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Recent Trends In Automotive Engineering And Developments

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Abstract

Automotive engineering is a field of applied science that focuses on the design, development, and production of ground vehicles. Vehicle construction is an interdisciplinary optimization challenge with a plethora of design criteria that often clash. Major architecture criterions in the construction of a modern vehicle include fuel efficiency, vehicle stability, crashworthiness, reliability, ride convenience, handling habits, ergonomics, aerodynamics, and noise, vibration, and harshness (NVH) principles. Due to the rigorous dynamics of the automobile business, original equipment manufacturers (OEMs) are obliged to make key decisions among these design objectives. Due to environmental and energy concerns, fuel input is the most significant building characteristic. Transportation is also powered by fossil fuels. Gasoline and diesel made for 92 percent of all transportation energy in 2016. Bioethanol and biodiesel are utilized at around 5% of the time. Natural gas and electricity each account for 3% and 1% of total energy use, respectively. Transportation accounts for 67 percent of all global oil consumption. Oil demand is anticipated to climb by 70% by 2050, while CO2 emissions would increase by 130 percent. Carbon levels this high are expected to boost global surface temperatures by 6 degrees Celsius, culminating in unavoidable climate change. CO2 emissions may be reduced by 85 percent, according to the Intergovernmental Panel on Climate Change (IPCC), to keep global surface temperature rise below 2°C. Alternative fuels, batteries, and hybrid automobiles are promoted as cleaner modes of transportation with lower CO2 emissions (Taylor, 2010; Eberle et al., 2012; Chang et al., 2017). In truth, fossil-fuel vehicles will be phased out in the near future. Norway has decided that gasoline and diesel vehicles would be banned by 2025. (The Independent, 2017). By 2040, France and the United Kingdom want to prohibit the export of fossil-fuel cars (Environews, 2017). Work on fully electric cars and hybrid electric vehicles is currently underway. The drivetrain of these automobiles is replaced by electrical motors, control electronics, capacitors, and battery packs. The electrical equipment interacts with the mechanical components of the vehicle in a sophisticated way. In terms of total efficiency and energy utilization, this connection must be optimized.

Keywords— Include at least 5 keywords or phrases

I. INTRODUCTION

Whether driven by internal combustion engines or electric motors, the aim is to build smaller and more energy efficient automobiles. Lightweight materials are one of the most significant study topics in automobile engineering. While a range of materials are used in the production of a car, such as glass, plastics, rubber, and special fibres, the significant contribution Advanced high strength steels are being manufactured in order to reduce the thickness of sheet metals (Nehuis et al., 2014; Hardwick & Outteridge, 2016). To reduce total weight, aluminium and magnesium alloys are also employed in the construction of automobile bodywork (Geck, 2014; Hirsch, 2014; Joost & Krajewski, 2017). In comparison to the alternatives, low-carbon steel offers the advantages of low cost, ease of manufacture, wide availability, use of existing manufacturing facilities, and design adaptability. Other lightweight materials that have recently been discovered include innovative polymers (Lyu & Choi, 2015) and natural fibre reinforced composites (Srinivas et al., 2017). The aim of autonomous vehicle technologies is to reduce road collisions while also lowering energy demand and emissions (Bagloee et al., 2016). There are multiple stages of autonomous vehicle technology, according to the National Highway Traffic Safety Administration (NHTSA, 2013). The highest level is Grade 4, which allows the automobile to drive itself without the help of a human driver (Anderson et al., 2014). Automotive electronics, human-machine interface (HMI) systems, vehicle networks, and automotive protection all deal with autonomous vehicle technology (Fleming, 2015). Different system architectures are proposed in the literature to minimise the computing cost, fault-tolerant characteristics, and modularity of the whole system (Jo et al, 2014). If an autonomous car fails, it is also unclear who will be held liable. As a result, autonomous vehicle technology is a good candidate for regulatory oversight (Geistfeld, 2017).

Noise, vibration, and harshness are also another significant subject in automotive engineering (NVH). Both noise and vibration have the same function in that they are both caused by oscillatory movements. For both internal and external noise in cars, the causes and possible remedies are somewhat close. Noise from the outside is a problem. Automotive electronics has quickly been a key force of new vehicle production over the last decade (Ribbens, 2017). Aside from the business giants, Google, Tesla, Lucid, and Apple are all vying for a piece of the electric autonomous vehicle pie (Fleming, 2015). Autonomous vehicle technologies, human-machine interaction, vehicle networks, and automotive defence, among other new advances in automotive electronics, demand a system design and implementation approach that is substantially different from what OEMs are now pursuing. This chapter discusses recent breakthroughs in automobile engineering. Themes and directions for future analysis are presented.

II. HYBRID AND ELECTRIC VEHICLES

Table 1 lists three types of electric cars: hybrid electric vehicles (HEVs), plug-in electric vehicles (PHEVs), and full electric vehicles (FEVs). (FEVs). In a hybrid electric car, an internal combustion engine (ICE) and an electric motor are integrated (HEV). An internal combustion engine (ICE) that runs on fossil or renewable fuels is the major source of energy in these vehicles. In a hybrid electric vehicle (HEV), the electric motor is powered by electricity generated by regenerative braking and thermoelectric generators (Hartley et al., 2010). HEVs are built to be fuel efficient and pollutant-free (Enang & Bannister, 2017). Unlike HEVs, PHEVs may be plugged into an electrical power source. Different hybrid system types, including as series, parallel, and full hybrid systems, are employed on the market (Hannan et al, 2014). One example is a series scheme PHEV, such as the Fisker Karma.

Commercially available parallel hybrid systems may be found in automobiles like the Toyota Prius, Chevy Malibu, and Honda Insight. The electric motor and ICE will work together or separately in a parallel hybrid system. The term "complete hybrid system" refers to a system that combines series and parallel hybrid systems. Figures 1 and 2 depict the setup of a complete hybrid system and the Toyota Prius II powertrain system, respectively. The gearbox, alternator, and starting motor are all part of this machine.

TABLE I: TYPES OF ELECTRIC AND HYBRID VEHICLES

Vehicle type	**Powertrain**	**Battery charging**
Hybrid electric vehicle (HEV)	ICE + electric motor	Internal
Plug-in hybrid electric vehicle (PHEV)	ICE + electric motor	Internal + external
Full electric vehicle (FEV)	Electric motor	External

FEVs do not have an internal combustion engine; instead, they depend solely on electric motors for control. These zero-emission cars are gaining popularity as a result of environmental and energy issues. FEVs must satisfy such requirements in order to replace conventional fossil fuel cars, such as high capacity, high torque, and a sufficient range. The electric motor and the battery are the main features for FEVs, in addition to an optimal energy management plan (Dorrell et al ., 2014). Electric motors with permanent magnets (PM) are the most effective (Boldea, 2014). These engines employ rare-earth permanent magnets including samarium cobalt and neodymium-iron-boron magnets. Magnets constructed of samarium cobalt can withstand greater temperatures (up to 500°C) than magnets made of neodymium, iron, and boron (Long et al., 2008). On the other hand, neodymium, iron, and boron magnets are the most strong. However, the usage of rare-earth permanent magnets must be restricted in order to be sustainable (Stegen, 2015). The Standard: MMPA-0100 provides significant permanent magnet physical features (MMPA, 2000).

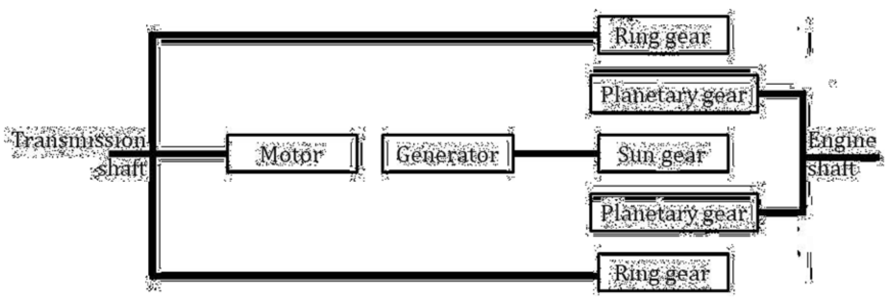


Figure 1. A complete hybrid system's configuration

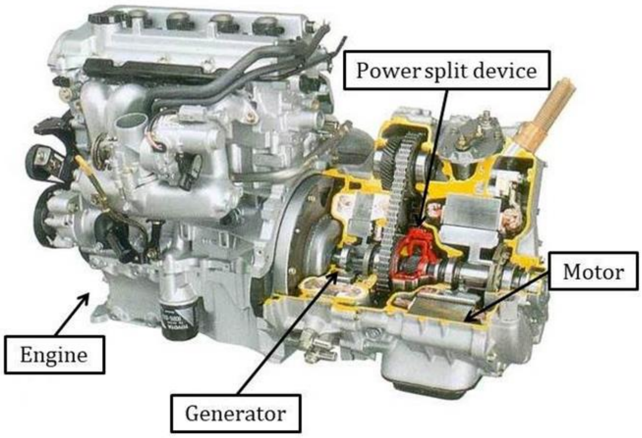


Figure 2. The hybrid powertrain of the Toyota Prius II (Courtesy of Toyota Motor Co.)

In recent years, a variety of electric motors have been developed for use in electric and hybrid vehicles. There are about 100 distinct types of electric motors in today's buses. The most common types of electric motors on the market are DC motors, multi-phase AC induction motors, permanent magnet (PM) synchronous motors (or brushless AC motors), switched reluctance (SR) motors, and brushless direct current (BLDC) motors (Hashemnia & Asaei, 2008; De Santiago et al., 2012; Yldrm et al., 2014; Kumar & Jain, 2014 It's critical to pick the right electric motor. In order to compete against fossil fuel cars, a FEV must effectively satisfy the following requirements:

A. Low speed hill climbing

B. Overload and fault tolerant capabilities

C. Instant acceleration

D. High speed cruising

E. High efficiency over a wide torque-speed range

F. Regenerative braking system

G. Operational controllability

H. Temperature management

Criteria	DC motor	AC induction motor	PM motor	SR motor
Power density	E	C	A	D
Efficiency	E	C	A	B
Speed	F	B	A	A
Torque density	E	D	A	C
Torque ripple	D	B	C	E
Overload capability	E	C	B	C
Controllability	A	A	C	E
Reliability	E	A	C	B
Service time	D	A	C	B
Maturity	A	B	C	D
Size and weight	E	C	B	C
Manufacturability	E	A	E	C
Cost	D	A	E	C

*DC: direct current, AC: alternative current, PM: permanent magnet, SR: switched reluctance

Table 2. Evaluation of electric motors used in the vehicle industry

At low speeds, DC electric motors have a high torque rating. They are durable and dependable, but high motor speed is limited by the existence of mechanical commutators and brushes due to high friction. Other disadvantages of DC electric motors include poor performance and high maintenance costs. Permanent magnet brushless DC motors have been designed to address the above disadvantages, which are mostly caused by commutators. They have a high power density and don't need to be maintained. Over a large torque-speed range, these motors have high performance. Multi-phase AC induction motors provide a number of benefits, including high reliability, a large torque-speed range, a long service life, low torque ripple, and low cost. The switched reluctance (SR) electric motor is another promising technology. High performance over a large torque-speed range, simple temperature control, high overload and fault tolerance capabilities are all advantages of SR electric motors. Table 2 compares the different kinds of electric motors (Zeraoulia et al, 2006; Kumar & Jain, 2014). The key characteristics of electric motors used in the automotive industry are rated on a scale of ‘A' to ‘F,' with ‘A' denoting the highest. Different OEMs, however, use various forms of electric motors in their latest versions. Table 3 lists several samples of FEVs that are currently available on the market. In FEVs, switched reluctance motors are still uncommon. Torque is created in these motors due to the attraction between the iron rotor and the electromagnet. Many various structural considerations have recently been proposed in the literature for using switched reluctance motors in electric vehicles (Moreno-Torres et al., 2016; Zhu et al., 2017; Diko et al., 2017, Gan et al., 2017).

OEM	Model	Electric motor	Power (kW)	Range (miles)
Tesla	Model 3	Induction motor	175	220-310
Tesla	Model S	Induction motor	235-345	400
BMW	i3	Induction motor	125	81-114
Mercedes-Benz	B-Class Electric	Induction motor	132	87
Lucid	Air	Induction motor	300-745	240-315
Toyota	RAV-4	Induction motor	115	103
Nissan	Leaf	Induction motor	80	124-155
Citroen	C-Zero	PM motor	49	93
Chevrolet	Bolt	PM motor	150	238
Ford	Focus Electric	PM motor	107	117
Hyundai	Ioniq	PM motor	88	124
Jaguar	I-Pace	PM motor	295	300
Kia	Soul EV	PM motor	81	93
Volkswagen	e-Golf	PM motor	100	125

Table 3. Examples of FEVs available in the market (2017)

Aside from powertrain characteristics, battery modelling and charging problems are critical. Many new developments for batteries, ultra-capacitors, and super conducting magnetic devices have been created to enhance energy storage systems. The core design criteria in battery modelling are energy capacity, reliability, life time, and safety. Lithium-ion batteries, among others, are the most promising high-energy storage devices. The lithium-ion batteries used in FEVs include lithium cobalt oxide (LCoO2, LCO), lithium manganese oxide (LiMn2O4, LMO/Spinel), lithium iron phosphate (LiFePO4, LFP), and lithium nickel–manganese–cobalt oxide (LiNi1-y-zMnyCOzO2, NMC). Despite continued research into developing lithium-ion batteries, it is widely acknowledged that these batteries are approaching their theoretical gravimetric energy density limit of 265 Wh/kg (Chen et al., 2012; Barchasz et al., 2012; Fotouhi et al., 2016). Energy storage systems with higher energy capacity values are expected to increase the range per hour of FEVs. Lithium-sulphur (Li-S) batteries are a great choice because they have greater energy efficiency, better thermal management, improved protection, and are less expensive.

Li-S batteries have a theoretical energy capacity of 2,500 Wh/kg (Nazar et al., 2014). Further research into the charge behaviour of Li-S batteries is needed before they can be used in FEVs (Propp et al., 2016). The lithium-air style batteries, which have an energy density of 11,000 Wh/kg (Alankuş, 2017), are another choice. As applied to the energy density of fuel, this value makes sense. Gasoline has a potential energy density of 13,000 Wh/kg. The functional energy density values of gasoline and lithium-air batteries are the same after losses; they are 1,700 Wh/kg (Girishkumar et al., 2010). The challenges of putting lithium-air batteries into practise do need to be studied further (Tan et al., 2017).

III. LIGHTWEIGHT MATERIALS FOR AUTOMOTIVES

Electric cars should have been developed using lightweight materials to compensate for their big batteries, despite the fact that they do not require solutions for fuel economy or emissions. High strength steels (HSS), aluminium (Al), magnesium (Mg), glass fibre composites, and carbon fibre reinforced polymer (CFRP) are used instead of low-carbon steel to minimise vehicle total weight (Taub & Luo, 2015, Pervaiz et al., 2016). Table 4 lists several vehicles that were built with lightweight materials as examples.

*Al: aluminum, HSS: high strength steel, Mg: magnesium, CFRP: carbon fiber reinforced polymer

Table 4. Examples of some vehicles constructed using lightweight materials (2017)

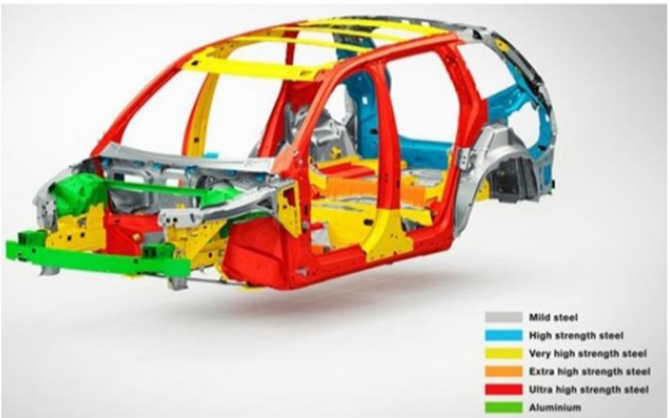
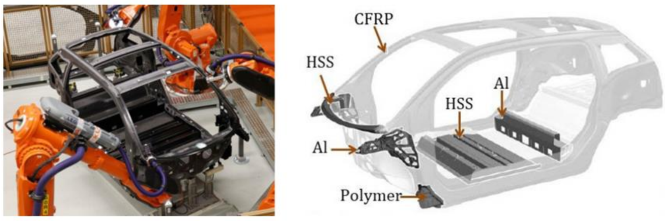


Figure 3. Materials utilised in the new Volvo XC90 (Courtesy of Volvo Car Corporation)

Various companies are currently using magnesium alloys, especially in cast pieces. Mg's low creep properties, corrosion behaviour, and ability to operate at high temperatures have limited its use in automotive applications (Kumar et al., 2015). Aluminum alloys are favoured because of their low cost, ease of fabrication, and corrosion resistance (Hirsch, 2014). In the design of recently built cars, such as electric and hybrid vehicles, high performance polymers are often used (Lyu & Choi, 2015). In aircraft, high-strength steel is widely used to minimise sheet thickness (Grajcar et al., 2012; Li et al., 2016). In the recent XC90, Volvo Car Corporation chose to use a combination of high-strength steels and aluminium. The hot-formed boron steel in Figure 3 is ultra-high strength steel (shown in red), which accounts for around 40% of the overall body weight (Volvo Car Corporation, 2017).

Carbon fibre reinforced polymers (CFRP) are of special concern to the automotive industry because of their high strength-to-weight ratio (Wu et al., 2014; Meek et al., 2016). The BMW i3's

BIW is made of CFRP, and much of the interior fittings are made of recycled or sustainable materials. Figure 4 depicts the components used in the construction of the i3 (BMW AG, 2017).



(a) The carbon fiber BIW of i3 (b) The materials used in the construction of BIW

(b)

Vehicle	BIW material	Curb weight (kg)
Audi A8L	Al	2,205
Mercedes-Benz SL	Al + HSS +Mg	1,740
Honda Acura NSX	Al	1,725
Cadillac CT6	Al + HSS	1,660
Tesla Model3	Al + HSS	1,609
BMW i8	Al + CFRP	1,567
Jaguar XE	Al + HSS	1,520
Chevrolet Corvette	Al	1,495
BMW i3	CFRP	1,195

Figure 4. The materials used in BMW i3 (Courtesy of BMW AG)

It is possible to minimise the overall weight of a vehicle by up to 45 percent by using lightweight materials (Mascarin et al., 2015). The overall weight of a car can be decreased by up to 30% at a reasonable expense and with a minimum technical risk. Carbon fibre and magnesium can be used widely in the design of a complete vehicle to minimise gross weight by 40%. A weight loss of 45 percent or more would necessitate certain unique features in the vehicle's electrical systems and internal components. Table 5 shows the weight savings and expense savings of using lightweight materials.

Cost has also prevented the use of lightweight materials in the past (Heuss et al., 2012). As a result of the cost increase, OEMs in the luxury car segment are increasingly using lightweight materials (see Table 4). For the next two decades, however, lightweight materials are predicted to see substantial cost reductions (Holmes, 2017; Faruk et al., 2017).

Lightweight material	Weight reduction (%)	Cost increase (%)
Carbon fiber	50-70	570
Magnesium	30-70	150
Aluminum	30-60	130
Ultra-high strength steel	15-25	125
Fiberglass	25-35	120
High strength steel	10-28	115

Table 5. Weight reductions and cost increases of using lightweight materials

Currently, large batteries are used in electric vehicles; for example, the batteries in the Nissan Leaf and Tesla Model S weigh 300 kg and 544 kg, respectively. The weight of batteries is supposed to be reduced as battery science advances. Lithium-sulphur (2,500 Wh/kg) and lithium-air (11,000

Wh/kg) batteries will decrease the overall weight of electric vehicles due to their particular energy values.

IV. NOISE AND VIBRATION IN AUTOMOTIVES

In the form of automotive acoustics, noise and vibration experiments are generally classified into three frequency regimes: low-frequency (20-200 Hz), mid-frequency (200-600 Hz), and high-frequency (600 Hz and beyond), and are treated using various approaches such as experimental, numerical, and composite considerations. Interior and external noise are two of the most important study topics throughout the vehicle manufacturing process. While the causes and possible remedies for interior and exterior noise are somewhat similar, the major motivating forces are not. Legislation regulates exterior pollution issues such as pass-by noise and road noise (ISO 362-1:2015). Random background noise, mostly from road and wind feeds, and isolated engine frequency components superimposed over the background noise make up vehicle interior noise (Jha, 1976). Because of its large number of degrees of freedom (DOF), the body-in-white (BIW) is the most dynamic vibratory device in a vehicle (see Figure 5), and it is the most important component of the noise assessment study because it is the mechanism that ultimately radiates the sound energy experienced by passengers. For a standard passenger vehicle fitted with an internal combustion engine (ICE), the maximum degree of dynamic response of a trimmed body is considered to be in the 70-200 Hz band (Priede & Jha, 2004). Background noise is the defining criterion for the loudness of internal noise in terms of human experience, while individual frequency components are the key source of the distracting sense (Shin et al., 2009). Although the degree of excitation of different harmonics varies with engine speed, only the first few harmonics of the ICE normally excite the most critical resonances within the described ensemble (Lalor & Priebsch, 2007). Deterministic element-based approaches such as finite element (FE) and boundary element (BE) methods are still the most suited tools for forecasting low-frequency noise and vibration (Fuchs et al., 2016). Statistical energy analysis (SEA) is commonly employed in high frequency regimes (Gur et al., 2015). The mid-frequency spectrum is more complex to plan. The modal density values in this range aren't high enough to use the SEA methodology to find a solution. When deterministic methods are used, however, the modal density values are not low enough to allow two well-separated modes to evolve. To cope with mid-frequency issues, a variety of ways have been proposed in the literature (Schaefer et al., 2017; Biedermann et al., 2017; Yin et al., 2017).

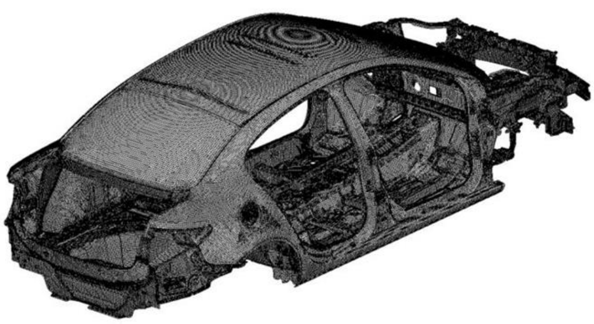


Figure 5. Finite element model of the BIW used in vibro-acoustic analysis (>3 million DOF)

Experimental approaches such as transfer path analysis (TPA) and experimental modal analysis (EMA) are extensively employed in NVH research (Oktav, 2016). Experiments are necessary not just for verification but also to supplement the computer model, especially when it comes to damping qualities. The damping effect is represented in the complex frequency response functions obtained in a TPA analysis and must be investigated during the post-processing step. In a recent review, the effects of damping, as well as the explanations for them and techniques for analysing them, were explored (Oktav et al., 2017a). The vibro-acoustic versions are affected by the inclusion of additional cavities (Lee et al., 2011). The presence of a trunk cavity reduces the acoustic eigenfrequency of the first acoustic mode substantially (Oktav et al., 2017b). The apertures designed as anti-trunk lid slam noise countermeasures operate as Helmholtz resonators, modifying the acoustic mode forms, because the trunk cavity and the cabin cavity are acoustically mixed.

In fully electric cars, the origins of internal and external noise are distinct (FEVs). In conventional cars, main noise sources that contribute to pass-by-noise are the ICE, intake system, exhaust system, and tire/road system (Braun et al., 2013). The powertrain noise, which includes the driving motor and gearbox, tyre noise, and wind noise, make up the majority of FEVs' exterior noise (Cao et al., 2016; Tousignant et al., 2017). The sound intensity levels of pass-by-noise and road noise for FEVs are significantly smaller than for conventional vehicles. In comparison to conventional fossil fuel cars, FEVs are much louder at low speeds (less than 30 km/h), to the point that pedestrians are unaware of their existence. The National Highway Traffic Safety Administration (NHTSA) was instructed by the Pedestrian Safety Enhancement Act (PSEA) of 2010 to design a safety standard for all types of electric and hybrid cars to produce a pedestrian warning sound. The Society of Automotive Engineers proposed J2889/1-measurement of minimum noise produced by road vehicles as a research standard in 2011. (SAE Standard J2889-1: 2011). This standard has also been accepted by the National Highway Traffic Safety Administration (Konetet al., 2011). Electric motor noise include aerodynamic, electromagnetic, and mechanical sounds (Dupont et al., 2013; Gurav et al., 2017). Aerodynamic noise, which is more prevalent at higher motor speeds, often occurs in the vicinity of the fan or a similar device. Electromagnetic noise is produced in the electric drive system as a result of the power electronic converter feeding the motor switching. The mechanical noise, which is primarily produced by the stator, is most noticeable at the powertrain's intermediate rpm. The relationship between psychoacoustic metrics, the threshold for detecting sounds, and perceived discomfort in FEVs was investigated by Lennström et al. (2013). Ma et al. (2017) employed the estimated A-weighted sound pressure level and six psychoacoustic characteristics, including loudness, fluctuation intensity, tonality, roughness, articulation index, and sharpness, to characterise noise samples for quantitative assessment of sound quality of a FEV. Swart & Bekker (2017) used the statistical correlation of the six psychoacoustic factors stated above to examine the customer satisfaction measure for FEV sound signatures. The electric driveline's high-frequency noise, as well as the motions of the auxiliary power unit and the air conditioner compressor, are all significant NVH hazards for FEVs (Guo et al., 2016). Chandrasekhar et al. looked at the torque ripple and whining noise in FEVs (2017). They came to the conclusion that more study is needed to completely understand the magnitude and phase of current harmonics, as well as the dynamic link between torque ripple and radial magnetic forces. Diez-Ibarbia et al. (2017) used a FEV to examine the effectiveness of two experimental techniques: transfer path analysis (TPA) and operational transfer path analysis (OTPA).

V. ELECTRONICS FOR AUTOMOTIVES

Modern vehicles come with a multitude of sensors and microprocessors, as well as many cyber-physical modules, computer control systems, in-vehicle networking networks, and hundreds of megabytes of software (Schulze et al., 2016; Ray et al., 2017). Automobiles are no longer just electronic instruments as they once were. They're quickly transforming into the ultimate mobile gadgets on wheels. The emerging developments in automobile electronics, such as autonomous driving, in-car infotainment, and pure electric vehicle tech design, necessitate a completely different mindset (Tummala et al., 2016). The initial step toward autonomous vehicle technology is the adoption of collision-avoidance/warning and active cruise control systems. These gadgets, in fact, demand that longitudinal and lateral vehicle control functions be automated (Vahidi & Eskandarian, 2003). Then it's discovered that these structures may be merged to achieve even better outcomes. OEMs and IT companies have made significant investments in the commercialization of self-driving automobiles (Zheng et al., 2015). These vehicles are expected to hit the market by 2020. The cameras and technology utilised in autonomous cars are depicted in Figure 6. The precise position of a self-driving automobile should be able to be determined. The GPS antennae in these cars give centimetre-level accuracy in their positional data. The car should be able to choose the best route to the destination. This is accomplished using the Lidar (light detecting and ranging) device. Lidar creates a 3D representation of the world using reflected photons from a pulsed laser light. The driver must identify pedestrians, other vehicles, kerbs, lanes, crosswalks, and speed bumps (Zhu et al., 2017). You'll need a high-resolution scope, radar sensors, and a computer to handle these tasks. While much progress has been achieved, autonomous driving still has a long way to go. The driving behaviour of an autonomous vehicle is directly influenced by neighbouring autos, other moving objects, and environmental elements. The issue requires vehicle-to-vehicle (V2V), vehicle-to-pedestrian (V2P), vehicle-to-infrastructure (V2I), vehicle-to-network (V2N), or, to put it another way, vehicle-to-everything (V2X) connectivity. V2X connectivity improves road safety, the availability of entertainment services, and the overall quality of transportation systems. System for two-way interaction (V2X) Extremely low latency and great dependability are required, especially for safety-related applications. V2X connectivity is required for the in-vehicle network to communicate (Tuohy et al., 2015). Ethernet would serve as the backbone for the next generation of in-vehicle networks. IEEE 802.11p, a standard for introducing wireless networking to cars, is being used for connection. V2X can also fulfil stringent endurance, low latency, high data rates, and a greater connectivity range in high-density traffic settings. Current research is focused on the advancement of LTE V2X and the future 5G V2X technologies (Ucar et al., 2016; Chen et al., 2017; Ashraf et al., 2017).

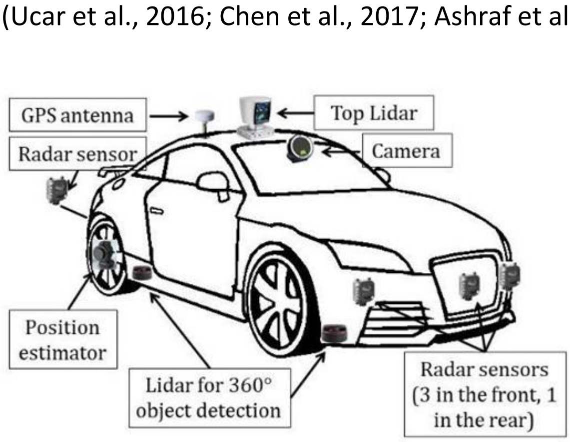


Figure 6. Sensors and technologies used in an autonomous

VI. Conclusion

Despite its reputation as a traditional industry, it is important to note that the global automobile industry has been the single most important driver of global economic growth (Marchi et al., 2014). The global light vehicle market is forecast to hit 93.5 million units in 2017. (IHS Markit, 2017). In 2017, FEV demand will account for just 0.7 percent of global new vehicle output. However, as a result of environmental and energy issues, the downturn in fossil fuel vehicle sales is happening sooner than predicted. After more than a century of selling fossil fuel automobiles, the global automobile industry must now reconfigure itself to adapt to the electric revolution. In the last decade, the global automobile industry has grown by 30%. Electronics and semiconductors, on the other hand, have doubled and tripled in size during the same time period (Strategy Analytics, 2017). The car sector must keep these advancements in mind. In the coming decade, only OEMs who develop in electric and autonomous vehicle technologies will be world leaders in the automotive business.

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