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An Approach of Adaptation of Autonomous Vehicle in the Indian Smart City

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Abstract: Many cities in India are best suited for development into smart cities, but in the current scenario, this necessitates an effective solution and major steps that should be taken for development and dealing with present and future challenges. The transportation system is a critical component of any smart city. Many road injuries and fatalities have occurred as a result of a poor transportation system, which can be avoided by transforming the current transportation system into smart transportation. This article focuses on the adoption of driverless vehicles in India's smart cities. The step-by-step methodology that can be extended to the introduction of driverless vehicles in Indian smart cities is properly addressed. The article also discusses the primary challenges that can arise with autonomous vehicles and their smart solution using existing technologies, as well as the benefits of this technology in the Indian economic context. The current paper also discusses the driving control structure of AV, its scope in Indian smart cities, and its benefits from the consumer's standpoint.

Keywords: Autonomous vehicle; Smart city; IoT; 5G technology.

1. Introduction

We are now living in a technological age in the twenty-first century. Technology has been an integral part of our lives over the years since it has enabled us to function more efficiently. Technologies like AI (Artificial Intelligence) along with IoT (Internet of Things) act as the future of more innovative upcoming technologies, with the emergence of smart cities. In general smart city is identified as a city that uses state-of-the-art technology to provide advanced services, IoT-enabled project solutions, and efficiently collected relevant data. The entire idea of smart cities is based on ICT, IoT, and computer systems. It focuses more on data sharing with the community as well as improving both the level of administrative operations and citizen welfare [1)]. Smart cities are being built all over the world in order to enhance people's living standards and financial success. Smart transportation is a vital component of every smart city. Various metropolises throughout the world may be characterized as digital cities or reaching toward the goal. Resources are limited and thus it requires many rational decisions to be made for the initial state of such tasks [2)]. AI is very important among such decisions and can be used to improvise and develop more futuristic technologies with better advancements and skills. With real-time information, mobile apps, and other technology, the digitization of public transportation will improve the passenger experience and enable travelers to make more proactive and effective mobility decisions. According to the Ministry of Road and Highways (MoRTH), the Government of India the majority of deaths are due to different causes. These may usually be categorized as human error, road condition, and vehicle condition. Accidents caused by human error comprise cases of accidents caused by violation of traffic rules, driving without a valid driving license, and not correctly using protective equipment[3)]. Autonomous vehicle technology can greatly reduce the chances of accidents and deliver even greater safety benefits to travelers [4)]. When we don't want to or can't do it ourselves, we can delegate the whole job of driving to them. In the future, AV technology may be seen as a crucial revolution in every smart city's transportation infrastructure.

Self-driving vehicles have been a common topic of conversation these days, and for good reason: driving cars will only bring about the greatest social revolution after, well, the industrial revolution, and it seems like everybody is getting into it. For this, many attempts have been made

by 21st-century researchers to accomplish a more reliable transportation system that causes less effect on people and the environment through the use of cost-effective and more reliable Artificial Intelligence, Machine Learning, IoT, 5G technologies, AVs and other smart software's [2]. There is a rising number of partially autonomous cars already in circulation and using technology such as parking assistance and warning for a lane change. There is an immense opportunity found in AVs in both economic terms and social gains. AVs could eradicate 90% of human error-induced traffic injuries, saving up to a million lives per year. Anton Manfreda et al. [2] suggested a proposal to give millennials an appreciation of the implementation of autonomous vehicles (AV). Adults aged 22-38 years are a significant community for digital city ideas as they are eager to embrace modern modes of travel and technologies. Their research focuses on the implementation of technology, infrastructure, protection, perception of advantages, efficiencies related to mobility, and concerns as the main factors for AV adoption. They also used a simulation of a structural equation and used data from 382 millennials to assess the effect of these variables. They reported that the advantages of AV are major aspects of AV acceptance, while the security of AV decreases the effect of different problems. The technology and ethics regarding administrative algorithms in AVs were explored by Lim et al. [5] by investigating how operating choices can promote segregation & generate advanced public security risks. This paper is on the concept of poor AI, characterized by "specific tasks requiring individual human capabilities, such as visual perception, context understanding, probabilistic reasoning, and complexity management". Robust AI requires "a human or superhuman intelligence system" to carry out human thought, including legal decisions, "symbolic reasoning" and "social situation management." They also addressed the response to resolve such problems, outlining the ongoing investigation holes and the necessity to reduce those problems by the creation of procedures, strategies and protocols for AV which can benefit the smart and sustainable cities.

As we all know, the concept of AV is sweeping the world, but in India, it is still out of reach for the majority of the population due to its high cost. Additionally, as our government aims to have all EVs on the road by 2030, we attempted to combine the concepts of both AV&EV and explain how this will help in controlling many problems such as pollution, accidents & deaths, etc. This paper focuses on the introduction of driverless cars in Indian cities, how they will benefit Indian people, what advantages they will have, how they will minimize the incidence of accidents in India, and how a driverless car will be cost-effective for Indian citizens and also promote the sustainable development [6]. In this article, we will examine each of the above facets of AI-integrated IoT self-driving cars one by one, to determine how these self-driving cars will improve India's travel and transportation. But first, the shortcomings of the present transportation infrastructure will be explored. A smart solution towards the proposed framework and control structure of AV for Smart Cities is also suggested. According to the study, this AV will greatly help Indian customers and lessen accidents.

2. Autonomous Vehicle

Automobile with attributes that allow them to accelerate, brake, and navigate by negligible driver intervention is considered a self-driving vehicle. Autonomous vehicles are classified into two types: semi-autonomous and fully autonomous. The current work focuses on fully autonomous vehicles, which can travel between places with no driver intervention. There are many autonomous vehicles on the track, such as Google cars, Tesla cars, Nissan cars, and so on. Recent advancements in this field indicate that this technology will eventually replace the current transport method. 5G technology [7], IoT, and AI. The future of Connected Car is 5G and IoT technologies, which would link consumers to autonomous vehicles.

2.1 5G Technology

Sadia Din et al. [8] suggested a device architecture focused on the 3 levels of function, namely: the detection level, the relay level, and the central web level. Constant functionality is accomplished by SDN features, through modular and programmable features. This 5G architecture also offers fast data rates and bandwidth, in addition. The simulation results show that better results are obtained by the suggested system architecture than by the arbitrary displacement vector routing protocol.

2.2 Internet of Things (IoT)

IoT is the web-based networking of various users to exchange data and access added-value services. Autonomous vehicles are so inter-connected that data from onboard sensors, as well as data from pedestrian and cyclists' smartphones, traffic sensors, parking detectors, and other sources, is shared [9]. The 'Drone Track' system is a web storage object pursuit method that makes use of UAV and IoT [10]. A drone map plan is used in this study to monitor a mobile item through the internet. The pursuit contradicts the Laptop Vision Formula and the GPS coordinates of web storage. Mozaffari et al. [11] suggest IoT connections that use fewer resources for portable UAVs. The research is focused on accurate UAV orientation, 3-D positioning, and resource management. Dynamic IoT systems are analyzed in relation to the same time and also the relationship between them of the square scale. Nowadays, various things are being endlessly connected to form an IoT, hence it may be viewed like a synthesis of multiple fields. Figure 1 depicts a clarifying record of certain fields that contribute to the IoT.

2.3 Artificial Intelligence (AI)

AI refers to the replication of an individual's intellect by devices that have been trained to think and act like humans. The word can also be extended to a device that displays attributes similar to human intelligence. ML [12] is a subcategory of AI that relates to the notion of computers that could adapt and respond to advanced knowledge with no intervention of humans. Deep learning techniques change automated Training through the consumption of vast amounts of disorganized information such as texts, photos, or film. One of the most important applications of artificial intelligence is autonomous driving. Autonomous vehicles (AVs) are outfitted with a variety of sensors, including cameras, radars, and lidar, to aid in their understanding of their surroundings and route planning. The volume of data produced by these sensors is enormous [13-14].

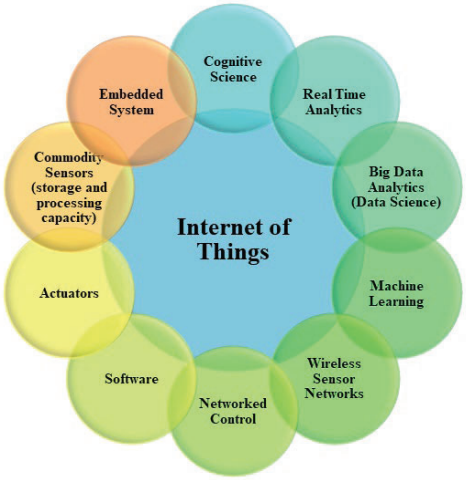

Fig. 1: Domains creating the IoT.

2.4 The Main Connected Components of AV

Sensors, actuators, complex algorithms, machine learning programs, and powerful processors are all needed for autonomous vehicles to run code. Autonomous vehicles use a variety of sensors in various parts of the vehicle to create and preserve a map of their surroundings (Fig. 2).

Fig. 2: Autonomous Vehicle [14].

Sensors in different parts of the car have data that allows the system to stay aware of the road condition. Video cameras are used to watch other vehicles, identify traffic lights, see road signs, and keep an eye out for road crossings [15]. Radar sensors are widely used to track surrounding cars. Distances are measured, road edges are detected, and lane markers are identified using Lidar (light detection and ranging) sensors. When parking, the ultrasonic sensor is used in the wheels to sense curbs and other cars. Figure 3 shows the architecture of the Autonomous driving control system.

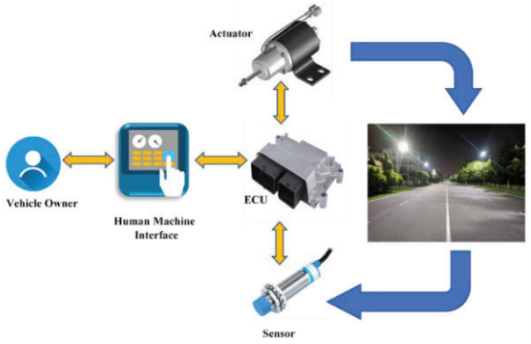

Fig. 3: Autonomous driving control system.

3. Indian Smart Cities and the Existing Traffic Situation

Based on spatial criteria, the central infrastructure of a smart city should concentrate on sufficient residential, adequate drainage, composting, optimal agility, multi-mode mobility, integrated telecoms, connectivity networks, public safety, particularly for women, children, and physically disabled persons, non-polluting environment, better facilities for education and health. India is anticipated to become the globally largest populated country by 2030.

In recent years MoRTH has confirmed that road injuries in Uttar Pradesh exceeded 30,000 in 2019 3). Among towns, with 1,463 deaths, Delhi maintained its first rank. The National Capital Territory (NCT) Delhi was perceived to become the benchmark for the calculation of the national accidents that occurred in India. Road incident statistics are given in Table 1. In smart cities, entrepreneurship, technology, and collaboration skills should be encouraged to build a determined economy. Secure and productive IoT solutions for smart cities can be generated through universal instrumentation by linking physical infrastructure, the business world, and people [16].

Table 1. Road accidents, the number of people killed and wounded in the last five years [3].

Year	Road Accidents (in numbers)	Number of Persons Killed	Number of Persons Injured
2015	5,01,423	1,46,133	5,00,279
2016	4,80,652	1,50,785	4,94,624
2017	4,64,910	1,47,913	4,70,975
2018	4,67,044	1,51,417	4,69,418
2019	4,49,002	1,51,113	4,51,361

3.1 Transformation of Technology to Build a Smart City

For the construction of basic infrastructure and the introduction of smart technologies, the smart city transformation architecture is suggested based on the 19 groups in Fig. 4. To turn a city into a smart city, the suggested structure covers four main areas. Specifically, the planning process, setup, ICT structure, and intelligent technology deployment. This suggested system includes [1)] A comprehensive list of resources and grouping of different services for deployment across major cities [17)] realms in exchange for making a city smart. [2)] A system layout is provided to depict the dynamic process of transforming a city into a smart city. [3)] Numerous smart strategies, such as the use of ICT and emerging technology, as well as service preparation and execution, are coordinated to improve the living environment. [4)] Upgrade an existing smart city or build a new smart city [16)].

4. An approach of AV adaption

4.1 Autonomous Driving Control Structure for Smart Cities

A strategy consisting primarily of information and communication technology (ICT) to develop, enforce and encourage sustainable development activities is needed to address the increasing challenges of urbanization. In essence, this plan involves an intelligent network of machines and objects linked to data transmission through wireless technology. Self-driving cars connecting to a 5G network would now be able to communicate with numerous connectivity components that make up our highways and other mobility networks, in addition to communicating with other vehicles. As the AV system is an evolving form of transport that varies greatly from current modes of public transport, a large number of individuals might be concerned about the use of AVs. It is also necessary to consider the concerns of customers who are potentially using and embracing AV [18), 19)]. The key factors for the adaption of AVs in Indian smart cities are shown in Fig. 5.

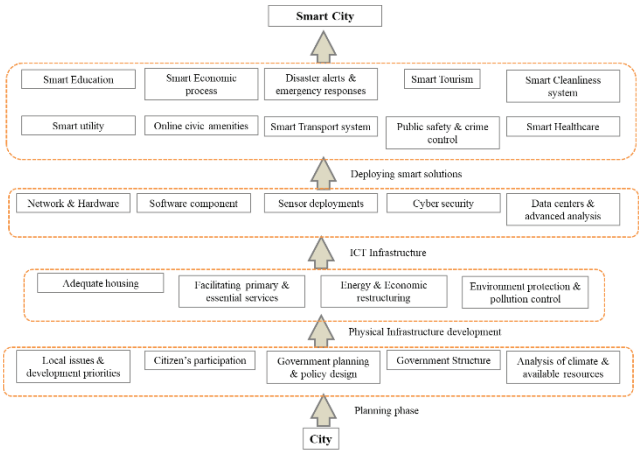

Fig. 4: Proposed framework for smart city transformation.

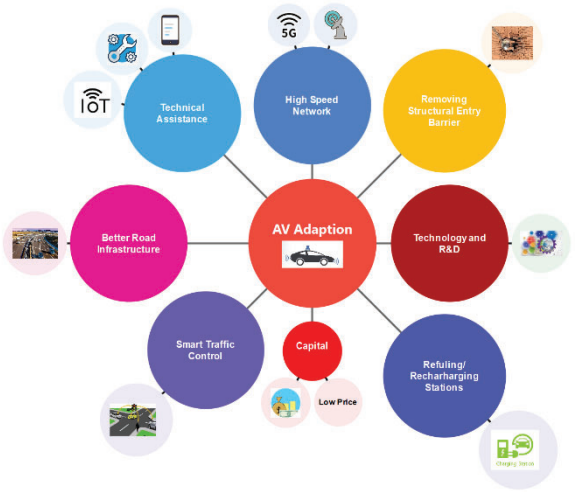

Fig. 5: Autonomous driving control structure

4.2 Scope of AV Technology in India

From Fig. 6, it is apparent that the demand for autonomous vehicle technology in India is the biggest. We are conscious of Indian roads that are popular for the traffic that often leads to congested roads. Due to this, there is a breathtaking increase in the number of road accidents and deaths. Therefore, there is a requirement of autonomous cars in India. As IoT is an emerging field nowadays, thus it will make autonomous vehicles safe. The government of India is pushing electric vehicles [20)] and electric production utilizing renewable energy [21)], therefore electric vehicles may be the first choice for AV adaptation.

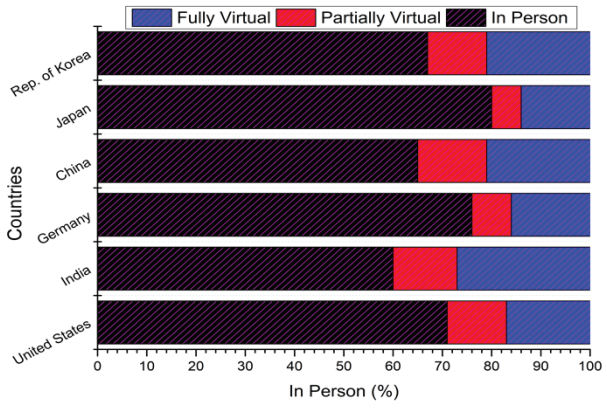

Fig. 6: Consumer's perspective on their next automobile [22)].

4.3 Implementation Problems

Below are the aspects that are exemplary of the fact that the smart city concept has multiple development problems despite being a dream project. The project has been released several times under various titles, but the full ruling is still awaited.

1. When it comes to smart cities, financing is said to be one of the greatest obstacles. There is not so much effect

on state-sponsored enterprises. These schemes can also be funded by banks, although this is the primary explanation for a spike in the amount of non-performing assets. Recently, the government has taken steps to fund these initiatives by introducing budget adjustments.

2. Strong coordination of the center-state will result in a project being better executed. When it comes to preparing for the growth of smart cities, the proper order is expected.

3. The majority of Indian cities do not have their master plans and plans for construction in place. Planning also eliminates the dangers of ambiguity. Growth planning offers certainty and increases the efficiency of the decision-making process for the private sector as well as for state, provincial, or local governments.

4. Facility availability is a big issue in our region. We know that India is not that prepared to build smart cities in terms of qualified manpower and advanced technology requirements.

5. Corruption is the root cause of all the problems listed above. Corruption is responsible for both the lack of coordination and time lag that occurs during the procedures, both at the core and state levels. Because of this issue, the financial constraints are also reflected [23].

Despite the great advantages of AVs, their implementation is uncertain in the future due to different customer concerns such as security, safety, regulatory matters, and privacy [24]. The impact of AV technology will undoubtedly be influenced by political infrastructure. This will be a different experience in India than in Western countries. It is well known that Indian towns and roads are over-crowded, and thorough data analysis of traffic [25] and effective use of AI is required, but the poor network may provide a significant obstacle to AVs. on the other hand, AVs with EVs are deployed, proper charging station planning is essential. The current framework does not include any consumer preference-based research, which should be addressed before the implementation of the proposed framework.

5. Conclusion

The self-driving mechanism extant today is appearing as communication or automation in vehicles, ranging from automatic emergency brakes, path and parking assistance techniques to allow secure driving, to internet access through mobile networks competent of holding car users connected to the online environment. Yet the move towards maximum autonomy would not be a recent or unexpected notion for either of us. Although this technology has enormous potential and could help the Indian smart cities to develop faster. While it is expected that this technology will boost car purchases, which could increase vehicle buying costs, loan costs, and devaluation, which could help lower gasoline costs, the consequences of AV technology are not yet clear enough. Adaption of this technology will greatly benefit the public and Taxi services. It can be said that the AV technology is all ways advantageous to Indian society and should be adapted, though it will require prior arrangements to be implemented.

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