sensors and the growing number of electronic control units have given cars the necessary computational power to facilitate the adoption of ADAS. Several ADAS solutions are offered by various sensor types, including cameras, lidar, radar, and ultrasonic sensors. The majority of contemporary automobiles employ vision-based ADAS, which largely makes use of cameras as vision sensors. Some of the most advanced ADAS capabilities and the sensors needed to accomplish them are shown in Figure 3. (Kukkala 2018.)

5.1.1 Types of ADAS

Passive ADAS systems:

Regardless of the kind or quantity of sensors used, a passive ADAS system warns drivers of possible dangers. The driver must, however, take the required precautions to prevent accidents brought on by these dangers. Sirens, flashing lights, and tactile input like a vibrating steering wheel may be included in these warning systems when blind spot recognition is present. For the driver to make wise judgments on the road, this human-machine interface (HMI) gives real-time data on the driving environment. Visual cues are the main method for information dissemination, with aural and tactile cues serving as secondary channels of data transmission. Visual warnings are still often utilized because of their intuitive nature and capacity to communicate information using symbols and colours, despite the possibility that they will temporarily impair the driver's focus. (BasuMallick 2022.)

Active ADAS systems:

With active ADAS systems, the vehicle acts autonomously to take preventative actions against worst-case scenarios. For instance, Automatic Emergency Braking (AEB) can spot a collision coming and automatically apply the brakes without the driver's involvement. Adaptive Cruise Control (ACC), Lane-Keeping Assist (LKA), Lane Centering (LC), and Traffic Jam Assist are further useful features. When a slower vehicle is identified in its route, the Active ADAS System can automatically change the host car's speed from its pre-set level, similar to conventional cruise control. LKA and LC make sure the car stays inside the lane lines. Traffic Jam Assist combines ACC and LC functions when there is a lot of traffic. The foundation for partially or completely autonomous cars is laid by these automated components. (BasuMallick 2022.)

5.1.2 Applications of ADAS

Creating new artificial intelligence (AI) components that use sensor fusion to recognize and analyze things is required to place cameras in automobiles. Large volumes of data may be combined using image recognition software, ultrasonic sensors, lidar, radar, and sensor fusion. In addition to monitoring streaming videos in real-time, understanding the data, and selecting the right response, this technology can operate more quickly than a human driver.

The following list of prominent ADAS systems includes:

Adaptive cruise control:

The cruise control system of a car may modify its speed based on the traffic conditions thanks to a function called adaptive cruise control (ACC). Slower moving cars in the path of the ACC vehicle are identified by a radar sensor mounted at the front of the vehicle. The ACC system controls the clearance, or temporal gap, between the ACC vehicle and the front vehicle and decreases the speed of the vehicle if it is detected. The ACC system accelerates the car back to the predetermined cruise control speed when the forward vehicle is no longer recognized. Because to this function, the ACC car may change its speed in traffic without any human involvement. By engine throttle control and controlled braking, the ACC vehicle's speed is managed. (Anaheim 2005.)

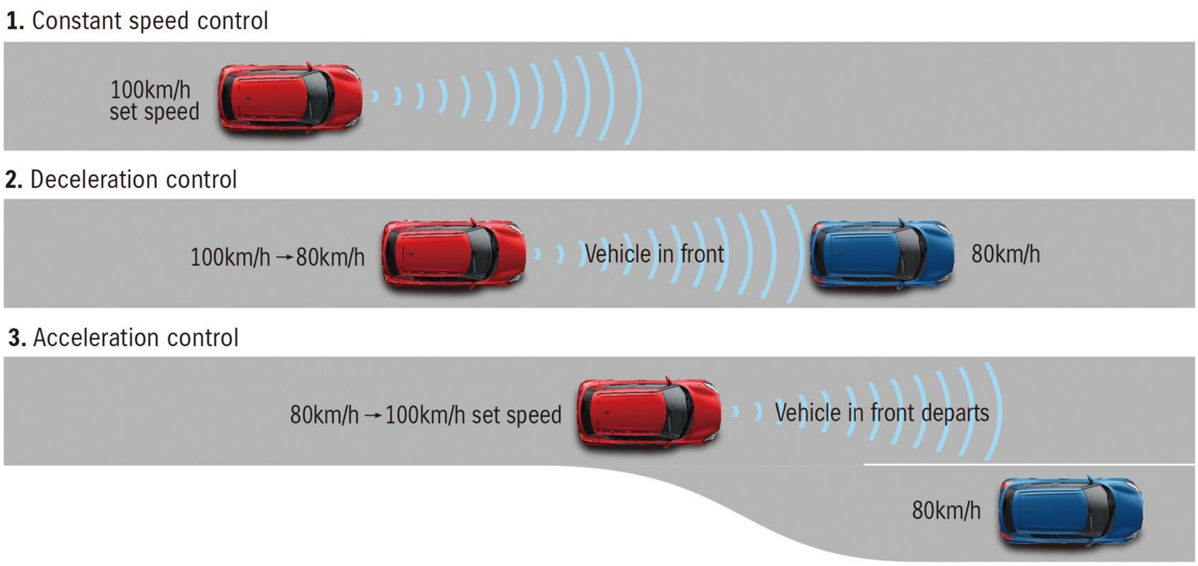

Figure 4. Adaptive cruise control adjusting speed of a car in different environments. (Naylor 2021)

Figure 4 above shows how cruise control adjust speed of vehicle in different situations. The vehicle will continue to the set speed at first and if the system detects any vehicle in front than it automatically decelerates and maintain the distance from front vehicle. If the front vehicle departs from the lane than it will accelerate to meet the previous set speed.

There are various restrictions and difficulties with ACC system installation that need to be resolved. The effect of weather conditions like rain, snow, or fog on the sensors required by ACC systems is one of the key difficulties. These circumstances might make the sensors less visible and less accurate, which could result in erroneous readings and poor system decisions. Another drawback is that radar sensors, which are used by ACC systems, have a short range and might be interfered with by nearby objects or other moving vehicles. This might result in circumstances when the system is unable to identify a car or object in front of it, which could cause accidents. Another issue is that users of ACC systems could grow overly dependent on them and avoid paying attention to the road. If the technology malfunctions or if unexpected changes in traffic circumstances occur, this may result in accidents. Also, ACC systems might not function well on busy streets or stop-and-go conditions. (Anaheim 2005.)

An article on motortrend.com claims that bad weather and debris can impair adaptive cruise control if they block the cameras and/or radar sensors that enable the system to function. Unexpected evasive actions to avoid traffic snarls are also on you (Ogbac 2020). One of this system's major flaws, according to another article on caranddriver.com, is that it is not fully autonomous. To achieve the optimum outcomes from this technology, the driver of the car must continue to cultivate safe driving practices.

Blind spot detection (BSD):

On the highway, the biggest risk to a motorist frequently comes from other vehicles, especially when the driver is ignorant of their presence. An important function of an in-car safety system is to detect the presence of an adjacent vehicle in the driver's blind spot and notify them (as in Figure 4 below). This knowledge can help the motorist change lanes and may affect how they decide to proceed. The issue of blind spot detection involves detecting other vehicles in the area surrounding the host car using different sensor technologies. This is a crucial step in collision avoidance systems and has been tackled using radar technology in first-generation systems. However, these radars have limited range and a reduced field of view, resulting in blind spots and requiring multiple sensors. In contrast, newer embedded security systems utilize small cameras placed in various locations on the vehicle, providing a broader view and lower cost. These cameras can also be combined with radars for improved detection capabilities. (Jamal Saboune 2011.)

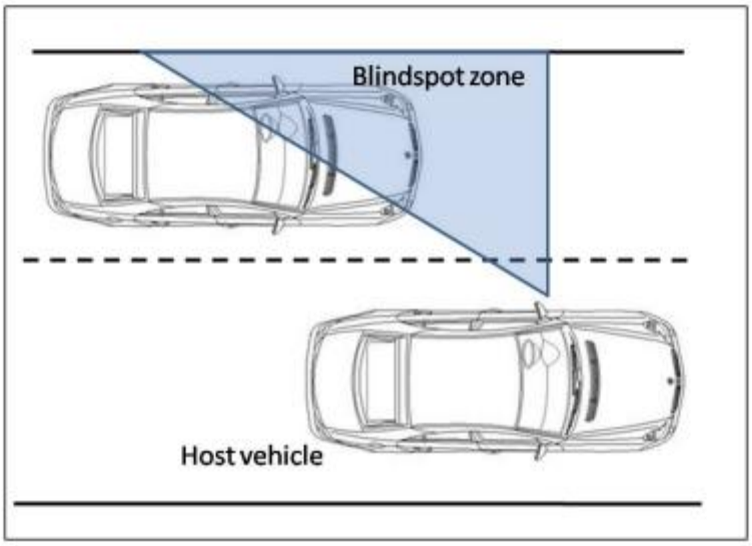

Figure 5. The blind spot zone description**.** (Jamal Saboune 2011)

High-frequency radio waves are used by radar-based BSD systems to identify other cars in the driver's blind zones. Even in poor weather, these systems are quite precise and can locate other cars at a great distance. They are also incredibly dependable and effective under a range of driving circumstances. Radar-based devices, however, can be expensive to install and operate. They consume a lot of energy while operating, which over time can deplete a car's battery. And last, they might not be able to pick up stationary or tiny things like bicycles or parked automobiles. Sound waves are used by ultrasonic-based BSD systems to identify other cars in the driver's blind zones. These devices can operate well in a range of weather situations and are less costly than radar-based systems. They are also quite trustworthy and have the ability to find both fixed and moving things. Nevertheless, because of their restricted range, ultrasonic-based systems may be unable to find distant or rapidly moving vehicles. Smaller items like bicycles or persons could also escape their detection. (Song, Chen & Huang 2004.)

To identify other cars in the driver's blind spots, camera-based BSD methods incorporate cameras. These systems are reasonably priced and may be added to an automobile's current camera system. They may also provide the driver with visual alerts, which is quite beneficial. Camera-based solutions, however, might not perform well in poor lighting or weather. They could also be less sensitive than radar-based systems and incapable of detecting far-off or swiftly moving vehicles. In short, each sort of sensor technology implemented in BSD systems has pros and cons of its own. When deciding which technology to utilize, automakers must carefully evaluate the driving conditions under which their vehicles will be used as well as the expense of installing and maintaining these systems.

Electronic stability control:

ESC, short for Electronic Stability Control, utilizes computer-controlled braking of individual wheels to aid drivers in maintaining control of their vehicles during critical driving situations. By preventing slipping wheels and loss of road traction, ESC helps avoid vehicle "spinning out" or "plowing out" incidents. Although it does not explicitly prevent rollovers, ESC helps keep the tires in contact with the road surface, reducing the risk of rollover accidents. ESC is marketed under various names, such as Vehicle Stability Control (VSC), Electronic Stability Program (ESP), Dynamic Stability Control (DSC), and more. (Hardesty 2022.)

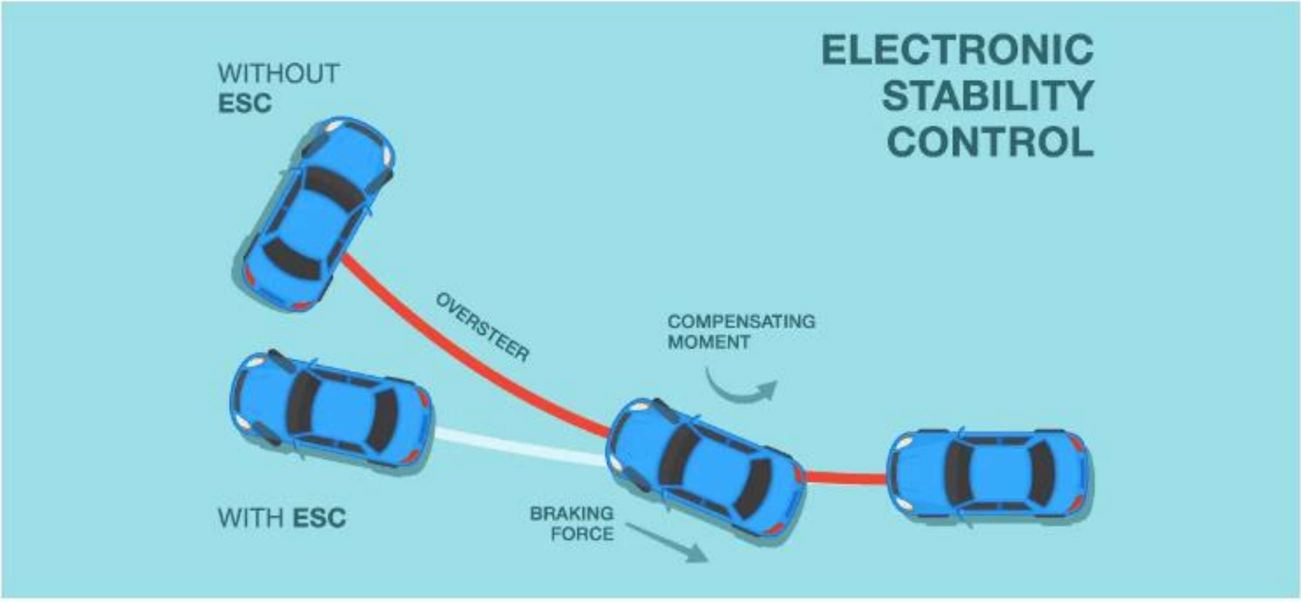

Figure 6. Figure showing the ability of controlling vehicle with ESC (Ackodrive 2022)

Figure above shows how electronic stability control works. When sudden break is applied, vehicle can be turned with oversteering while with stablity control enabled vehicle can be controlled easily. Electronic stability control is also a safety feature in automobile which can overcome accident or incident while appling emergency break or sudden force break.

The ESC continually monitors steering and vehicle direction, comparing the planned direction of travel by the driver based on steering wheel angle to the actual direction based on lateral acceleration, rotation, and road wheel speeds. Only when it notices a possible loss of control—during emergency swerves, skidding, or hydroplaning does it step in. By delivering unequal braking pressure to specific wheels and decreasing engine power, ESC can stop skidding. It can operate on any surface, reacts more quickly than human drivers, and might lead to overconfident driving. ESC frequently uses dashboard indicators or alert tones to notify the driver when it intervenes. It occasionally purposely veers off the driver's desired route to maintain stability. (Ahmed Elmarakbi 2013.)

Automotive Navigation system:

Automotive navigation systems are computerized tools that assist drivers in finding their destination. They can either be integrated into the vehicle or purchased separately and added later. These systems are typically mounted on the dashboard for easy reference and use a computerized road map and GPS satellite link to display the vehicle's location in real-time (Rankin 2023.)

Figure 7. Navigation system display (Paul 2019)

An automotive navigation system typically has an internal database of road maps that can be updated by connecting the car's computer with the manufacturer's website. It receives signals from GPS satellites and has a backup system in case of signal loss due to terrain. The navigation system uses these devices to provide information on the vehicle's location, destination, and travel routes and times. Advanced systems offer additional features, such as identifying local landmarks, locating nearby gas stations and reporting their gas prices, and providing information on current traffic, parking spots, and speed cameras. Some systems can even track the vehicle in case of theft. (Paul 2019.)

Detection of driver drowsiness:

Road accidents can result from microsleep, which is a temporary unconsciousness brought on by drowsy driving. Sometimes, even though a driver's eyes are open, they are not properly controlling their car. According to research, driving after 24 hours without sleep might cause the same amount of impairment as drinking alcohol to an unsafe level.

There are protections in place for some occupations, such as truck drivers who are not permitted to operate a vehicle beyond 14 hours of their shift, but there are no similar laws for the typical driver. It is crucial to keep sleepy drivers off the road since studies show that they contribute to 25% of traffic accidents by losing attention. Driver drowsiness detection systems, which are a component of Advanced Driver Assistance Systems (ADAS) intended to make driving safer and lower the likelihood of human mistake, are one approach to solve this problem. Driver drowsiness detection systems can utilize cameras, eye tracking sensors, and other hardware to monitor visual indicators such as yawning frequency, eye-blinking frequency, eye-gaze movement, head movement, and facial expressions to identify tiredness. Moreover, the devices can watch for abnormal steering motions, pedal use, and lane deviations. In order to minimize accidents brought on by microsleep, exhaustion, and lack of focus, it is essential to identify sleepy drivers and advise them to take a break (Wessel 2022.)

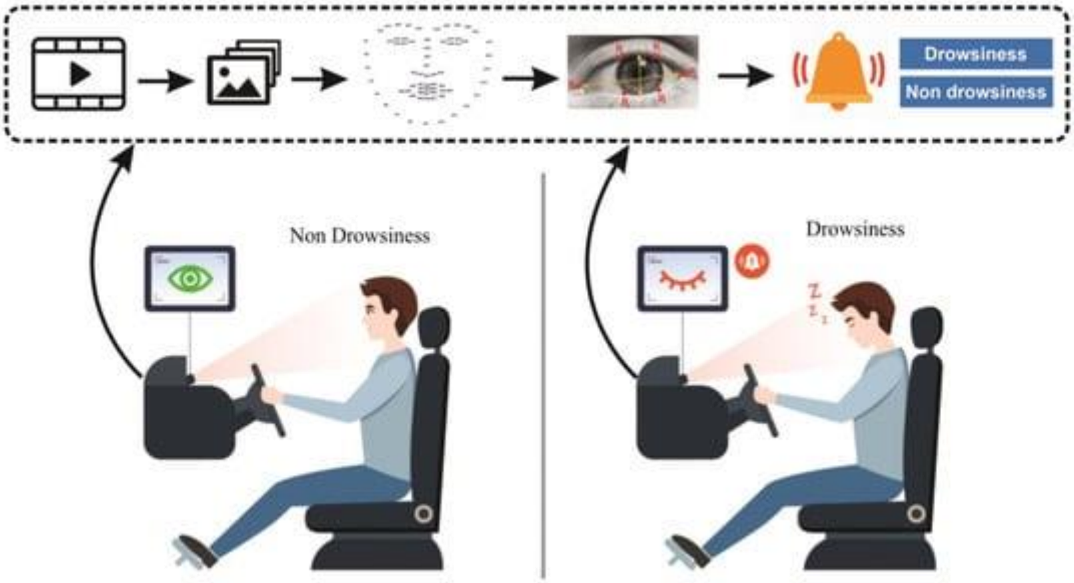

Figure 8. General model of the drowsy detection system. (Anh-Cang Phan, 2021)

5.2 Automatic Emergency Breaking (AEB)

Due to the excessive growth in autonomous cars in the contemporary period, which has resulted in the democratization of the vehicle, autos have made transportation relatively simple for millions of people. Many problems have been brought on by this increase in the number of automobiles, including traffic jams, air pollution from greenhouse gas emissions, and soil erosion from liquid and solid discharges. One of the most important problems with roads nowadays is accidents.

According to the global health organization (WHO), road traffic collisions end the lives of around 1.35 million people each year (WHO 2022). Over 3700 individuals worldwide lose their lives in car and bus accidents each day. Almost 76 percent of accidents are the result of human error or a failure to brake in time. Driving while distracted might have detrimental effects. First-time automatic emergency braking was developed by George Rashid to reduce the likelihood of rear-end or turn collisions as well as the negative effects of such incidents (Pollard 1988). Because it is activated when the automobile is started, an automated emergency braking system (AEBS) helps the driver at all speeds and both day and night.

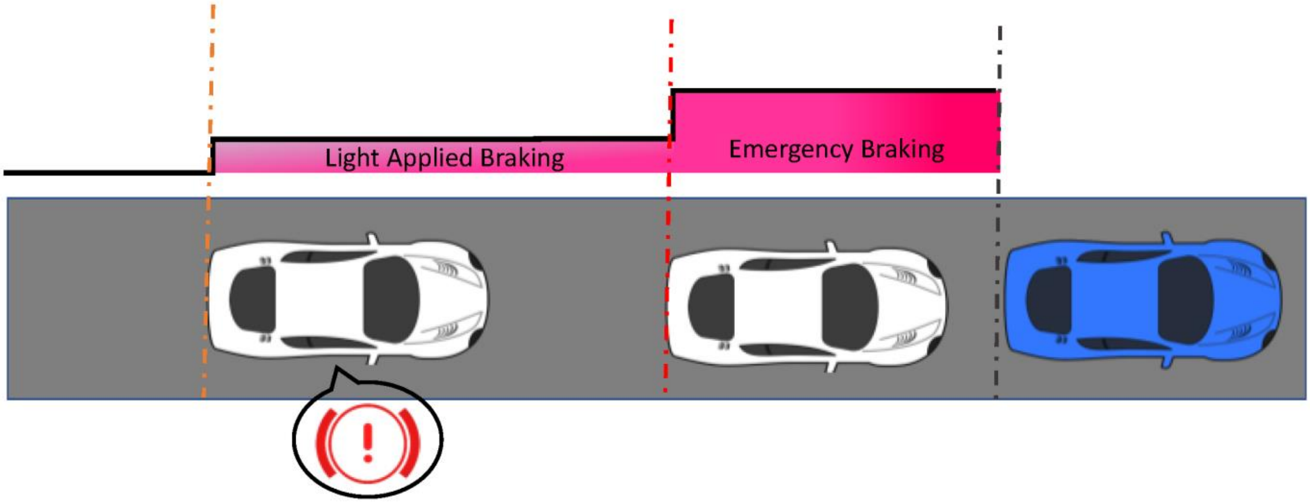

Figure 9. Overview of the AEB process **(**Ucińska & Pełka 2021)

Figure above shows how automatic emergency breaking works. AEB gives you an extra set of eyes to assist you monitor the items in front of you and maintains an extra set of feet on the brakes to help you avoid a collision. You might feel more confident driving because of the technology's automated detection and application of the brakes.

Many studies from Europe and other countries have shown that AEBSs are among the finest collision-avoidance systems you can have in your automobile. In one of the most recent studies, conducted in April 2019, the Insurance Institute for Highway Safety and the Highway Loss Data Institute found that front-to-rear collisions and road accidents with injuries decreased by 50% and 56%, respectively, for vehicles equipped with the forward warning and AEBS. (Isaksson-Hellman 2012.)

Radar, cameras, and lidar are frequently used in modern technology to detect impediments in emergency braking systems. The likelihood that the AEBS can stop the car in time to avoid a collision increases with the vehicle's speed. An automatic braking system is a crucial component of vehicle safety technology (Shahbaz & Amin 2021). It is a cutting-edge technology designed to either stop possible crashes or slow down a moving vehicle before hitting a pedestrian, another vehicle, or any other obstruction. These systems examine the environment in front of the automobile for potential impediments using a mix of sensors, such as ultrasonic, video, infrared, or radar, and if any of the obstructions are discovered, brake control is employed to prevent a collision. (Ivanov 2018).

Automated braking systems rely on sensory input, with radar, lidar, or cameras used by manufacturers to detect objects in front of the vehicle. Once an object is detected, the system measures the distance between the vehicle and the object, as well as their relative speeds. If the system determines that the vehicle's speed is greater than that of the object in front, it can automatically apply the brakes to avoid a collision. In some cases, the system can also leverage a car's GPS and traffic database to further enhance braking response. While the specific technology used by automakers may vary, the fundamental process of detecting and responding to potential collisions remains the same. (Yeong 2021.)

5.3 AI-based Driver Monitoring Systems

Driver monitoring systems (DMS) using cameras can help detect driver drowsiness and distraction, improving driving safety. Traditionally, DMS solutions were developed using Computer Vision/Image Processing, requiring fine-tuning of various parameters for different conditions like lighting and ethnicity, making it challenging to develop generic solutions. More recently, conventional machine learning approaches have been used, requiring expertise to select important features for the machine to learn. In contrast, the Deep Learning approach takes a holistic view of the data and generates features from the data itself, eliminating the need for hand-crafted features by humans. Deep learning involves neural networks inspired by the functioning of the human neural system, making them highly versatile and effective in various conditions. (Nirmal Kumar Sancheti 2019.)

Figure 1. Driver monitoring system monitoring driver status**.** (Pinkow 2019)

Euro NCAP states that the majority of car accidents (90%) are caused by driver error, which can arise due to factors like inattention, fatigue, distraction, inexperience, chemical impairment, or medical incapacitation. To address this issue, Euro NCAP envisions new models of cars incorporating driver-monitoring system (DMS) implementations that can detect impaired or distracted driving, appropriate issue warnings, and take necessary remedial action. From next year, the assessment of car safety will focus on the reliability and accuracy of driver status detection and the effectiveness of the vehicle's move based on the information. The protocol may also include monitoring the driver's position in future iterations. (Dahad 2019.)

AI technology has become increasingly prevalent in the automotive industry, with car manufacturers integrating AI into various aspects of the car-making process. One example of an AI-based system is the Driver Monitoring System (DMS), which can predict driver safety by using big data and previous driver behaviour. For instance, AI-Powered Driver Risk Assessment apps use this approach to assess driver safety. In addition, Tesla's Autopilot also utilizes a vision-based approach, generating massive amounts of data comprising a million 10-second videos and 6 billion objects. General Motors' Dreamcatcher uses Machine Language (ML) for economic prototyping, while Volkswagen uses generative design to improve the compactness of its vehicles. These examples demonstrate the diverse ways in which AI technology can be applied in the automotive industry.

6 THE FUTURE OF AI IN THE AUTOMOTIVE INDUSTRY

The automotive industry has been captivated by the potential of AI, especially in the context of driverless cars, which has introduced a new era of driving. The massive computational requirements for driverless cars have pushed AI to new heights. AI's advancements have played a significant role in the development of the automotive industry by creating and advancing self-driving vehicles such as cars, taxis, trucks, buses, and bikes. The full implementation of driverless technology has the potential to dramatically reduce traffic collisions, accidents caused by human error, aggressive driving, and other road-related issues. Not only does AI facilitate autonomous driving and ensure driver safety, but it also improves the manufacturing process of vehicles. The automotive industry is already experiencing significant changes as a result of AI, ranging from how we drive to how we interact with connected devices. The integration of AI is leading the automotive industry toward a significant transformation. (Theo 2021.)

The use of AI in the automobile sector will continue to grow. Since a few years ago, the word automation has gained popularity in the automobile industry. The usage of AI in the global automobile sector is expanding. Every step of the automobile production process is being automated by AI technology, which is used by automakers all over the world. Autonomous vehicles navigate through traffic safely using a combination of AI and machine learning. The introduction of AI technology has significantly altered the automobile sector. AI has a positive influence on production and assists automobiles when they are driving. Robots powered by AI are anticipated to replace humans in production over the next ten years. Cloud computing, IoT, ML, deep learning, and cognitive systems are just a few of the technologies that AI is prepared to use to bring effective and safe autonomous cars to market. AI-driven smart automobile production is anticipated to increase in popularity as technology develops. The predicted increase of AI deployment and development in the automobile sector between 2015 and 2030 is shown in the figure below. (usmsystems 2022.)

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The predicted increase of AI deployment and development in the automobile sector between 2015 and 2030 is shown in the figure 11 below.

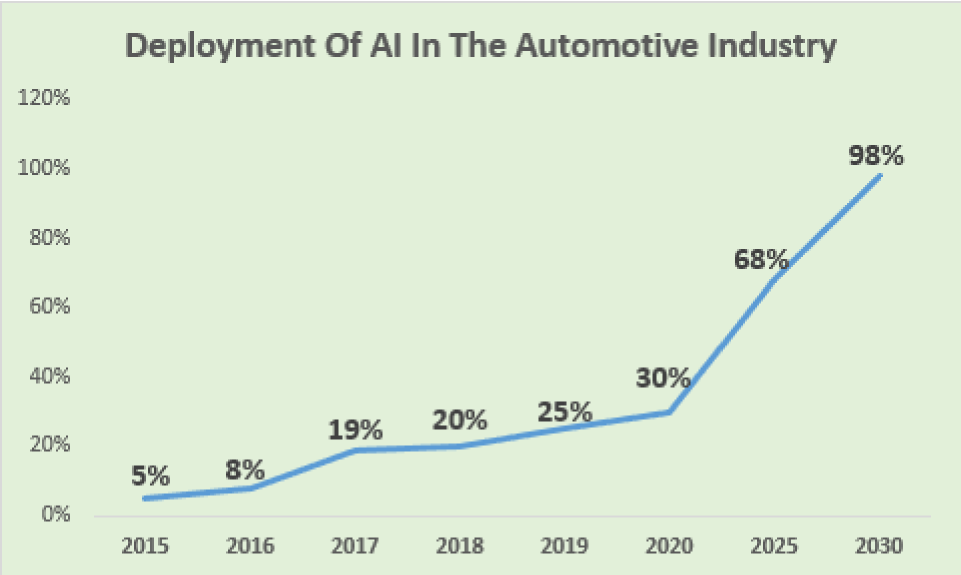

Figure 11. Graph showing the use of AI in automotive industry by 2030 (usmsystems 2022)

As seen in figure 11 above, AI will be key to the automobile industry's future. Self-driving cars are anticipated to be on the roads by 2030, taking into account numerous other AI advances in the automotive sector. Rapid AI development will allow the technology to establish its name in the automobile industry. The use of industrial AI robots on the assembly and manufacturing lines in automobile factories will likewise surge. According to all of these statistics, using artificial intelligence in the car industry is the way for AI firms to increase production and guarantee quality.

7 CONCLUSION

In conclusion, the potential of artificial intelligence (AI) technology to increase driving safety and enhance the entire driving experience has been addressed in this thesis. The usage of data gathering and analysis, as well as the present level of AI technology in the automotive sector, have all been reviewed. Several methods for utilizing AI to make cars safer have also been covered, including ADAS, AEB, and AI-based driver monitoring systems. Also the thesis ethical issues including bias and privacy regarding AI's use for driving safety.

Furthermore, the thesis also revealed that the use of AI technology in the automobile sector has the potential to drastically lower the frequency of collisions and fatalities among people. With self-driving cars expected to be on the road by 2030 and an increase in the usage of AI-powered driver assistance and safety systems, the future of AI in the automotive sector is bright. Manufacturers, decision-makers, and society at large must carefully weigh the advantages and dangers of AI technology in the automobile sector and attempt to deploy it in a moral and responsible manner.

Overall, artificial intelligence has been utilized in various studies to enhance road safety and reduce accidents. The use of AI in collision avoidance systems, speed monitoring, and driver behaviour analysis has shown promising results in reducing fatalities and improving driving behaviour. However, there are still challenges to be addressed in implementing these systems on a larger scale and ensuring their effectiveness in different environments and scenarios. Further research and development in AI-based road safety systems are necessary to achieve the goal of safer roads for all.

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