An Introduction Of Autonomous Vehicles And A Brief Survey

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AN INTRODUCTION OF AUTONOMOUS VEHICLES AND A BRIEF SURVEY

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Abstract:
An autonomous car is also called a self-driving car or driverless car or robotic car. Whatever the name but the aim of the technology is the same. Down the memory line, autonomous vehicle technology experiments started in 1920 only and controlled by radio technology. Later on, trails began in 1950. From the past few years, updating automation technology day by day and using all aspects of using in regular human life. The present scenario of human beings is addicted to automation and robotics technology using like agriculture, medical, transportation, automobile and manufacturing industries, IT sector, etc. For the last ten years, the automobile industry came forward to researching autonomous vehicle technology (Waymo Google, Uber, Tesla, Renault, Toyota, Audi, Volvo, Mercedes-Benz, General Motors, Nissan, Bosch, and Continental's autonomous vehicle, etc.). Level-3 Autonomous cars came out in 2020. Everyday autonomous vehicle technology researchers are solving challenges. In the future, without human help, robots will manufacture autonomous cars using IoT technology based on customer requirements and prefer these vehicles are very safe and comfortable in transportation systems like human traveling or cargo. Autonomous vehicles need data and updating continuously, so in this case, IoT and Artificial intelligence help to share the information device to the device. This review paper addressed what the technologies and strategies are used in autonomous vehicles by literature reviews and the gap between them.

Keywords: Artificial Intelligence, Autonomous Vehicles, Automation, Robotics, Sensor Fusion.

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INTRODUCTION:

All over the world eagerly waiting for autonomous cars and researchers thought this vehicle satisfies customers' needs, especially those who feel bore on driving or restless driving [1] [2]. But in some places already hit the road and using also based on geological conditions, fully available navigation system [3][4], etc., It is useful for all aged persons [5] and no need for a driving license[6]. The benefits of an autonomous car are safe to travel (normal humans like take risks means rash driving but autonomous car obey rules and control speed of the vehicle and able to sleep in night time), Time-saving (Time is money), avoiding traffic systems (possible to reduce in peaks times in busy streets), vehicle Parking space (hardly find a parking place in cities), increase the lifetime of the vehicle, save fuel or electric power, pollution-free and reduce the vehicle thefts [7][8]. Disadvantages of autonomous cars are cost, mostly lost driving jobs (Ola, Uber, etc.,) [9][10] and policy-making issues[11][12][13]. Going to the intro of this technology, as per the SAE International's standard J3016 [14] definessixlevelsautonomousvehiclesshownintable1.

Table.1. Levels of Autonomous Cars and Manufacturing Companies

	Level – 0 [15]	**Level – 1 [16]**	**Level – 2 [17]**	**Level – 3 [18]**	**Level – 4 [19]**	**Level – 5 [20]**
System Capability	Fully human assistance	Need human assistance			No human assistance	
Execution of steering & acceleration and Monitoring of driver environment	Driver needed	System Control / Driver needed		System Control		
Vehicle Companies	A 1967 Porsche 911 [21]	Adaptive cruise control[22]	Audi, Cadillac Super Cruise, Mercedes-Benz Driver Assistance Systems, Tesla Autopilot [23], Volvo Pilot Assist.	Audi[24]	Google's defunct Firefly pod-car (Speed Limit 25 MPH)	Waymo [25]

The present researcher crossed level 3 scenarios and hit the road also [26]. Research is a never-ending process, so all the researchers are focused on level 4 and level 5 [27]. This means no human assistance, full system control using Artificial intelligence technology [28]. Many researchers and experts are believed that level 4 and 5 technology helps the society like

reduce the environmental issues [29], traffic problems and time-saving of the customers, etc.,

Research Journey of Autonomous cars :
Let us review the journey of autonomous car shown in table 2.

Table.2. Research Journey of Autonomous cars

Year	Car Manufacturing name
1920	Houdina Radio Control [30], Chandler Motor Car[31]
1930	General Motors [32][33]
1950	Radio Corporation of America [34], General Motors Firebird [35]
1960	Ohio State University [36], Citroën DS [37], Bendix Corporation, Stanford University, Coordinated Science Laboratory University of Illinois at Urbana–Champaign [38]
1980	Mercedes-Benz [39], Defence Advanced Research Projects Agency , Carnegie Mellon University [40], Environmental Research Institute of Michigan, SRI International, HRL Laboratories
1990	VaMP [41], Vita-2, Jaguar Cars, Carnegie Mellon University – Navlab [42], S-Class Mercedes-Benz, Park Shuttle, People mover
2000	National Institute of Standards and Technology [43], DARPA [44], Radio-frequency identification, Royal Academy of Engineering [45], Toyota [46], Aluminium division of Rio Tinto [47], Google [48].
2010	General Motors, Ford Motor Company, Mercedes-Benz, Volkswagen, Audi, Nissan, Toyota, BMW [49], Volvo [50], Freie Universität Berlin, Karlsruhe Institute of Technology, Infiniti Q50 [51], Google [52], Tesla [53][54], Waymo [55].
2020	Waymo, Tesla, Argo AI, GM Cruise, VIT University [56] and some research and development centres.

In 1925, Houdina radio control worked on the radio-controlled autonomous vehicles and tested on New York streets in a dynamic environment. Later in 1926, the chandler motor car company added the transmitting antenna on the vehicle, and it was controlled by one person in another vehicle, then its send out and receives the radio signals of the following vehicle. In 1939, General Motors equipped by radio-controlled electric cars by electromagnetic fields available of circuits embedded in the sideways of the road. In 1953, Radio Corporation of America successfully launched a prototype car, and it is controlled by weirs and tested in U.S Route 77 and Nebraska Highway 2. In the 1960s, Ohio State University developed a driverless car operated by electronic devices and embedded in the roadways. In the 1970s, Bendix Corporation launches and tested the driverless car, and it is controlled by buried cables, operated by roadway communicators, and reposing computer messages.

In the 1980's Mercedes-Benzes robotic van designed and tested at a speed of 63km/h on the road without traffic. In the same decade, some universities' with the DARPA team and SRI internationals conducted research and developed the autonomous vehicle. And first-time Lidar, computer vision and robotics control system technology used and tested at a speed of 31KMPH. Finally, Carnegie Mellon university lunch's new technology is called a neural network to control the autonomous vehicle. In 1994 semi-autonomous vehicles developed by Daimler-Benz and Uni-BwM research center developed and tested more than 1000KMPH on a Paris highway in heavy traffic at a speed of 130kmph. In 1995, Carnegie Mellon university's researchers completed the 98.2% autonomous controlled vehicle. And it is tested almost 5000KMPH traveled across the U.S country; they called No Hands across America. These researchers are using neural network technology for controlling the steering and remaining all controlled by a human for safety control. In 1998 Toyota manufacturer first introduce an adaptive cruise control system. In 2000, US government funded unmanned ground vehicles for using military applications for navigate the off-line road paths and obstacle avoidance. In 2009, Google started research in self-driving cars privately. In 2010, major automobile industries started research in autonomous vehicles. Audi first time released and tested a driverless car AudiTTS in mountain. In 2011, General Motors also released Electric Networked vehicle. In 2012, Volkswagen created temporary auto pilot (TAP) and tested in a highway at a speed of 130km/h. In 2013 Toyota created semi-autonomous vehicle with sensors and communication systems. In 2014, Mercedes S-class released in market with many autonomous options in city and highway traffic at a speed of up to 200KMPH. Tesla Motor also created first version of Auto pilot Model S with semi-autonomous vehicle. Later updated software again released new model. SAE International published 6 standard levels of automotive system. In 2015, Volvo car released level 3 autonomous car, but hitted the road on 2017. In 2017, Audi also started a new model of A8 with full autonomous options and speed limit also up to 60kmph using its Audi AI [57]. In 2020, all automotive industries trying research to level 5 autonomous vehicles.

Sensors Technology:
Basic Principal of the sensors are detects physical qualities in the real world. In Section II, explained about the autonomous vehicles research journey. Initially they used for communication radio frequencies later on the that upgraded to right now using different types of sensors for each working process shown in Fig.1.Present Autonomous vehicles mainly need localization system (position & orientation). By using Dead Reckoning [58] and Perception [59] methods find out the localization system explained in Fig 2.

Dead Reckoning working principal is measure the current position by using previous available data. GPS closed loop system is best suitable sensor for measure Dead Reckoning. Real time Kinematic (RTK) [60] and Differential Global Positioning System (DGPS) [61] sensors are using for measure High Precision data. Perception system, for read the external world, obstacle

avoidance, Cameras, Radar, Lidar and Ultrasonic sensors used. Cameras, it uses depending upon vehicle requirement configuration and weather conditions.

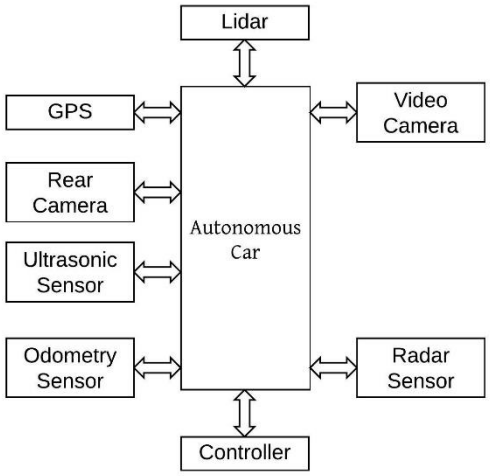

Fig 1. Architecture of Autonomous Car

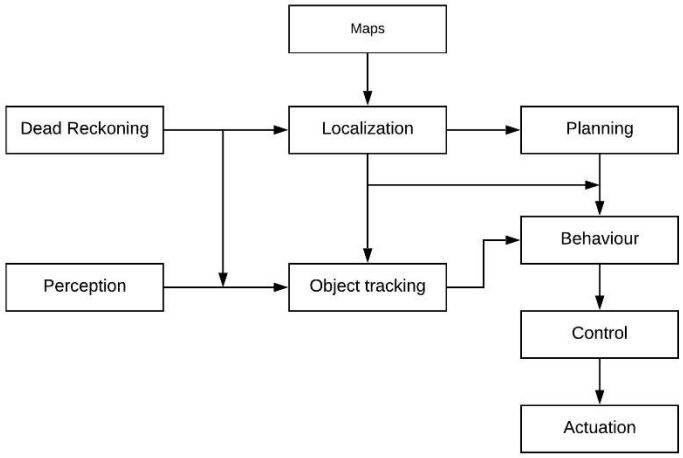

Fig.2. Block diagram of Localization and control system

Radar, It is long range sensor depends upon different wave lengths (24 GHz and 77GHz). The working principle is detect the reflections form the object and emitted the radio frequency waves form sender to object. Lidar (Light Detection and Ranging) is the mid-range sensor, it sense the object at minimum distance only. Main drawback this Lidar sensor is if distances increase beam will spread. It works based on the light pulse (~905nm or 1550nm) and it produces 3D data. Some Lidar sensors are working on electromagnetic-beam steering. It can be used for identify the traffic signs. Ultrasonic sensors, similar to radar sensor but use high frequency sound wave (20KHz). And short range sensors (up to ~ 5m). Mostly these sensors used in park assistance applications, V2X communications [62] and high definition maps. Other than these sensors V2V communications [63], Computer vision technologies also used in Autonomous vehicles.

For all these sensors equipped, calibration and time to time synchronous is the main challenges of the sensor fusion.

Survey report conducted in India :

This survey conducted for public opinion about autonomous car technology and randomly chosen peoples in metropolitan, urban, suburban, and rural areas in India. The study submits and filtered responses from 982 responses.

The questionnaires are:

Table 3. Survey responses

Questionnaires'		Percentage			
		Metropolitans = 347	Urban S = 331	Rural S = 304	Total S = 982
Q1. Age	18 to 25	23.9	24.5	18.4	22.26
	25 to 35	26.4	25.7	14.5	22.2
	35 to 45	21.5	22.7	21.32	21.48
	45 to 55	17.5	21.8	24.7	21.33
	Above 55	10.6	13.1	14.5	12.73
Q2. Gender	Male	52.5	51.6	51	51.7
	Female	47.5	48.4	49	48.3
Q3. Education	Less than graduation or equal	61.4	57.4	62.7	60.5
	Post-graduation & above	38.6	42.6	37.3	39.5
Q4. Employment	Yes	40.8	41.4	43	41.73
	No	33.3	30.1	34.5	32.63
	Retired	9.5	8.1	6.7	8.1
	Searching	16.4	20.4	15.8	17.53
Q5. Own Car	Yes	40	22	23	28.33
	No	60	78	77	71.66

Survey results:

Q6. Familiarity about Autonomous Cars.

This survey proved that majority of people Known about autonomous vehicle technology. In metropolitan and urban places (on average, 56%) and rural places, only 40% of people are aware of this technology. The above results show in Fig 3.

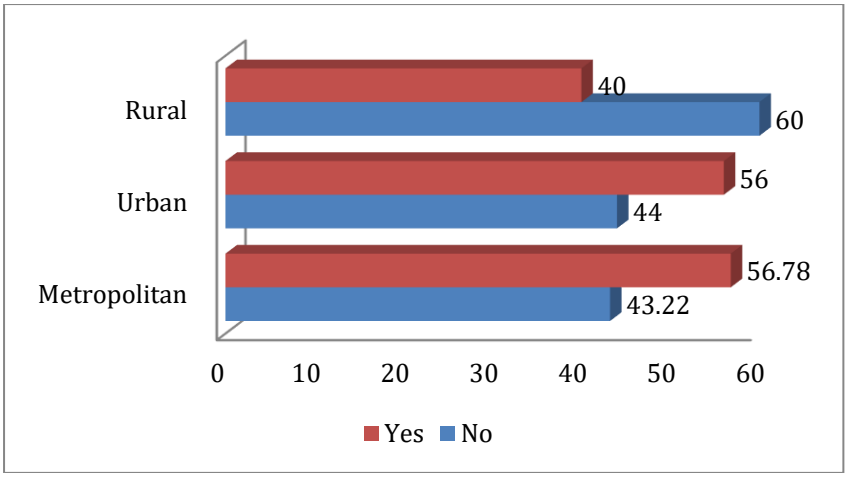

Fig 3. Responses of Have you ever heard or read about an autonomous Car?

Q7. Will you accept autonomous car technology suitable in Indian transportation systems?

For this query majority of people responded yes except rural area people. The primary reason is in a rural area may be a lack of awareness and transportation system in their regions. These survey results are shown in Fig 4.

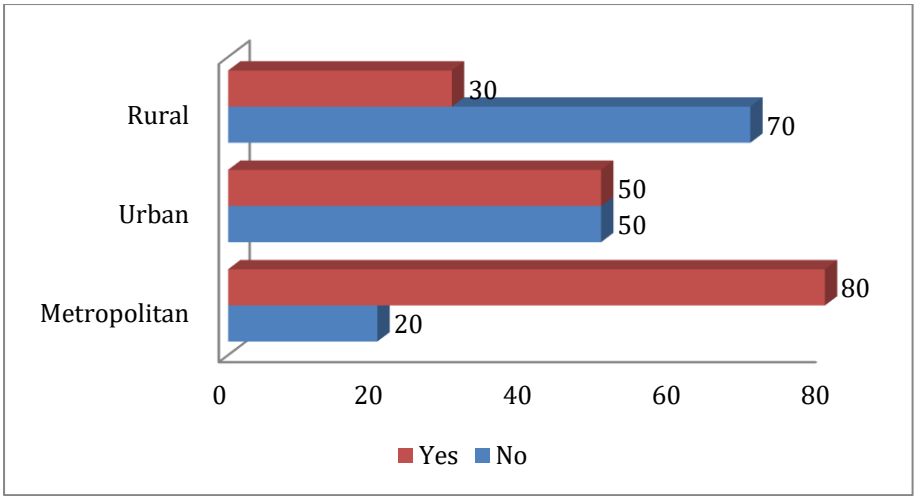

Fig 4. Responses of Will you accept an autonomous Car in India?

Q8. what type of activity interest in doing in an Autonomous car?

In this survey, passengers choose how they spend travel time in a fully autonomous mode. 39% respondents work in the car, 18% respondents observing the technology of the vehicle, 12% respondents choose sleeping or relaxing option, 11%respondents are reading the books, magazines, and newspapers, etc.,10% respondents use their electric gadgets, 7% least respondents do eating, drinking and smoking.

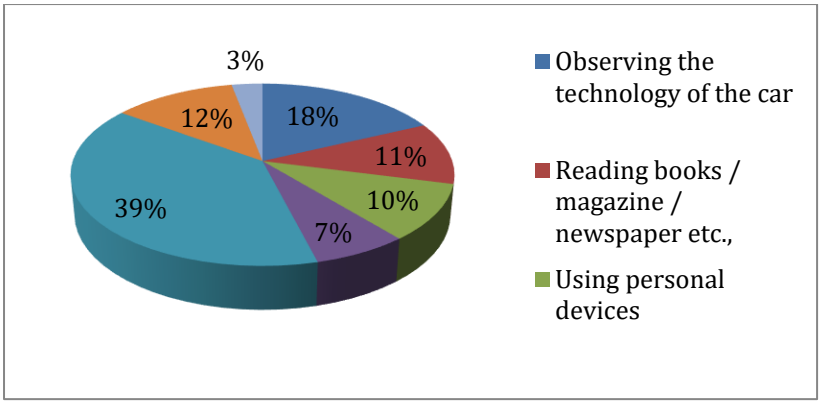

Fig 5. Responses of Most popular activities do inside the autonomous car.

CONCLUSIONS:

Overall the survey respondents, mostly interested in autonomous vehicle technology and waiting for ready to travel in the AVs. But in India, the primary problem is a traffic control system. Only Metropolitan areas only following full traffic systems other than urban and rural areas if weather and roads are in the right conditions. Our road transport and highways minister Nitin Gadkari said driverless cars would not be allowed in India because the government will not promote any technology that comes at the cost of jobs [64]. But coming decades, mostly all transportation systems inevitably adopt autonomous technology, and it is an excellent opportunity for improving education levels.

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