Current Technologies,Future Directions Policy Implications in Automatic Vehicle

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ABSTRACT

Automated cars are sometimes known as self-driving or autonomous autos. Automated cars, which can operate entirely or partially without human input, are about to start upending the world's auto industry. These vehicles utilize advanced sensors, artificial intelligence and machine learning (AI & ML) algorithms to navigate and operate without human intervention [1].

The main drivers behind the research and development of autonomous vehicles are the following: growing infrastructure, relying more on machines for jobs like driving and other tasks, an aging population that increases the number of vehicles on the road, the need for increased driving safety, and the requirement for resource and time management. [2]. With the growth of population, a very stressful impact has been created on the roads, infrastructure, open spaces, fuel stations, and resources.

The benefits of the Automated Vehicle include enhanced traffic safety convenience and improved fuel economy, especially in the case of trucks and mobility.

Level 0 is No Automation that indicates the human driver is responsible for all aspects of driving. The vehicle may have basic systems that can provide warnings or momentary assistance. The ability of the car to help with steering or acceleration/deceleration, but not both at once, is referred to as level 1 driver assistance. The car's steering and acceleration/deceleration are controlled by partial automation, or Level 2Level 3 is called Conditional Automation, in this level the vehicle can perform driving tasks under specific conditions. With Level 4 High Automation, the car may perform all driving tasks by itself. In certain circumstances, it can even monitor its environment and operate as an autonomous vehicle. Lev el 5 is Full Automation; at this stage, a car is completely self-sufficient and able to navigate itself in any circumstance without the need for human assistance. There is no need for a human to driver the vehicle [3].

Keywords: *Automated Vehicle, Technology, IOT ,LiDAR ,Radar, Vehicle Navigation Systems, Road Safety, Traffic Optimization.*

1. IMPOTANCE OF AUTOMATED VEHICLES

Estimates about a little over one million individuals worldwide lose lives in traffic accidents each year. As a consequence , crashes involving vehicles constitute among the biggest causes of death around the world, especially among youngsters. Nearly 150,000 people in India lost their lives in motor vehicle accidents every year [4]. Millions of people suffer from severe injuries that may result in lifelong disabilities. Causes of accidents is riding the vehicle in high speed, drunk and driving, distracted driving, and nonuse of seatbelts and helmets are significant contributors by the human side. A greater number of accidents can also be caused by undesirable road conditions, improper signage, shoddy pedestrian crossings, differences in vehicle safety rules and regulations, and the use of older, less safe cars in numerous locations [7]. Automated vehicles (AVs) have the ability to drastically lower traffic fatalities and injuries by addressing the main causes of accidents that are linked to human error. Because they avoid many of the human errors that cause accidents, automated vehicles have the potential to substantially decrease the number of road fatalities and injuries [8].

1.1 Requirements:

Well-maintained roads with clear lane markings, signage, and smooth surfaces are crucial for AV sensors and navigation systems. India's roads could currently support semi-autonomous vehicles, but more advanced vehicles like automated vehicles would not be viable without significant improvements in infrastructure [2]. Designating

specific lanes for AVs on highways can reduce interactions with human driven vehicles, lowering the risk of accidents and improving traffic flow in highway lanes and in urban areas establishing AV-friendly zones with well defined pick-up and drop-off points can enhance the efficiency and safety of AV operations. Road signs and markings need to be easily detectable by people and interpretable by AV sensors. This includes standardizing signs to be visible in various weather and lighting conditions [5].

High-speed, internet connectivity is necessary for the data exchange between AVs and infrastructure. Many experts believe that it's hard to provide a timeline, fully automated vehicles are at least 10 years away from becoming a reality in India [9].

2. KEY GOVERNMENT INITIATIVES

The invention of self-driving cars is encouraged by governments of all around the world.

In the US, manufacturers have the right to test a greater number of autonomous vehicles (AVs) on public roads beneath the direction of the National Highway Traffic Safety Administration (NHTSA), that additionally provides cybersecurity and safety criteria for manufacturers to abide by. Cities like Columbus, Ohio, received develop smart transportation solutions, including the use of AVs for public transit [8].

European union Focus on harmonizing regulations, ensuring data privacy and cybersecurity, significant funding are also allocated for projects on autonomous driving technologies, smart infrastructure, and mobility services [6]. Digital single market strategy measures include standardization of technologies, data sharing protocols, and crossborder testing corridors. Japan also provides Strategic Innovation Promotion Program (SIP) that includes projects on next generation transportation systems, smart traffic management, and safety standards using automated vehicles [10].

Germany provides recommendations on safety, data privacy, and ethical considerations for AV operations and provides Autonomous driving innovation programme. In this programme government grants and incentives for companies developing AV systems and related technologies [11].

China is emerging as a global leader in the development and deployment of autonomous vehicles (AVs). The Chinese government, along with major technology and automotive companies, is investing heavily in AV technology [12]. China is making significant strides in the development and deployment of autonomous vehicles, driven by strong government support, active participation from technology giants and automotive manufacturers, and a robust innovation ecosystem [13].

2.1 Technological Development:

Sensor Technologies: LiDAR, radar detectors, photographic equipment, and ultrasonic sensors were the primary sensors utilized in unmanned aircraft [AVs][14]. These sensors gather information about the surroundings of vehicle in actual time, which AI systems utilize to make driving decisions. Artificial Intelligence: The capacity to evaluate sensor data, generate conclusions, and learn from driving actions is dependent upon AI algorithms, particularly reinforcement learning and deep learning. AI systems specifically suited to the unique driving conditions of Indian highways have been actively designed by Indian companies and research institutions [15]. Vehicle-to-Everything (V2X) Communication: AVs may communicate to other motor vehicles, the infrastructure, and pedestrians with the help of V2X technology [16]. This communication is vital for improving safety and traffic management in Indian cities**.**

2.3 Sensors used in AV:

Cameras: Vehicles have visible light cameras to view of the surroundings. They detect and recognize the objects and these data are sent to the AI based tools for further use[17]. Dual cameras are used to detect depth, while monocular cameras, that utilize a single lens, are used to capture photographs.

LiDAR, or "Light Detection and Ranging," combines beams of laser light which reflect off objects and return to the sensors to estimate distances and create a reliable a three-dimensional map of the environment[18]. Though LiDAR is an expensive sensor, it is powerful and efficient. The GPS (Global Positioning System) is a sensor that connects to network satellites to provide users data regarding time of day, positioning as well as and navigation.

A minimum of four satellites belonging to GPS transmit signals to the automobile's GPS receivers. Triangulation is an approach through which the receiver identifies the exact location of the vehicle by estimating its distance from each satellite[19].

Global Navigation Satellite Systems (GNSS): GNSS calculates the distance between a vehicle and satellites in geostationary orbit by using triangulation to determine the position of receivers. Localization precision and reliability are improved through the implementation of a lot GNSS satellites. Continuous tracking information can be guaranteed with access to multiple GNSS systems, even in a situation that one system is temporarily unavailable[20].

RADAR (Radio Detection and Ranging): RADAR sensors that estimate the distance, velocity, speed, and direction of an object. autonomous vehicles may utilize a range of innovations, including as LiDAR, RADAR, cameras, ultrasonic sensors, GPS, IMUs, and V2X communication, to grow more aware of the surroundings. RADAR provides velocity information of moving objects [21]. As technology improves, these kinds of sensors will grow more efficient, specific, and accessible accelerated the worldwide implementation of autonomous vehicles.

3. BENIFITS OF AUTONOMOUS VEHICLES

The positive aspects of autonomous vehicles Safety: autonomous vehicles could reduce disasters caused by human negligence, which is responsible for a significant number of fatal crashes in India[22]. Efficiency: By promoting efficient driving, autonomous vehicles may boost traffic flow, reduce congestion, and consume less power[23]. Accessibility: Autonomous vehicles may enhance the independence of the elderly and disabled through providing mobility remedies[24].

3.1 Impact on society:

Increase in automatic vehicles may impact on economic , environmental, social.

In economic impact , AV reduces employment of the people in driving professionals. If AV becomes more prevalent it declines these roles[22]. AVs are operated more efficiently than human-driven vehicles, especially in transformation.

In environmental impact, with the use of AV's we can reduce greenhouse gas emission and fuel consumption. Many AVs are contributing to lower emission compared to engine vehicles. AV can encourage development of green space and reduces need of parking space[25].

In social impact, AV can improve the transportation facility in rural as well as local areas. AVs can significantly reduce accidents and improves the road safety[26].

AVs can reduce the need of parking infrastructure and allow that place to repurpose land for other uses such as parks, housing, or commercial spaces. Improving the traffic signals and AV-friendly roadways, that will be support to the integration of Avs.

3.2. Detection of Pedestrians:

Sensors are used to detect pedestrians. It incorporates four components: Segmentation, Feature Extraction, Segment categorization, and Track Categorization[27]. Monocular and stereo cameras are used to detect thearea around the cars. Laser pulses are released via light detection and ranging (LiDAR) sensors, and they additionally monitor the time it takes for the pulses to return after hitting an object. With the use of this information, an extensive three-dimensional map of that region is generated that makes it simpler to find and follow pedestrians. It makes use of ultrasonic technology to identify objects which are near by. Blurry weather conditions limit preexisting pedestrian detection methods, reducing perceptibility and causing hazy outlines in camera images, which significantly impacts the accuracy of visual-based detection systems.[28]. By employing track categorization, the system can predict the positions of pedestrians based on their previous movements, thereby improving recognition when they are temporarily out of the camera's view.[29].

4. Challenges:

India's roads are highly congested, with traffic patterns and traffic jams, making it difficult for automatic vehicle systems to use smoothly. The consistency and quality of road infrastructure vary greatly across the country. The roads are lacking proper signage, lane markings, and maintenance. Weather conditions, such as heavy monsoons, dust storms and fog can impact the sensor detection function and reduce the reliability[30]. Reliable power supply and connectivity are essential for autonomous vehicles, and these can be unreliable in many parts of India. Ensuring the security of collected data by autonomous vehicles and addressing privacy concerns are critical issues

that need robust solutions**.**

Infrastructure: India's current infrastructure, including road quality, traffic signals, and signage, needs significant upgrades to support AV deployment[31].

Regulation and Policy: Establishing a comprehensive regulatory framework that addresses safety standards, liability, and insurance is crucial for AV adoption[32].

Public Acceptance: Public trust in AV technology must be built through awareness campaigns and demonstrating the technology's reliability and safety[33].

Policy Recommendations

Infrastructure Development: Investment in smart infrastructure, including high-quality roads and V2X communication systems, is essential[34].

Regulatory Framework: Developing clear regulations and standards for AV testing and deployment, addressing data privacy, and setting safety benchmarks are necessary steps.

Public Engagement: Initiatives to educate the public about the benefits and safety of AVs can facilitate smoother adoption[2].

5. CONCLUSIONS

Improvement in CAV technology during the last decade has been rapid. While research conducted to yet and related trials, we have mentioned have been successful, the next stage will be to merge all the components into a single platform that works seamlessly without security or operational issues[35]. Making intersections less dangerous for pedestrians while keeping them less dangerous for drivers will be difficult for the public. With such a big number of pedestrian and bicycle traffic as well as human-controlled cars and CAVs to contend with, there are certain to be chances for mishaps. It is critical that each component performs perfectly while maintaining full network speed. Inter-CAV communication is the interconnecting point used by CAVs, junction managers, and RSUs to notify each other and pedestrians. Collision and pedestrian avoidance are crucial in ensuring that human life is preserved[36]The adoption of autonomous vehicles in India holds promise for transforming the transportation landscape. However, achieving this potential requires concerted efforts in technology development, infrastructure enhancement, regulatory clarity, and public engagement. Continued research and collaborative initiatives will be key to overcoming the challenges and realizing the benefits of AV technology in India.

6. REFERENCES

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