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Advanced Automotive Technologies

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Abstract: ***Currently all the eyes are watching automobile industry to minimize the environmental hazards that are causing due to vehicle emissions. In this Paper alternative energy sources were highlighted that can substitute the IC engines. Industry is evolving rapidly in terms of energy management, metal usage, product lifecycle, prioritizing the passenger comfort rather than easy designable ergonomics, linkage of electronics with mechanical subsystems, introduction of ADAS, usage of mixed plastics to reduce the gross weight, alternative eco-friendly battery chemistries and Automation in cars.***

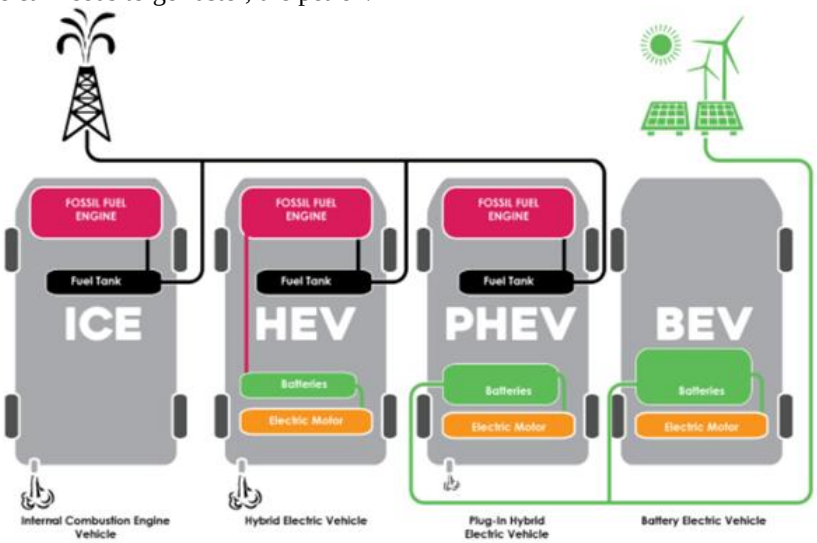
Keywords: BIW, reinforced plastics, BEV, PHV, HEV, HFEV, ADAS, Automation

1. Introduction

As the world is stepping towards sustainable development, there are revolutionary technological changes taking place in Vehicles. All the original equipment manufacturers are transforming their production from Combustion to Electric, Hybrid and Fuel cell Powertrain Systems. Also, substitution of Vehicle body and BIW metals with reinforced plastics, High strength steel and sheet Aluminum etc., materials made vehicles lightweight and better build quality. Advanced electronic actuators and improved mechanical systems results in safe ride of the passengers.

Latest Power train Systems

1) Battery Electric Vehicles (BEV's): A battery electric vehicle, pure electric vehicle, only-electric vehicle or all-electric vehicle is a type of electric vehicle that exclusively uses chemical energy stored in rechargeable battery packs, with no secondary source of propulsion (e. g. hydrogen fuel cell, internal combustion engine, etc. BEVs use electric motors and motor controllers instead of internal combustion engines for propulsion. They derive all power from battery packs and thus have no internal combustion engine, fuel cell, or fuel tank.
2) Hybrid Electric Vehicles (HEV's): HEVs are predominately normal petrol / diesel cars. Their very small battery typically either helps the car go further and/or improves its performance (such as acceleration). The car will often run on the battery alone at low speeds. As soon as the car needs to go faster, the petrol / diesel engine kicks in. The driver of a HEV will hear the petrol /diesel engine running most of the time. During regenerative braking, the electric motor captures electric energy generated by the rotating wheels and stores it in the battery. Although HEVs aren't considered electric vehicles, they do certainly utilize electric power for smaller engines and many of the vehicle's accessory functions such as lights and sound system, and when the vehicle is stopped it helps reduce engine idling.
3) Plugin Hybrid Vehicles (PHV's): PHV's are the vehicles with both an electric motor powered by a rechargeable lithium-ion battery and a petrol-powered internal-combustion engine, but it will only use the latter as a back-up plan should the electric motor run out of charge, which will come as a comfort to drivers who have range anxiety. To recharge the electric part of the system-the battery-you simply plug the PHEV into a charger (or into the PowerPoint in your garage if you don't have a specific charging wall box installed at home).
4) Fuel cell Electric Vehicles: Fuel cell electric vehicles are different from other electric vehicles. Instead of a rechargeable battery, they use fuel cells that generate electricity through a reaction between hydrogen and oxygen. They have to be re-fueled at hydrogen charging stations. The electricity from the fuel cell then powers an electric motor, which powers the vehicle just like a BEV.



Emerging Chemistries of Energy Storage Systems:

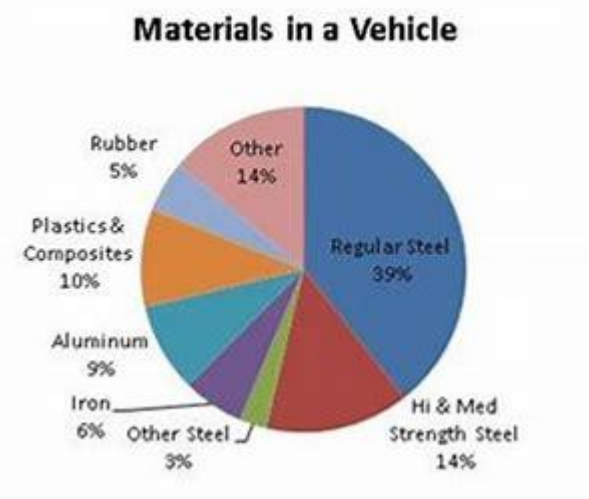
1) Lithium ion batteries: Lithium ion batteries have a wide range of applications lithium-ion batteries, were initially developed and commercialized for use in laptops and consumer electronics. With their high energy density and long cycle life they have become the leading battery type for use in EVs.
2) Aluminum air batteries: Aluminium–air batteries produce electricity from the reaction of oxygen in the air with aluminium. They have one of the highest energy densities of all batteries, but they are not widely used because of problems with high anode cost and by-product removal when using traditional electrolytes. This has restricted their use to mainly military applications. However, an electric vehicle with aluminium batteries has the potential for up to eight times the range of a lithium-ion battery with a significantly lower total weight. These batteries are primary cells, i. e., non-rechargeable.
3) Sodium sulphur batteries: The sodium sulphur battery is a high-temperature battery. It operates at 300°C and utilises a solid electrolyte, making it unique among the common secondary cells. Although the reactants, and particularly sodium, can behave explosively, modern cells are generally reliable. From a technological point of view, the sodium-sulfur battery is very promising as it has very high efficiency (about 90%), high power density, a longer lifetime (4500 cycles), and 80% discharge depth.
4) Magnesium ion batteries: Magnesium battery is very durable and storable since it always has a protective cover which is naturally formed on the surface of the magnesium anode. It has a very good self life; it can be stored for a long time even under high-temperature. This battery can be stored up to 5 years at the temperature 20oC. It has twice capacity compared to equivalent size leclanche battery. Higher battery voltage than zinc-carbon battery. Cost is also moderate.
5) Nickel Zinc batteries: A nickel–zinc battery, abbreviated NiZn, is a type of rechargeable battery similar to NiCd batteries, but with a higher voltage. Nickel–zinc batteries perform well in high-drain applications, and may have the potential to replace lead–acid batteries because of their higher energy-to-mass ratio and higher power-to-mass ratio as little as 25% of the mass for the same power. Ni-Zn are cheaper than nickel-cadmium batteries, and are expected to be priced somewhere between NiCd and lead–acid types. Battery cycle life is most commonly specified at a discharge depth of 80 percent of rated capacity and assuming a one-hour discharge current rate. As the discharge current or the depth of discharge is reduced, the number of charge-discharge cycles for a battery increases.

New Age Materials used in Vehicle Body:

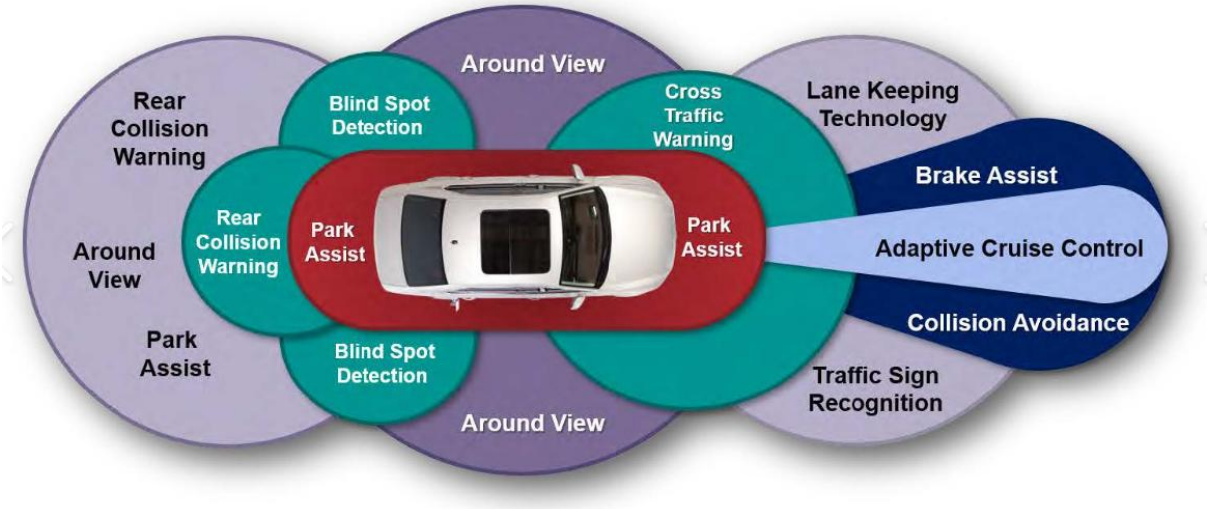
1) Particulate reinforced Aluminium Matrix composites: Aluminium metal matrix has growing demand in aircraft, automotive and other industries due to its light weight, high strength to weight ratio, corrosion resistance and workability. Particle reinforced aluminium matrix composites are preferable due to their reduced cost, uniform properties, and their ability to be like monolithic materials.
2) Fiber reinforced thermoplastics: Fiber reinforced thermoplastics (FRTP) are commonly used in automotive industry components because they offer a very high strength to weight ratio. These thermoplastics also offer fire resistance and the option to include decorative finishes in the manufacturing process. The major advantages of these products include sustainability in mass production processes and are recyclable.
3) Types of plastics used in automobiles:
   a) Polyurethanes: Polyurethanes are widely used in car manufacture, offering real benefits in terms of comfort, protection and energy conservation. Polyurethane foams can be found in seats, armrests and headrests of most cars, where their cushioning properties help to reduce the fatigue and stress often associated with driving. Their durability and light weight, combined with their strength, make them ideal not only for cushioning purposes, but also within the bodies of cars, where their insulation properties provide protection against the heat and noise of the engine.
   b) Polyvinylchlorides: PVC itself is a material with a comparatively low energy consumption thereby cutting down the depletion of natural resources. In vehicles, this is enhanced further by the lightness of PVC components in comparison to traditional materials, therefore reducing weight and thus fuel consumption. PVC compounds used in vehicles offer excellent cost-performance advantages. This freedom given by PVC in car interiors allows for even the most challenging designs to enhance the comfort of car interiors.
   c) Polypropylene: Polypropylene is used in automotive bumpers and wheel covers, but is also used in chemical tanks, cable insulation and in carpet fibres. It is also often utilized as a thermoplastic binder component for natural fiber composites. Also used with a variety of vehicle applications such as door panels, console, seatbacks, trunk liners, and much more. Some of its advantages include excellent environmental performance, good thermal properties and high resilience.
   d) ABS Plastics: ABS is popular due to its low production cost and the ease with which the material is machined by plastic manufacturers. It is made by polymerizing styrene and acrylonitrile. What's more, the styrene gives the plastic a shiny, impervious surface. It has outstanding high and low-temperature performance, great insulation properties, and is easy to paint and glue. Its applications can be found in dashboards, wheel covers, and automotive body parts.
   e) Fiberglass plastics: Plastics that are made stronger using glass fibers have been utilized in the transportation sector ever since mass-produced pultrusion methods were first recognized. A liquid resin matrix was combined with continuous strands of reinforced fabric to make improvements in the structural integrity of the material, allowing the glass wool to be fabricated into high-strength structural shapes. This inventive use of fiberglass products has

improved the mechanical scope for composite materials in the automotive industry.

4) Magnesium Alloys and aluminium Alloys: The application of magnesium alloys in automotive has witness the developments and successful application of these alloys in automotive component such as steering wheels, steering column parts, instrument panels, seats, gearboxes and air intake systems. Magnesium has several advantages over aluminum in terms of manufacturability due to its mechanical and physical properties. Vehicles are more aerodynamic and lighter weight with the use of Aluminium alloys. For many vehicle distributors, aluminum alloys offer the most efficient choice of vehicle material. In automotive engines, aluminum alloys are put to good use, this is particularly applicable where weight saving is desired such as crankcases and cylinder blocks. An engine's cooling system is critical since, at elevated temperatures, alloys are susceptible to warping.



Advanced Driver Assistant Systems:



Technologies that help in Dynamics of Vehicle:

1) Traction control Sensor: The traction control system (TCS) is made up of wheel speed sensors, solenoids, an electric pump, and a high pressure accumulator. The wheel speed sensors monitor the rotational speed of each wheel. The solenoids are used to isolate certain brake circuits. Traction control comes into the picture when the car loses its traction or ability to grip the surface. Traction control can work in numerous ways.
1) Blind spots: Blindspot detectors are used for detecting bystanders, obstacles and other automobiles for protection against mishaps such as accidents and collisions with automobiles or obstacles. They are also used for cross-traffic warning to alert a driver of what is approaching from the left and right sides while stepping out of the car.
2) Lane departure warning: A vehicle's lane departure warning system uses forward-facing cameras mounted on the windshield, near the rearview mirror. Cameras monitor lane markings. If the vehicle starts to leave the marked lane while the turning signal is off, the system alerts the driver. A lane departure alert can be an audible alert, a dashboard indicator, or a seat or steering wheel vibration.
3) Parking Assist: Park Assist is an automated parking aid that helps drivers park with greater precision, using guidance system technology that rivals ultrasonic and other camera-based solutions with superior, advanced technology. The parking guidance system (PGS) is customer-centric in many ways.
4) Electronic Stability Control: ESC (Electronic Stability Control) is a computerised vehicle stability system that constantly monitors your car's steering angle, vehicle direction and speed. ESC works by use of various sensors in and around the vehicle.
5) Adaptive Cruise Control: Adaptive cruise control is a form of intelligent cruise control, also known as active cruise control, autonomous cruise control, smart cruise control, and radar cruise control. A radar sensor is installed on the car's front grille, which can sense how close or far away the vehicle in front is. By sensing this distance, the car will "adapt" its cruise control speed to maintain a safe distance from the vehicle ahead.
2) ABS: Anti-lock braking system Increases braking distance: Braking force is maximum just before wheel's about to lockup. But as soon as the lockup of the wheels, the braking distance increases considerably as the vehicle skids. The ABS system keeps the tyres in a good zone while braking and braking is more effective that way.
3) Steering sensor: Steering sensors are crucial for measuring the rotational angle of a steering wheel and

communicating this information on navigation. These sensors are used for automated systems that require electronic command steering (ECS) and electric power steering (EPS) systems.

4) Hill assist: Hill assist uses Sensors in the vehicles, which are used to detect when a vehicle is on an incline. The hill start assist maintains the brake pressure for a set period of time as you switch from the brakes to the gas pedal. Once you press the accelerator, it releases the brake. In cars with manual transmission that have this feature, the hill start assist will also maintain brake pressure until the driver lets up on the clutch.
5) Active suspension system monitor: An active suspension relies on traction sensors connected to the wheels and brake system of the automobile. These sensors monitor the overall stability of the automobile while it is moving. When the sensors detect tire spin or rocking situations, the system automatically tightens the suspension components, making the car handle better.

Autonomous Vehicles

An autonomous vehicle, or a driverless vehicle, is one that is able to operate itself and perform necessary functions without any human intervention, through ability to sense its surroundings. It utilizes a fully automated driving system in order to allow the vehicle to respond to external conditions that a human driver would manage.

Sensors in Autonomous cars: The majority of today's automotive manufacturers most commonly use the following three types of sensors in autonomous vehicles: cameras, radars, and lidars. Autonomous cars often have video cameras and sensors in order to see and interpret the objects in the road just like human drivers do with their eyes.

Levels of Automation: There are **six different levels of automation** and, as the levels increase, the extent of the driverless car's independence regarding operation control increases.

At level 0, the car has no control over its operation and the human driver does all of the driving.

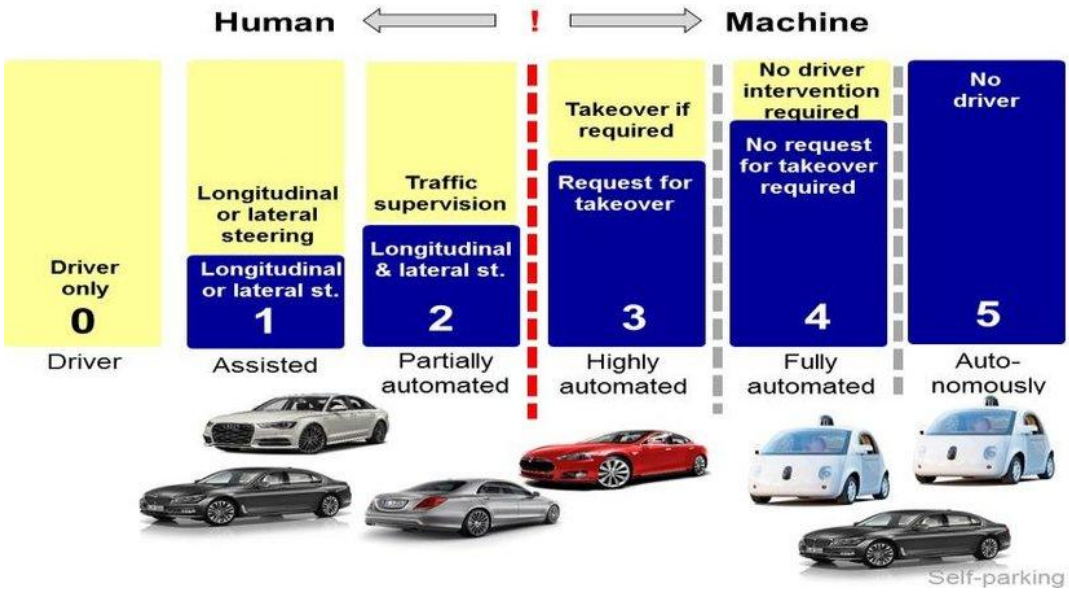
At level 1, the vehicle's ADAS (advanced driver assistance system) has the ability to support the driver with either steering or accelerating and braking.

At level 2, the ADAS can oversee steering and accelerating and braking in some conditions, although the human driver is required to continue paying complete attention to the driving environment throughout the journey, while also performing the remainder of the necessary tasks.

At level 3, the ADS (advanced driving system) can perform all parts of the driving task in some conditions, but the human driver is required to be able to regain control when requested to do so by the ADS. In the remaining conditions, the human driver executes the necessary tasks.

At level 4, the vehicle's ADS is able to perform all driving tasks independently in certain conditions in which human attention is not required.

Finally, level 5 involves full automation whereby the vehicle's ADS is able to perform all tasks in all conditions, and no driving assistance is required from the human driver. This full automation will be enabled by the application of 5G technology, which will allow vehicles to communicate not just with one another, but also with traffic lights, signage and even the roads themselves.



2. Conclusions

- Auto makers are constantly trying to improve the passenger's safety by integrating mechanical parts with electronic sensors.
- World is shifting towards eco-friendly transportation Solutions
- Advancements in mixture of materials for better strength to weight ratio.
- New age transmission systems for hassle free rides.

- Full automation cars have no physical work to the drivers.

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