A SURVEY ON FUTURE OF IOT IN SAFE DRIVING

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Abstract - The significance of Internet of Things in current trends is continuously growing. It encompasses various objects and communication methods for exchanging data and information. It envisions a connected world where everything is linked to the internet and unlocks opportunities for new services and innovations, impacting diverse areas from smart cities to home applications. The future of IoT will witness a surge in content-oriented traffic as millions of devices interact with each other. However, along with its popularity various challenges have also emerged.The rapid progress of the Internet of Things has introduced exciting opportunities to enhance road safety and also elevate the driving experience. Through the integration of IoT technologies into vehicles, road infrastructure, and driver assistance systems, a multitude of inventive solutions have surfaced, specifically designed to tackle the safety concerns prevalent in driving. This paper examines the concept of safe driving, IoT enabled solutions for safe driving, Data analytics and predictive modelling and compares the solutions (V2V communication and ADAS).

Keywords – Safe Driving, Internet Of Things, Vehicle – To – Vehicle Communication, Advanced Driver Assistance Systems.

1. INTRODUCTION

Vehicles are mainly used to transport people, goods and the services from one place to another. With the increase in population the traffic has also increased exponentially. Also, the number of accidents is also increasing. The accidents usually occur due to negligence of the people and violating the rules of traffic. In order to reduce the traffic and the accidents, the Government has introduced various solutions [1].

Driving on modern roads presents a range of risks and challenges that can jeopardize road safety. Lack of real-time information, Human error, Driver fatigue and impairment, and insufficient traffic management are among the pressing issues faced by drivers worldwide. These issues can lead to traffic congestion, accidents and compromised driving experiences.

However, by harnessing the power of IoT, which enables the seamless connection and communication between devices and systems, safe driving can be significantly improved. These solutions facilitate the exchange of data between vehicles, infrastructure, and driver monitoring systems, enabling proactive decision-making, early intervention, and enhanced situational awareness.

There are basically two solutions discussed in this paper and a survey is created between these solutions. The solutions are Vehicle-to-Vehicle Solution and Advanced Driving Monitoring System.

While IoT-based safe driving solutions offer tremendous potential, there are challenges that need to be addressed. These include concerns related to privacy and the data security, the need for standardized communication protocols, infrastructure requirements, and driver acceptance and adoption of new technologies. Overcoming these challenges is crucial for the successful implementation and widespread adoption of IoT in safe driving initiatives.

2. INTERNET OF THINGS IN SAFE DRIVING

The Internet of Things encompasses a vast network of physical objects, commonly known as "things", which are equipped with software, sensors and connectivity capabilities.

These objects possess the ability to communicate and interact with one another and their surroundings, enabling the collection and exchange of data to accomplish specific objectives and tasks. The information gathered by these interconnected

devices undergoes analysis to facilitate intelligent decision-making, process automation, and improved efficiency and convenience across diverse fields.

In the realm of transportation, IoT assumes a pivotal role in revolutionizing our interaction with vehicles. By integrating this technologies into vehicles, they are transformed into smart or connected vehicles. Equipped with sensors, processors, and communication modules, these connected vehicles establish communication channels with other vehicles, infrastructure, and external systems or services. Lastly, it enables seamless connectivity and infotainment services.

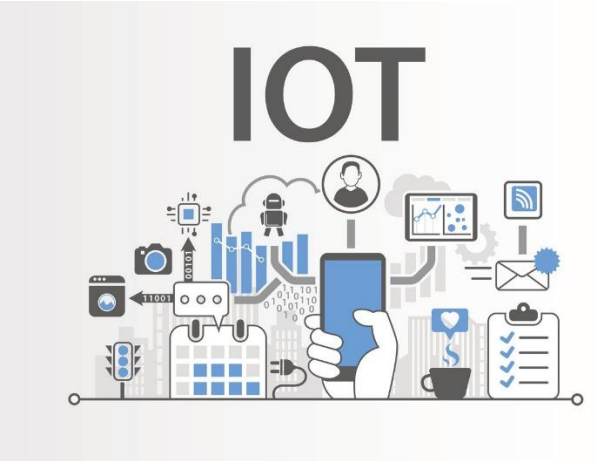

Fig 1. Internet of Things

3. IMPORTANCE OF SAFE DRIVING

Safe driving is of paramount importance as it directly impacts the well-being of individuals, communities, and society as a whole. Here are some key reasons highlighting the significance of safe driving:

1. HUMAN LIFE : The preservation of human lives is directly linked to the adoption of safe driving practices, which are vital in preventing accidents and mitigating the occurrence of injuries and fatalities on roadways. Annually, a substantial number of lives are tragically lost as a result of road accidents, highlighting the urgent need to promote and encourage safe driving behaviour. By emphasizing the importance of safe driving, we can work towards diminishing the frequency of these devastating incidents.

2. DRINK AND DRIVING : The act of operating a vehicle while under the influence of drugs or alcohol presents a significant issue of concern. Individuals who drive while impaired experience diminished coordination, impaired judgment, and delayed reaction times, rendering them more susceptible to accidents. According to estimates from the World Health Organization (WHO), a substantial proportion of global road traffic fatalities can be attributed to accidents involving alcohol.

3. DISTRACTED DRIVING : The increasing prevalence of smartphones and other mobile devices has played a role in the escalation of distracted driving occurrences. Engaging in activities such as texting, making phone calls, or utilizing social media while operating a vehicle diverts the driver's focus away from the road, consequently amplifying the likelihood of accidents. The National Highway Traffic Safety Administration (NHTSA) reports that distracted driving annually claims the lives of numerous individuals and leads to a substantial number of injuries.

4. ROAD CONDITIONS AND INFRASTRUCTURE : Insufficient road infrastructure, substandard maintenance, and inadequate signage present notable obstacles to road safety. Hazardous intersections, inadequate lighting, and insufficient provisions for pedestrians contribute to the occurrence of accidents and injuries. According to the World Road Association, an estimated 50% of global road traffic fatalities are linked to roads that suffer from inadequate design.

   Effectively recognizing and tackling these road safety challenges necessitates a comprehensive strategy encompassing various facets. This approach encompasses educational initiatives, strict enforcement of traffic regulations, enhancements in infrastructure, and the integration of cutting-edge technologies like IoT into safe driving initiatives. By comprehending the significance of safe driving and the obstacles it encounters, stakeholders can join forces in a collaborative manner to foster safer road environments and diminish the frequency of accidents and fatalities [2].

4. IoT ENABLED SOLUTIONS IMPLEMENTED FOR ROAD SAFETY:

Basically two solutions are discussed in this paper and a comparative study is implemented which will give an idea of how these solutions are useful and in what circumstances. The two

solutions compared here are Vehicle-to-Vehicle solution and Advanced Driver Assistance System.

4.1 Vehicle-to-Vehicle communication

Vehicle-to-Vehicle (V2V) communication facilitates real-time data exchange between vehicles, enabling them to communicate and share crucial information such as speed, location, and direction. The implementation of V2V communication aims to enhance road safety by providing advanced warnings to drivers about potential collisions or hazards. The United States government, specifically the National Highway Traffic Safety Administration (NHTSA), has taken significant steps to implement this communication. In 2017, the NHTSA proposed a rule mandating V2V communication technology in all new light vehicles, aiming to establish a standardized communication system that fosters inter-vehicle communication, prevents crashes, and reduces road fatalities [3].

The effectiveness of this communication in promoting road safety hinges on various factors. Research and simulations have demonstrated promising outcomes, indicating its potential to prevent a considerable number of crashes. By offering real-time alerts to drivers regarding potential collision risks, and it empowers them to swiftly react and avoid accidents.

However, the efficacy of V2V communication is contingent upon widespread adoption of the technology. To realize its full potential, a critical mass of vehicles must be equipped with the communication capabilities, facilitating broad-based communication and information sharing. Effective collaboration among automotive manufacturers, government agencies, and other stakeholders is essential in achieving this objective.

APPLICATIONS OF V2V COMMUNICATION

V2V communication has various applications such as traffic management, driver assistance applications, direction and route optimization and Safety are categorized the below table. Each year approximately 1.35 million people die as a result of road traffic accidents. Among vulnerable users the pedestrians, motorcyclists and cyclists are affected seriously. The traffic injuries are the main cause of deaths for children and young adults between the ages of 5 and 29 [4].

APPLICATIONS OF V2V			
TRAFFIC MANAGEMENT	**ROAD SAFETY**	**DIRECTION**	**DRIVER ASSISTANCE**
Monitoring traffic	Collision Avoidance	Road Condition	Lane Assistance
Minimize delay	Collision Detection	Path SelectiAon	Parking
Reduce the need for new infrastructure	Crash Prevention	Predicting the Path	Anti-Lock Braking System
Minimize Conjunctions	Efficient Driving	Improve Services and Tips	Blind Spot Detection

Table 1. Applications of V2V

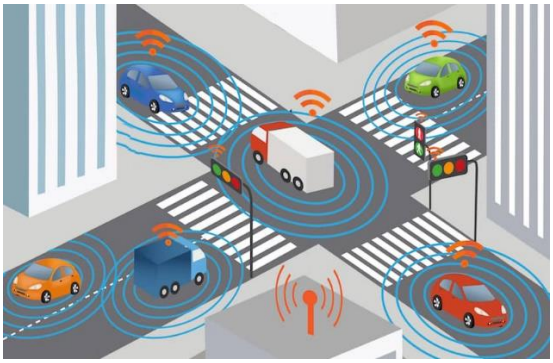

Fig 2. Vehicle – To – Vehicle Detection

4.2 Advanced Driver Assistance Systems (ADAS)

The majority of vehicle accidents arise from human error, a factor that can be mitigated through the utilization of Advanced Driver Assistance Systems (ADAS). ADAS plays a pivotal role in averting fatalities and injuries by diminishing the frequency of car accidents and mitigating the severity of unavoidable incidents.

4.2.1 The Working of ADAS

As the automotive industry advances towards the era of autonomous vehicles, automobiles serve as the cornerstone of the next generation of mobile-connected devices. The development of autonomous applications necessitates the partitioning of solutions into various chips known as systems on a chip (SoCs). SoCs (Systems on a Chip) play a vital role in establishing connections between sensors and actuators through interfaces and high-performance electronic controller units (ECUs).

Self-driving cars extensively rely on these applications and technologies to achieve a comprehensive 360-degree vision, encompassing both the immediate vicinity and distant surroundings

of the vehicle. Consequently, hardware designs are embracing more sophisticated process nodes to meet increasingly demanding performance targets, all while reducing power consumption and physical footprint.

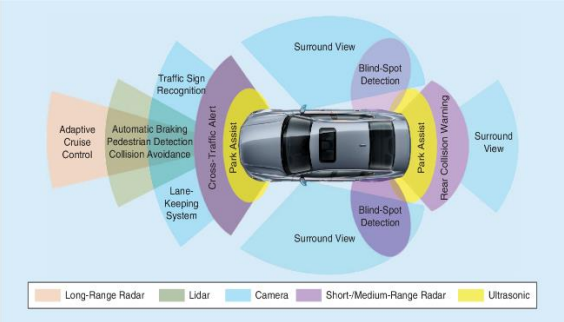

Fig 3 [6]. Advance Driver Assistance System

4.2.2 SENSORS USED IN ADAS

VISION SENSOR

Cameras are widely employed as primary vision sensors in vehicles. Vision-based Advanced Driver Assistance Systems (ADAS) utilize one or multiple cameras to capture images, while an embedded system analyze, detects, and tracks various objects within the images. High-end ADAS employs cameras to monitor both the vehicle's interior and exterior. The integration of cameras into modern vehicles has become increasingly prevalent due to their affordability and ease of installation. In fact, Mobileye announced at the 2018 Consumer Electronics Show that smart cameras would be implemented in millions of cars released that year. Moreover, legislation like [5] that mandates the use of vision-based ADAS in vehicles manufactured from May 1, 2018, onwards promotes camera integration. Cameras possess distinct advantages as they capture information related to color, contrast, and texture. Vision-based ADAS commonly utilizes two types of cameras: monocular and stereo [6].

MONOCULAR CAMERA

Monocular camera systems consist of a single lens, resulting in a single image output at any given time. Due to this limitation, these systems have lower image-processing requirements compared to other camera types. However, they still find applications in various areas, including obstacle detection, pedestrian recognition, lane detection, and traffic sign identification [7]. Monocular cameras can also be utilized for driver monitoring purposes, such as face and eye detection, as well as head-pose analysis [8]. Nevertheless, it's important to note that monocular camera images lack depth information, making them unreliable for distance estimation. To overcome this limitation, certain techniques enable the approximation of distance by identifying key features in captured image frames and tracking their positions while the camera is in motion [7].

STEREO CAMERAS

Stereo camera systems employ two or more lenses, each equipped with image sensors, which are positioned at a specific distance from each other, known as the stereo base. These systems offer the capability to extract three-dimensional (3D) information by matching pairs of stereo images, typically obtained from left and right sensors. Through the use of a disparity map, the relative depth of a scene can be estimated. Stereo cameras find utility in various applications, including traffic sign recognition, lane detection, pedestrian detection, obstacle detection, and distance estimation, providing significantly higher accuracy compared to monocular cameras. When it comes to precise distance estimation, stereo systems are particularly reliable within short distances, typically up to 30 meters. In most vehicles equipped with stereo cameras, the cameras are positioned inside the vehicle, situated behind the rear-view mirror, slightly angled downward, and oriented toward the road [6].

5. Data analytics and predictive modeling in safe driving

Data analytics and predictive modeling play a crucial role in enhancing safe driving practices by identifying risk factors, analyzing driver behavior patterns, and implementing proactive safety measures. Here's some information on each aspect:

5.1 Identifying Risk Factors and Improving Road Safety:

Data analytics techniques can be applied to vast amounts of data collected from various sources, including vehicles, road infrastructure, weather conditions, and historical accident data. By analyzing this data, patterns and correlations can be identified to understand the underlying risk factors that contribute to accidents. This information helps in developing targeted interventions and implementing measures to improve road safety.

5.2 Analysis of Driver Behaviour Patterns and Accidents:

Data analytics allows for the analysis of driver behaviour patterns by examining variables such as speed, acceleration, braking, lane changes, and

adherence to traffic rules. By correlating these patterns with accident data, insights can be gained into the specific behaviours that increase the likelihood of accidents. This knowledge can be used to design educational programs, driver training initiatives, and personalized feedback systems to address risky driving behaviours.

5.3 Predictive Analytics for Proactive Safety Measures and Accident Prevention:

Predictive modelling techniques can be utilized to anticipate potential accidents based on historical data and real-time inputs. By applying machine learning algorithms to analyse various parameters, such as road conditions, weather, and driver behaviour, predictive models can identify situations with a high risk of accidents. This enables the implementation of proactive safety measures, such as timely warnings, adaptive speed limits, and route recommendations, to prevent accidents from occurring.

Furthermore, predictive analytics can be used to identify emerging trends, such as accident-prone areas, times, or specific driving conditions. This information helps in allocating resources effectively, implementing targeted interventions, and optimizing road infrastructure to mitigate risks and enhance overall road safety.

6. Security and privacy considerations

6.1 Security Vulnerabilities in IoT-based Vehicles:

IoT integration in vehicles introduces new security risks. The connectivity and communication between various components in a vehicle create potential entry points for cyberattacks. Malicious actors can exploit vulnerabilities in IoT devices, software, or networks, compromising the safety and functionality of the vehicle. Security vulnerabilities in IoT-based vehicles include unauthorized access, remote hijacking, data breaches, and tampering with critical systems. It is crucial to implement robust security measures, such as secure communication protocols, encryption, access controls, and intrusion detection systems, to mitigate these risks.

6.2 Privacy Concerns and Ethical Considerations:

The collection and sharing of driver and vehicle data in IoT-based safe driving systems raise privacy concerns. Driver behaviour, location data, and vehicle performance information are often collected and analyzed to improve road safety. However, the gathering and utilization of this sensitive data should comply with privacy regulations and ethical standards. Individuals should have control over their personal data, with clear consent mechanisms and transparent data handling practices. Anonymization techniques should be employed to protect the privacy of individuals while still allowing for effective analysis and research.

Furthermore, ethical considerations come into play when determining how collected data is used and shared. It is essential to strike a balance between the benefits of data-driven insights for road safety improvements and the potential risks of infringing upon individuals' privacy. Data governance frameworks and ethical guidelines can guide the responsible collection, usage, and storage of data to ensure privacy protection and ethical practices.

7. CONCLUSION

Determining the better solution between Vehicle-to-Vehicle (V2V) communication and Advanced Driver Assistance Systems (ADAS) in terms of IoT in safe driving requires considering their respective capabilities and contributions. Both V2V communication and ADAS play crucial roles in enhancing road safety, but they serve different purposes and address distinct aspects of safe driving.

V2V communication enables vehicles to exchange real-time data with one another, such as speed, location, and direction. This communication allows vehicles to share critical information and warnings about potential hazards, improving situational awareness for drivers. V2V communication has the advantages such as Collision Prevention, Intersection Safety and Hazard Warnings.

Whereas, ADAS refers to a range of technologies and systems that assist drivers in various ways to enhance safety on the road. ADAS utilizes sensors, IoT technologies, and algorithms to gather data, analyze the driving environment, and provide real-time alerts or assistance. Some examples of ADAS features include Lane Departure Warning Systems , Adaptive Cruise Control , Collision Avoidance Systems and Driver Monitoring systems.

In terms of which solution is better, it is important to note that V2V communication and ADAS are complementary rather than mutually exclusive. They address different aspects of safe driving and can work together to enhance road safety. V2V communication focuses on sharing information between vehicles to improve situational awareness, while ADAS technologies provide direct assistance to drivers in real-time.

Ultimately, the effectiveness of each solution depends on several factors, including technology adoption, infrastructure support, and regulatory frameworks. Widespread adoption of both V2V communication and ADAS technologies, along with proper integration and coordination, can significantly enhance safe driving outcomes and reduce the risk of accidents. Therefore, a comprehensive approach that leverages the strengths of both V2V communication and ADAS is likely to be the most effective in promoting safe driving practices.

8. FUTURE PROSPECTS

8.1 Edge Computing:

Edge computing involves processing and analysing data at the edge of the network, closer to the data source, rather than relying solely on cloud-based systems. In the context of safe driving, edge computing enables faster data processing and real-time decision-making, which is crucial for time-sensitive applications. By leveraging edge computing capabilities, IoT devices in vehicles can quickly analyse sensor data, detect potential hazards, and trigger immediate responses, enhancing safety measures. Edge computing also reduces reliance on cloud connectivity, making safe driving systems more resilient and less susceptible to network latency or disruptions.

8.2 Connected Ecosystems and Integration:

The future of IoT in safe driving lies in the integration and collaboration of various technologies and stakeholders. This includes seamless integration between vehicles, infrastructure, smart cities, and other connected devices. By creating a connected ecosystem, data can be shared and analysed across multiple platforms, allowing for better coordination, real-time monitoring, and predictive capabilities. For example, integrating vehicle data with smart traffic management systems can optimize traffic flow and reduce congestion, thereby enhancing safety.

8.3 Data-driven Insights and Personalized Safety:

The increasing availability of data from IoT sensors and devices enables the generation of data-driven insights. Advanced analytics and AI techniques can uncover hidden patterns, identify high-risk areas, and provide personalized safety recommendations to drivers. By leveraging individual driver data, personalized safety alerts and interventions can be tailored to specific behaviour, enhancing overall safe driving practices.

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