CONCEPT OF AUTONOMOUS VEHICLES IN AUTOMOTIVE WORLD

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Abstract - *Now a day's huge technological development around the world. The era of self-driving car is not far. Autonomous vehicles (driverless, self-driving and robotic vehicles) are having travel demands and transportation planning in near future. Many car manufacturers trying to implement self-drive cars. Tesla Inc. company already implemented such technology in its cars. Driverless cars are designed to operate safely and autonomously without requiring human intervention. They won't have a steering wheel, accelerator or a brake pedal because they don't need them, software and sensors do all the work. It takes humans where they want to go at the push of a button. This Technology step towards improving road safety and transforming mobility for millions of people.*

Key Words: *Artificial Intelligence, Hardware Sensors, Maps, and Driverless car.*

INTRODUCTION:

Autonomous vehicles have long been prediction in automotive industry. In past few years, major corporations have announced plans to begin and sell vehicles in a few years called as Tesla Inc. Autonomous cars use various kinds of technologies to operate in an efficient manner. They are built with GPS sensing knowledge to help with navigation. Use of different types of sensors and other tools helps to avoid collisions. By use of technologies such as augmented reality, vehicle displays information to drivers in new and innovative ways.

HISTORY OF AUTONOMOUS VEHICLE:

Vision's of AVs and automated highways in the mid-20th century remained largely in the eye of futurists and science fiction enthusiasts. In 1958, for example Disney aired a program titled "Magic Highway USA" that imagined a future with, among other technologies, AVs guided by colored highway lanes and operated with addresses coded on punch cards. It was not until the mid-1980s that the underlying computing and other technologies needed to realize (and revise) these visions truly became available. The advances made in the last 25 years can be understood in terms of these successive waves of developmental gains.

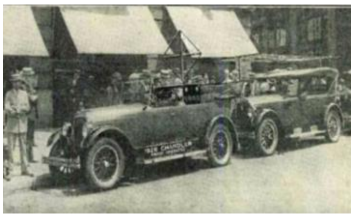

Fig – 1: World's first Radio controlled AV

CONCEPT OF AUTONOMOUS VEHICLE:

An Autonomous vehicle (sometimes referred as automated car or self-driving car) is a robotic vehicle that is designed to fulfilling the transportation capabilities without a human operator. Qualifying to it as fully autonomous, vehicle must be able to navigate without human input to the destination that is predetermined over UN adapted roads and is capable to sense the environment. Audi, BMW, Google, Ford are some of the companies developing and testing these vehicles. Technologies making a system fully autonomous are Anti-Lock Brakes (ABS), Electronic Stability Control (ESC), Cruise control, Lane Departure Warning System, Self-Parking, Sensors, and Automated Guided Vehicle Systems.

AUTONOMOUS DRIVING LEVELS:

- **AUTONOMOUS DRIVING LEVEL 0:**

There is no degree of driving automation. All driving-related tasks will have to be performed by the driver himself.

- **AUTONOMOUS DRIVING LEVEL 1:**

In this case, the vehicle has some form of driving automation system. This would be a driving assistant. The vehicle has some driving automation system, whether for longitudinal control or for lateral control, but not for both at the same time.

- **AUTONOMOUS DRIVING LEVEL 2:**

Assistance systems such as an example, be included in level 2. In level 2, the vehicle has driving automation systems both for longitudinal control and for lateral control at the same time.

- **AUTONOMOUS DRIVING LEVEL 3:**

This level implies a technological and legal leap, since under specific conditions (highways, slow-speed driving, or in good weather) the driver could relinquish full control to the system, being able to perform other tasks in parallel, such as reading or using his mobile phone. However, he would not be authorized to sleep. In this level, the driver would have to be prepared to intervene if prompted by the system, or if some failure occurs.

- **AUTONOMOUS DRIVING LEVEL 4:**

Level 4 implies a high level of driving automation. Cars at this level no longer need a driver that is ready to intervene at the request of the system or in case of failure. The vehicle itself includes a system to act in these cases. At level 4, the notion of a driver no longer exists, however, the system still has limitations, and certain situations may emerge in which the vehicle may no longer be able to drive itself and needs to stop.

- **AUTONOMOUS DRIVING LEVEL 5:**

At level 5 it is full driving automation. These are autonomous vehicles in the strictest sense of the word. The driver is no longer necessary.

COMPONENTS OF AVs

Under the bonnet it integrates three constituents:
1. Google Maps
2. Hardware Sensors
3. Artificial Intelligence

1. GOOGLE MAPS:

The Global Positioning System (GPS) is also known as space-based global navigation satellite system (GNSS) it provides information such as location and time in all weather conditions. Now a days each and every automotive equipped with GPS system in case of self-driving car GPS has unique functionality. The main functionality is to collect various real time data, time line history, data map, speed of the vehicle etc and make perfect movement of vehicle. It helps to get new clear road, diversions, caution regarding dead end of the road, so the self-driving car can move easily. It is high resolution global positioning system.

2. HARDWARE SENSORS:

Real time and dynamic Environmental conditions (properties) attained by the car. To need real time results, sensors are attempted to create fully observable environment. These hardware sensors are lidar, video camera, position estimator, distance sensor, aerial and computer.

A. LIDAR:

(Light Detection And Ranging also LADAR) is an optical remote sensing technology which Is used to measure the distance of target with illumination to light in the form of pulsed Laser. It is a laser range finder also known as "heart of system", mounted on the top of the spoiler. A detailed #-D map of the environment is generated by the device velodyne 64-beam Laser (for autonomous ground vehicles and marine vessels, a sensor named HDL-64E LIDAR is designed for obstacle detection and navigation. Its scanning distance Is of 60 meters (~ 197 feet). For 3D mobile data collection and mapping application This sensor becomes ideal for most demanding perceptions due to its durability, very High data rates and 360-degree field of view. One-piece design patented the HDL-64e's Uses 64 mounted lasers that are fixed and each of it is mounted to a specific vertical Angle mechanically with the entire spinning unit, to measure the environment surroundings. Reliability, field of view and point cloud density is dramatically increased by using this Approach.) High resolution maps of the world are combined by the car laser measurement to produce different types of data models that allows it to drive itself, avoiding obstacles and respecting traffic laws. A LIDAR instrument consists of a Laser, Scanner and a Specialized GPS receiver, principally.

- **LIDAR DATA COLLECTION:**

A beam of light is reflected by the surface when it encounters with the Laser that is pointed at the target area. To measure the range, this reflected light is recorded by a sensor. An orientation data that is generated from integrated GPS and Inertial

Measurement Unit System scan angles and calibration with position. The result obtained is a dense, and "point cloud" (A detail rich group of elevation points consists of 3D spatial coordinates i.e. Latitude, Longitude and Height).

Fig – 2: Velodyne LIDAR

B. VIDEO CAMERA:

A sensor that is positioned near to the rear-view mirror that detects the upcoming traffic light. It performs the same function as the mildly interested human motorist performs. It reads the read signs and keeps an eye out for cyclists, other motorists and for pedestrians.

Fig – 3: Cameras for AVs

C. POSITION ESTIMATOR:

An ultrasonic sensor also known as (Wheel Encoder) mounted on the rear wheels of vehicle, determines the location and keep track of its movements. By using this information, it automatically updates the position of vehicle on Google Map.

D. RADAR:

Radio Detection and Ranging works similar way of a lidar except to know the distance of an object, distance and speed it uses radio signals. Radar is used as object-detection system which contains electromagnetic waves to check the range, direction and speed of moving as well as fixed objects. It enables self-driving car to maintain perfect distance between preceding and following cars by increasing or decreasing speed of the car that is without using driver.

Fig – 5: Long-range RADAR

E. ULTRASONIC DISTANCE SENSOR:

Other sensors which include: four radars, mounted on both front and rear bumpers are also carried by this autonomous vehicle that allows the car to "see" far enough to detect nearly or upcoming cars or obstacles and deal with fast traffic on freeways.

Fig – 6: Ultrasonic distance sensor

F. AERIAL:

A highly accurate positioning data is demanded by a self-navigating car. Readings from the car's onboard instruments (i.e. Altimeters, Tachometers and Gyroscopes) are combined with information received from GPS satellites to make sure the car knows exactly where it is.

G. COMPUTER:

Car's central computer holds all the information that is fed from various sensors so to analyze the data, steering and acceleration and brakes are adjusted accordingly. Not only traffic laws, but also the unspoken assumption of road users is needed to understand by the computer.

3. ARTIFICIAL INTELLIGENCE:

Artificial Intelligence provides the autonomous car with real time decisions. Data obtained from the Hardware Sensors and Google Maps are sent to A.I for determining the acceleration i.e. how fast it is; when to slow down/stop and to steer the wheel. The main goal of A.I is to drive the passenger safely and legally to his destination.

Fig – 7: Artificial Intelligence

ELECTRONIC CONTROL UNIT:

The automotive industry is in a transition phase, while the first vehicle generations were dominated by mechanics. In a subsequent era, electronics were introduced, also partially replacing mechanics (known as "electrification"). Now the automotive industry is heading towards connected vehicles, both car to car and car to Infrastructure, which will eventually also support fully autonomous driving. The main driving factor behind this is the reduction of fatalities and accidents and if we realize that more than 90% of all car accidents are caused by human failures, self-driving cars will play a crucial factor in accomplishing the "zero accident" vision of the automotive industry.

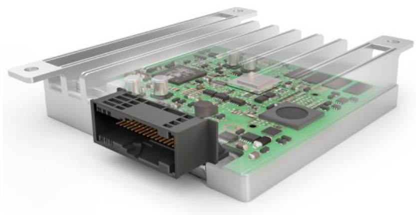

FIG – 8: ECU for AVs

Autonomous vehicles will not happen at once; a gradual introduction can be expected following from six subsequent levels defined by the Society of Automotive Engineers (SAE). These levels range from no automation via, amongst others, conditional automation to full automation (even when for the highest level of automation legal aspects need to be clarified). With increasing levels of automation, the vehicle will take over more functions from the driver, like control of speed and steering up to complete control of the vehicle. In addition, when automation levels increase, there will be a need for more processing power and sensors, with associated network bandwidth. This certainly may also lead to new car networks and associated future ECUs.

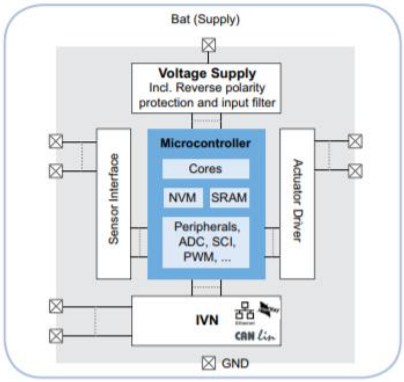

Fig – 9: Main block of ECUs

- **DOMAIN BASED VEHICLE NETWORKS:**

In a vehicle network that is based on multiple domains is shown. One important enabler for this architecture is the introduction of automotive qualified Ethernet PHYs and switches. Ethernet technology serves as a communication backbone. Furthermore, it follows that there will be several domain controllers. One example of this is the Advanced Driver Assistance Systems (ADAS) domain controller which is key for the enablement of (semi) autonomous vehicles. For this controller NXP offers the BlueBox as a development platform. The BlueBox engine processes multiple streams of sensor data, which can come from cameras and RADAR or LiDAR, the support of sensor fusion is a powerful key and crucial feature for autonomous vehicles.

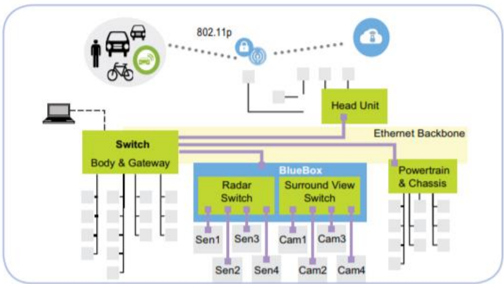

Fig – 10: Domain based network

ACTUATORS:

Always evolving, the automotive sector usually offers numerous drive solutions aimed at improving the comfort and safety of the members of a vehicle. Automotive actuators are perhaps the least known pieces but the ones that most have influenced the emergence of new movements.

Automotive actuators, as tools that print a force to move a mechanical device, can exert their strength with a hydraulic, pneumatic, magnetic or electrical dimension. In small movements that do not require the displacement of heavy elements, just an electromechanical device or actuators driven by a small gear motor.

TYPES OF ACTUATORS:

Pneumatic: they generate a force or resistance through air pressure. We could find them in the systems of tailgate lifting.

Hydraulic: they are actuators that generate the movement from the displacement of fluids (valves of a variable suspension system).

Electromagnetic: those based on electromagnetism, either through a magnet or an electromagnet. These are usually used in those mechanisms of the vehicle operating with electric current.

Gear motors or electric: drives where a motor intervenes: brushless, broom.

- **STEERING WHEEL:**

The regulation of the steering wheel position according to the driver, is a widespread movement which improves the comfortableness of driving. Through a linear actuator, is possible to draw the steering wheel closer or further in search of the most suitable position.

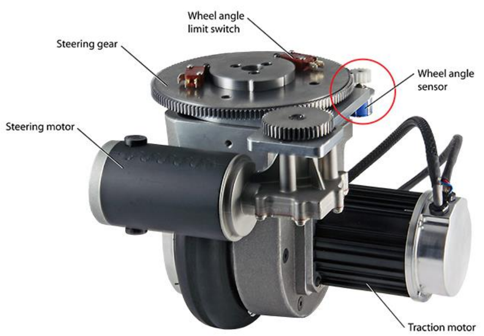

Fig – 11: Electric Steering Wheel Actuator

- **BRAKE ACTUATOR:**

Clearly, central controls such as braking is of the utmost importance in a self-driving vehicle. Electrification and the introduction of brake-by-wire technologies are also changing the landscape for brake systems, and innovations in the field will need to achieve remarkable levels of functional safety and redundancy.

The Society of Automotive Engineers (SAE), in light of these trends, has recently updated its Main Brake System Requirements to be followed by OEMs and Tier 1 suppliers. These include:

- Priority 1: Vehicle Deceleration: In any failure mode, appropriate deceleration must be achieved. The basic rule being that the higher the autonomous vehicle man oeuvre speed, the higher the deceleration in degraded mode should be.

- Priority 2: Vehicle Stability: During braking man oeuvre in any first failure mode, the locking of the rear wheels must be avoided.

- Priority 3: Vehicle Steerability: During braking man oeuvre in any first failure mode, the locking of the front wheels must be avoided.

- Priority 4: Secure Standstill: A vehicle that has been brought to a standstill in any first failure mode must be secured independently in that standstill for an infinite time period - typically solved with an independent actuator park brake or gear lock.

Fig – 12: Braking System of Bosch

- **THROTTLE CONTROL:**

The original throttle system operated on a continuously variable potentiometer that changed its value from 5500 when the acceleration pedal is at rest, to 0 when the pedal is fully compressed. The simplistic nature of this mechanical system makes it easy to electronically replicate. There were two replacement control systems the team considered: a linear actuator to physically compress the acceleration pedal, or manipulate the existing electrical system.

WORKING OF DRIVERLESS CAR:

- Destination is set by "The Driver "and software of car calculates a route and starts on its way.
- LIDAR, a rotating, roof mounted sensor monitors and scanners a range of 60- meters around the surroundings of car and creates rudimentary detailed 3-D map of immediate area.
- An ultrasonic sensor mounted on left rear wheel monitors movements to detect position of the car relative to 3-D map.
- DISTANCE SENSORS mounted on front and rear bumpers calculate distances to obstacles.
- All the sensors are connected to Artificial intelligence software in the car
- VIDEO CAMERAS and street view.
- Artificial Intelligence stimulates the real time decisions and human perceptions control actions such as acceleration, steering and brakes.
- The surface installed in the car consults with GPS for advance notification of things like landmarks, traffic signals and lights.
- To take control of the vehicle by human is also allowed by override function.

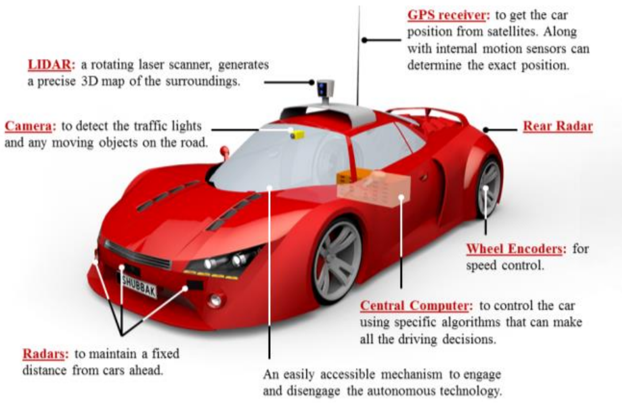

Fig – 4: Working of AVs

SAFETY OF AUTONOMOUS VEHICLES:

The new car is the next evolution of Google's self-driving car. While the new frame is untested, the company's previous versions have clocked up over 700,000 miles of testing on public roads, mainly around California, including over 1,000 miles of driving in the most complex situations and cities like San Francisco's hills and busy streets. The car itself is limited to 25 mph, which restricts it to certain roads, but also minimizes the kinetic energy it could carry into a crash if one should happen. The front of the car is also made to be as kind to pedestrians as possible with a foam bumper and a flexible windscreen that is designed to absorb energy from an impact with a person's body. Seat belts are also provided – a safety requirement for vehicles on the road – while the car has redundant systems, a "fault-tolerant architecture" as Google calls it, for both steering and braking, should the primary systems fails; plus the emergency stop button that passengers can hit at any time. Google has also taken the data and behaviors it learned from its previous vehicles to create a defensive, considerate driving style that is meant to protect both the passengers and other road users. For instance, the car will wait a second after the traffic lights turn green before it moves off, although this could incur the anger of drivers stuck behind it. Google also says that making it drive in a natural and predictable way has been one of the key goals, so that it behaves in a familiar way on the road for other drivers. A laser sensor on the roof constantly scans the surroundings.

ADVANTAGES OF AUTONOMOUS VEHICLES:

- Without the need for a driver, cars could become mini leisure rooms. Without the need for controls, there would be more space available inside the vehicle and no need for passengers to face forwards.

- Entertainment technology, such as video screens, could be used without any concern of distracting the driver.

- Human drivers notoriously bend rules and take risks, but driverless cars will obey every road rule and posted speed limit.

- Over 80% of car crashes in the US are caused by driver error. There would be less user errors and fewer mistakes on the roads if all vehicles became driverless. Drunk and drugged drivers would also be a thing of the past, and passengers might even sleep without risking safety.

- Travelers would be able to journey overnight and sleep for the duration.

- Traffic could be coordinated more smoothly in urban areas to prevent bottlenecks and traffic jams at busy times. Commute times could be reduced drastically.

- Driving fatigue and getting lost would be things of the past.
- Sensory technology could potentially perceive the environment better than humans could, seeing farther ahead, better in poor visibility, and detecting smaller and more subtle obstacles. Plus, several cameras might be used at once, and cameras have no blind spots, so they will be more aware and vigilant than a human driver ever could be.
- Speed limits could be safely increased, thereby shortening journey times.
- Difficult maneuvering and parking would be less stressful and require no special skills. The car could even just drop you off and then go park itself.
- People who have difficulties driving—such as disabled people, older citizens, and children—would be able to experience the freedom of solo car travel.
- There would be no need for drivers licenses or driving tests.
- Presumably, with fewer associated risks, insurance premiums for car owners would go down.
- Efficient travel also means fuel savings, simultaneously cutting costs and making less of a negative environmental impact.
- Greater efficiency would mean fewer emissions and less pollution from cars in general.
- Reduced need for safety gaps, lanes, and shoulders means that road capacities for vehicles would be significantly increased.
- Passengers should experience a smoother riding experience.
- Self-aware cars would lead to a reduction in car theft.

DISADVANTAGES OF AUTONOMOUS VEHICLES:

- A self-driving car would be unaffordable for most people, likely costing over $100,000.
- Truck drivers, taxi drivers, Uber/Lyft, and other delivery people will eventually lose their jobs as autonomous vehicles take over.
- A computer malfunction—even just a minor glitch—could easily cause a far worse accident than anything human error might typically incur.
- Autonomous cars notoriously have trouble navigating crowds of pedestrians. They have trouble distinguishing and determining human intention on the roads.
- Since driverless cars obey all the rules and regulations, this means that both the individual vehicle and the larger flow of traffic might be slower and less organic. These vehicles are said to behave like student drivers: slow, conservative, and timid. On a road shared with human drivers, they may be annoying to navigate around for human drivers.
- If the car crashes without a driver, who's fault is it: the software designer or the owner of the vehicle? Driverless systems will definitely trigger many debates about legal, ethical, and financial responsibility.
- The cars would rely on the collection of location and user information, creating major privacy concerns.
- Hackers getting into the vehicle's software and controlling or affecting its operation would be a major concern.
- Maintenance would have to be overseen. Some process of governmental oversight would have to be instated to make sure every driverless car is mechanically sound and up-to-date.
- Autonomous vehicles have difficulty operating in certain types of weather. Heavy rain interferes with roof-mounted laser sensors, and snow can interfere with cameras.
- Reading road signs is challenging for a robot. GPS and other technologies might not register obstacles like potholes, recent changes in road conditions, and newly posted signs.
- As drivers become more accustomed to not driving, their proficiency and experience will diminish. Should they then need to drive under certain circumstances, there may be problems.
- The road system and infrastructure would likely need major upgrades for driverless vehicles to operate on them. Traffic and street

lights, for instance, would likely all need be altering.

- Self-driving cars would be great news for terrorists, as those vehicles could be loaded with explosives and used as moving bombs.
- Ethical dilemmas could arise which a machine might struggle to deal with. Faced with a choice between plowing into a group of schoolchildren or going off a bridge and killing all its passengers, what will the vehicle do? Should the vehicle always swerve to avoid animals in the road or always prioritize the safety and comfort of passengers?
- Human behavior—such as heavy foot traffic, jaywalkers, and hand signals—are difficult for a computer to understand. In situations where drivers need to deal with erratic human behavior or communicate with one another, the driverless vehicle might fail.

CONCLUSION:

This paper discusses basic chronology leading to the development of autonomous cars. Autonomous vehicles developed from the basic robotic cars to much efficient and practical vision guided vehicles. The development of Mercedes- Benz vision guided autonomous van by Ernst Dickmanns and his team gave a paradigm shift to the approach followed in autonomous cars. Also, contemporary developments in autonomous cars reflect the vivid future autonomous cars behold. Official future predictions about autonomous cars point out that most automobile companies will launch cars with semi and fully autonomous features by 2020. Most cars are expected to be fully autonomous by 2035, according to official predictions as cited earlier.

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