9/20/2021

Automotive Electronics Integration

AuE 835 Assignment-1

SIDDHARTH THORAT
CU-ICAR

1. Research paper:

Automobile safety technology and its improvement by

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Functions:

The automotive safety technology functions are divided into two types

- Active safety technology
- Passive safety technology

1. **Active safety technology** -

The active safety technology is to reduce the impact of a sudden situation in emergency cases for the driver or to prevent the driver from accidents. Totally, it monitors the surroundings and the vehicle performance.

- The active safety technology used in this research paper are

- Chassis Active Control Technology
- Security Early Warning Technology

- Chassis Active Control Technology-

The driver's steering information data from the multiple sensors are collected by the chassis active control module and transmits to the ECM, brake control systems (ABS, electric unit).

Sensors:

The sensors used in the active safety technology are

a) Electronic brake control sensor

The Electronic brake control system reads the driver's data during the motion and activates the system whenever it is necessary.

b) Electronic stability control sensor

The electronic stability control sensor works when the vehicle loses its momentum or control on the road.

- Security Early Warning Technology –

The early warning system collects the various information from the driver through sensors and analyzes the collected information to remind and warn the driver which reduces the occurrences of the accidents.

Sensors:

The sensors used in the security early warning system are

a) Ultrasonic sensors

The ultrasonic measure the distance through the ultrasonic waves to get the immediate image of the other vehicle.

b) Vision sensors

The vision sensors help the driver to detect the cars by capturing and processing the live image with panoramic and depth views. It alerts the driver to slow down the speed of the vehicle or stop quickly.

c) Radar sensors

The radar sensors detect the distance between the vehicles or a large object in front of a vehicle. They are invisibly located at behind vehicle bumpers or radomes.

2. **Passive safety technology** –

The passive safety technology is to prevent the vehicle after the impact. The protection devices are used to protect the driver or passengers and outside the vehicle from impact as much as possible, to reduce the damage caused.

- The passive safety technology used in this research paper are

❖ Safety belt

The safety belt is the device protects the driver or the passengers against a sudden movement in the vehicle during collisions or sudden stopover.

Sensors:

a) Safety belt sensor

The safety belt sensor detects the knuckle metal buckle of belt when inserted into the female portion of the belt(seat).

- Airbag

An airbag is the system designed to inflate the bag to save the driver and the passengers in the vehicle during a sudden collision.

Sensors:

a) Electrical Sensors

The electrical sensors use a metal roller or a spring-loaded weight and an accelerometer to trip the sensor (Pressure, water pressure, impact, safety, crash sensors, G sensors)

b) Mechanical sensors

The mechanical sensors work independent of the electrical system and respond equally to the electrical sensors. The design that triggers a firing pin activating a small explosion after crash. This sensor doesn't require any power source, it cannot be disabled like an electrical sensor when the battery is disconnected.

Principle:

With the vast development of technologies in the automotive, the safety is involved in all aspects of the vehicle. This research paper describes about improvement in the traditional airbag to reduce the economic losses and casualties caused by road traffic accidents and at bad weather environment.

Actuators:

The Actuators used are as follows

a) Linear actuators

- The linear actuators consist of a cylinder, a cylinder head fixed to cylinder at one end, a piston slidable with in the cylinder, a rod extending outwardly.

b) DC Motor:

- The direct current (DC) motor converts the DC into mechanical work. The current carrying conductor placed in magnetic field and electric field it experiences the force which is Lorentz force. It works on the principle of Lorentz law.

Research paper link:

https://www.matecconferences.org/articles/matecconf/abs/2018/19/matecconf_eecr2018_05012/matecconf_eecr2018_05012.html

2. Automobile Electronic systems:

The electronic systems in automotive enables the driver comfort by driving act, fuel efficiency, in braking systems, telematics, safety airbags etc.

a) Engine electronic:

The engine electronics is the essential part of the automotive. The engines used in automobiles are fast and very complex. So, a 32-bit ECU powered processor are generally used. In modern vehicles they may have up to 100 ECUs and commercial vehicles may have 40 ECUs (NOx control, controlling of emissions, throttle, turbocharger, OBD, cooling etc)

Crankshaft position sensor-

The crank position sensors monitor the position of the crankshaft and also speed of the engine. So, without the crankshaft position sensor the engine will not start.

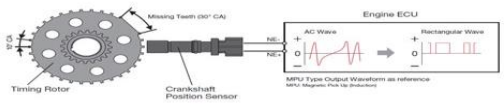

figure-1(Crankshaft position sensor)

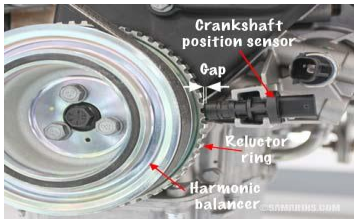

figure-2

Functions:

- The Crankshaft position sensor is located in the engine of a vehicle. The sensor records the rate of rotating of the crankshaft and passes the data to the ECU and decides the ideal fuel injection and regulation of ignition. Thus, it determines the effectiveness of the collected data.

Sensors:

There are two types of sensors used in the crankshaft position sensor

a) MPU Sensor

- The MPU sensors are used to calculate the crankshaft position, TDC, the rotational speed of the engine.

b) MRE Sensor

- The MRE sensor consists of a molded IC chip inside the cylindrical magnet.

c) Hall effect Sensor

- The hall effect sensors measure the change in voltage when placed in a magnetic field.

Actuators:

a) Camshaft actuator-
The camshaft actuator is the mechanical or electronic device which is mounted on the camshaft gear. Works when the camshaft opens or closes the intake or exhaust valves.

Electronic brake controller:

The Electronic brake controller helps to apply the electric trailer brakes. It helps the driver in the vehicle monitor the brake activity from the cab of the vehicle.

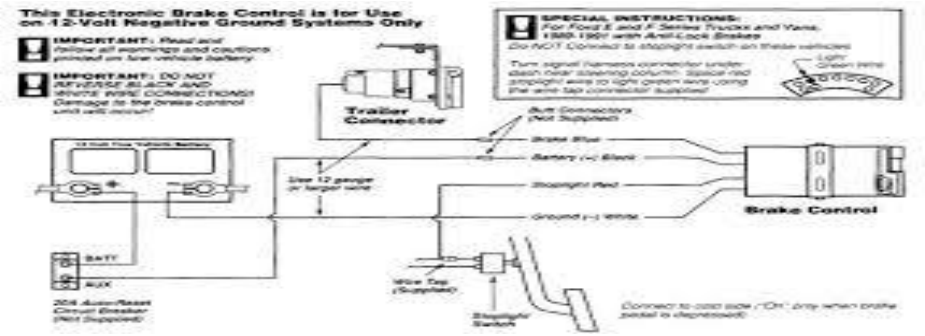

Figure-3(Electronic brake controller)

Function:

- The electronic brake controller is mounted in the cab of the vehicle which enables the interface to view the braking information and few buttons to control the manual activation and output

Sensors:

a) Accelerometer sensor:
- The accelerometer sensor is used to sense the changes in momentum in a vehicle.

b) Brake lever position sensor:
- The brake pedal position sensor alerts the other vehicle around whenever the driver stops or slows down the vehicle by illuminating the brake light at the behind.

Actuators:

a) Brake actuators:

- The brake actuators compress the air force in a vehicle into mechanical force which activates the brakes.

Washer fluid level sensor:

The washer fluid level sensor measures the fluid level in the washer reservoir.

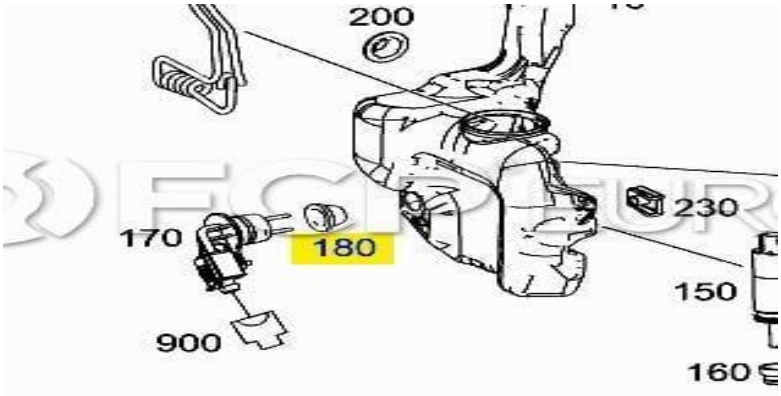

Figure-4(Washer fluid level sensor)

Function:

- The washer fluid level sensor warns in the dashboard to the driver if there is low fluid containing in the reservoir. This enables the driver to understand about the fluid level in the reservoir.

Sensors:

a) Reed Sensor

- The Reed sensor has a float with a magnet mounted which is generally placed in the reservoir. When the liquid level drops in the reservoir, the float goes down and this activates the Reed Switch. Thus, a lamp is then triggered on the dashboard in the vehicle.

Actuators:

a) Linear Actuators:

- The linear actuator has a simple mechanism which is more reliable which is designed to move in a straight line.

b) Rotary actuator:

- The rotary actuator creates a circular motion to complete a turning movement.

3. About ABS, TRC, VSC:

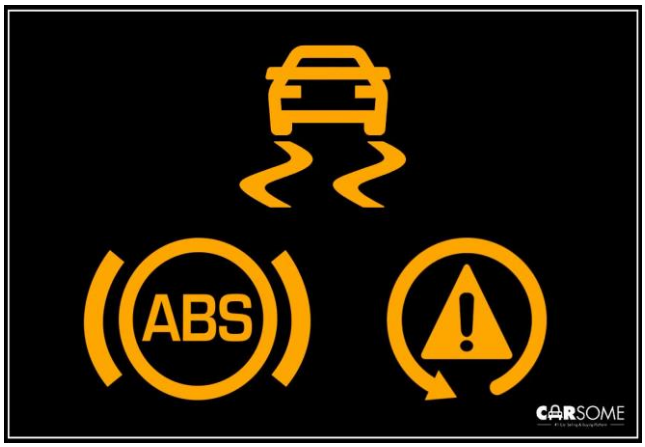

Figure-5 (Symbols of ABS, TRC, VCS in a vehicle)

a) Anti-Lock Braking System (ABS):

- The anti-lock braking system is the system where it ensures that the wheels from getting locked when the driver applies brakes suddenly. It avoids from skidding of wheels. This system provides smooth control to the driver in various situations and decrease stopping distances in an emergency case.

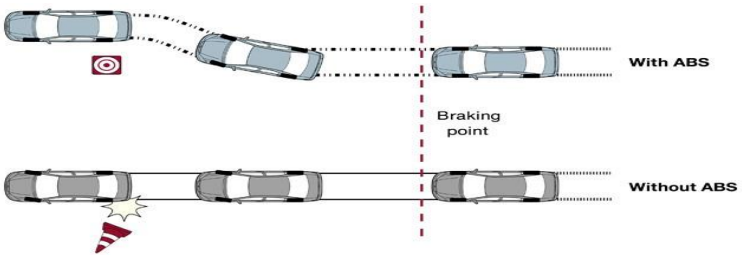

Figure-6(Anti-Lock Braking System)

b) Traction Control System (TRC):

- The traction control system is the system where it ensures that when the driver accelerates the vehicle with too much power it avoids the slipping of wheels and balances the throttle and traction on the road surfaces. This system works well in low traction situations. For an example rain and snow.

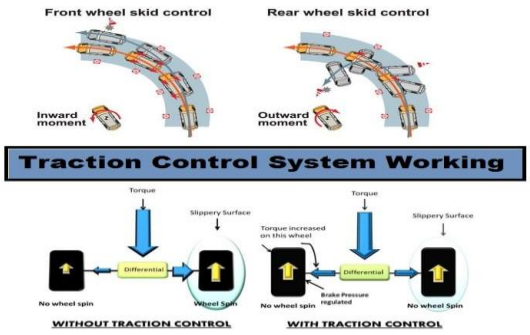

Figure-7(Traction Control System)

c) Vehicle Stability Control (VSC):

- The vehicle stability control is also knowns as electronic stability control or vehicle stability assist or dynamic stability control. The vehicle stability control system is the system where it ensures that the equal engine power is distributed to wheels so that it has good traction and control on the road surface.

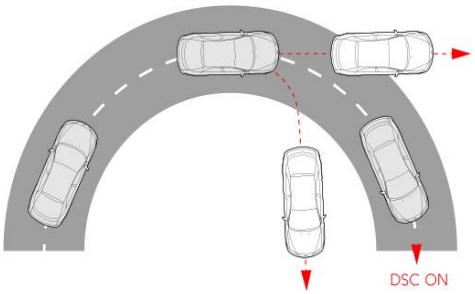

Figure-8(Vehicle stability Control)

Similarities:

- The similarities between the three sensor features enables the vehicle to allow optimal accelerative traction on any surface by measuring wheel spin, by controlling the vehicle and by employing throttle to trim power and slow the rotating wheel.

- The most common of these sensors which are mounted on the wheel speed sensors are sensor malfunctions. They can be either knocked out of alignment or become corroded or get damaged by the hazardous road surfaces.

- Mostly, The TCS and VSC are switched ON by the same button in the vehicle. These sensors' ABS, TCS, VSC provide safety and comfort to the driver and it ensures that the vehicle is smooth and controlled while moving on the road surface. They are continuously monitored on the on-board diagnostics in the vehicle.

Differences:

a) The anti-lock braking system (ABS) is effective in assisting with braking without skidding the wheels and also, allows the wheel-speed regulation required to limit the wheel-spin.

b) The Traction control system (TCS) ensures in assisting with acceleration without skidding.

c) The addition of the extra sensors enables ESC to offer the driver assistance in turning under hazardous conditions.

4. Differences between Active and Passive safety systems:

S.NO	Active Safety Systems	Passive Safety Systems
1.	The active safety systems are pre-crash systems.	The passive safety systems are post-crash systems.
2.``	They are hazard prevention systems.	They are damage reduction systems.
3.	These systems are reversible protection systems.	These systems are rescue systems.
4.	Controls vehicle dynamics and prevents from the accidents.	They protect occupants and pedestrians and help mitigating the consequences of accidents.
5.	They depend on people's behavior to reduce risk.	They do not depend on people's behavior to be effective.
6.	High cost of feature restricts introduction to small segments in vehicles.	Need to satisfy EUROCAP crash tests.
7.	Examples- • Anti-lock Braking Systems • Electronic Stability Control • Adaptive Cruise Control • Tire-pressure Monitoring systems • Lane Departure Warning • Night Vision Systems • Blind Spot Detection • Driver Monitoring • Road Sign Recognition • Automatic Emergency Braking	Examples- • Airbag • Seat belt • Occupant Sensing Systems • Whiplash Protection • Child Safety Systems • Pedestrian Safety Systems

5. Automotive Sensors (overview of vehicle electronics):

The three automotive sensors from overview of vehicle electronics are

a) Intelligent Route Planner
b) Adaptive LED Headlight
c) High Beam Assist

a) Intelligent Route Planner:

Function:

- The sensor will search and collect the traffic data and suggest the suitable roads to reach to the destination smooth and faster without using any smart phone app. Also, the planner will use the real time data -for suppose charging points for a vehicle, Gas stations, battery of the vehicle, Destination distance and decides the best route for the driver.

Principle:

- The intelligent route planner sensor will guide the driver in the vehicle in fastest route to arrive the given location, traffic conditions, road conditions,

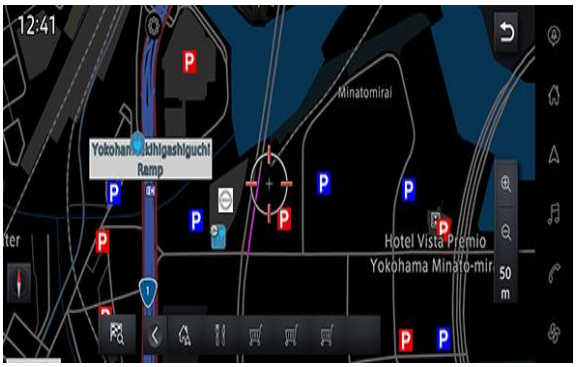

figure-9(Intelligent route planner)

Link-

- https://www.nissan-global.com/EN/TECHNOLOGY/OVERVIEW/irp.html

b) Adaptive LED Headlight:

Function:

- The adaptive LED Headlight sensor activates when driving with the headlight adjustment is in the AUTO position, the vehicle's high beam will remain on when the low light is detected. Also, if an incoming vehicle is detected by the sensor, the headlights will automatically shift from the high to low beam. As the vehicle is passed

away again automatically the high beam is switched ON. The Sensor is placed on the upper portion of the windshield for clear detection of the beam.

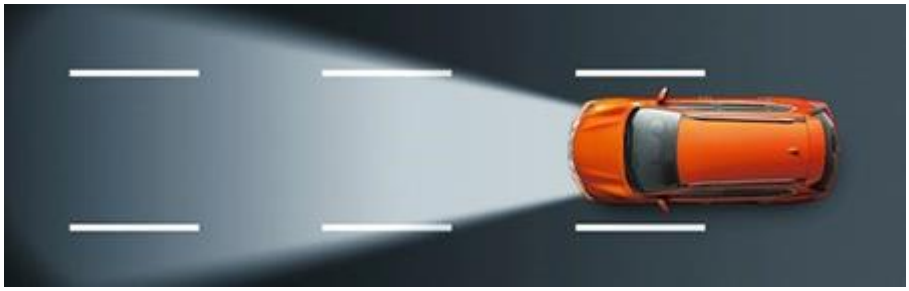

Figure -10(Adaptive LED Headlight on high beam)

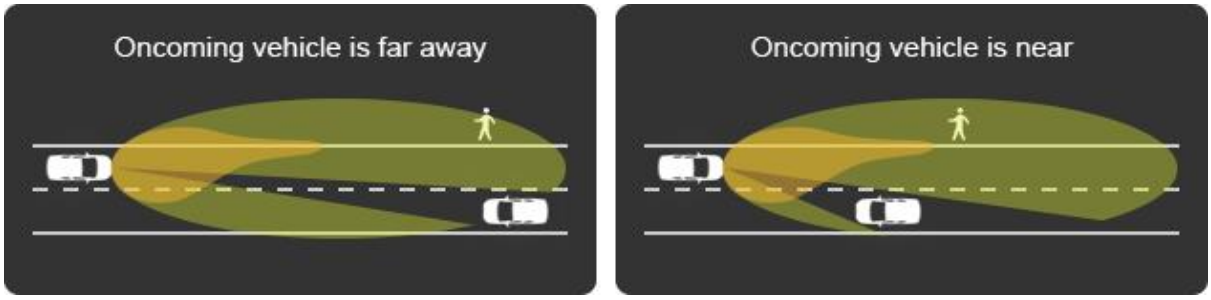

Figure-11(Adaptive LED Headlight on Low beam)

Principle:

- The adaptive LED Headlight sensor activates automatically whenever it detects the high beam approaching from the other vehicle. This system activates once the vehicle crosses above 19mph.

Link:

- https://www.nissan-global.com/EN/TECHNOLOGY/OVERVIEW/hba.html

c) Hands-free Automatic Sliding Door:

Function:

- The hands-free automatic door sensor in the vehicle activates when the passenger carrying the key approches near the vehicle, the two outer antennas fitted outside the handles of the door detects the passenger and opens the door automatically. The sensor detects only persons coming near by except animals or objects.

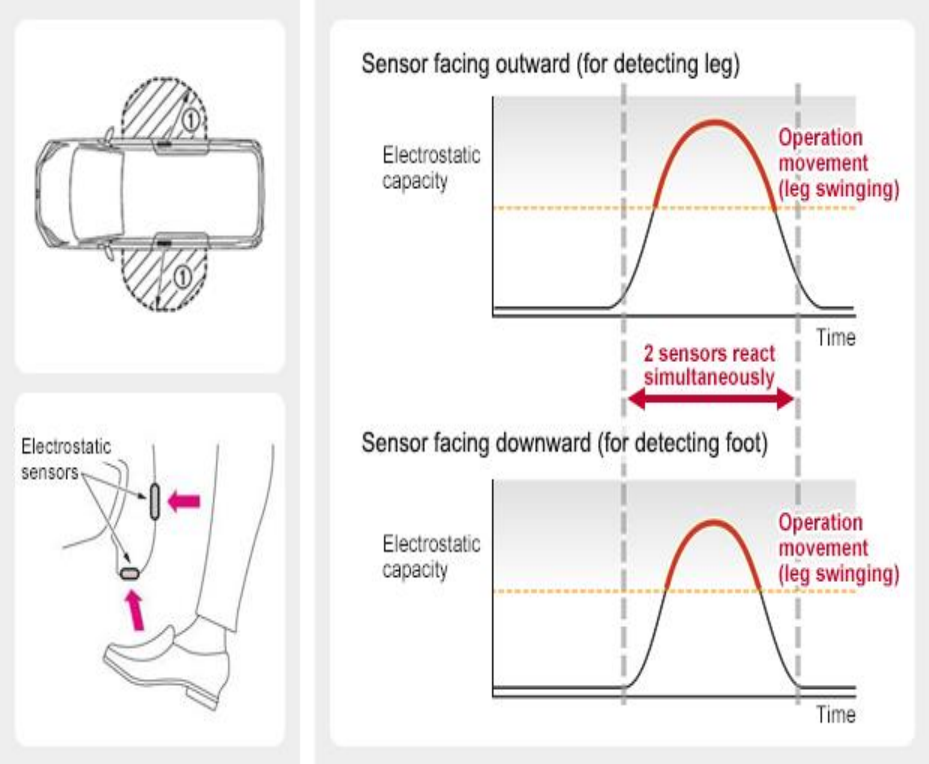

Figure-12(Hands-free automatic sliding door)

Principle:

- The hands free automatic sliding door sensor activates when the passenger comes near by to the door handle. It helps when the passenger is carrying shopping bags or in any emergency situations. Whenever the door opens the buzzer sound is given to the passenger.

Link:

- Hands-free Automatic Sliding Door | NISSAN | Technology (nissan-global.com)

6. Distance Sensors:

- Differences between Ultrasonic sensors, Radar sensors, Lidar sensors:

S.NO	Ultrasonic Sensors	Radar Sensors	Lidar sensors
1.	Principle- The utlrasonic sensors emit high frquency waves till the object and then, Again they collect the data by reciever which is reflected back to calculate the distance between the objects based on the time required.	Principle- The radar sensors uses radiwave signals for transmission and reception medium	Principle- The lidar sensors uses the laser beam for trasmission and reception medium
2.	The range of ultrasonic sensors is low.	The range of radar sensors is high.	The range of lidar sensors is high.
3.	The field of view is medium	The field of view is medium	The field of view is medium.
4.	The ultrasonic sensor resolution may be low	The radar sensor resolution may be high or low.	The lidar sensor resolution is low or high.
5.	The distance accuracy is low in longer wavelenth	The distance accuracy is high in longer wavelength.	The distance accuracy is low in longer wavelength.
6.	Temperature fluctuation effects the ultrasonic sensors.	It can even operate in even bad conditions.	Performance can be degraded withbad atmospheric conditions.
7.	Applications- • Anti-collision tests • People detection • Contouring or profiling • Presence detection • Easy control of trash collection vehicle.	Applications- • Object detection • Tracking • Weather tracking • Ground penetrating • Strong metal object reflection	Applications- • Lowreflection objects • Vehicle anti-collision. • To analyze targets in dust, smoke, rain, non metallic objects.

7. About Hall Effect Sensor:

- The hall effect is the difference of a production voltage that is transverse to the electric current in the conductor(electric) and applied magnetic field which is perpendicular to the current. They are mainly used to measure the density of the carrier of a current and also detects the presence of current in the magnetic field.
- The hall effect is calculated by

$$VH=IB/qnd$$

Where,

i. I is the current flowing through sensor.
ii. B is magnetic field strength.
iii. q is charge.
iv. n is number of a charge carriers per unit volume.
v. d is thickness of the sensor.

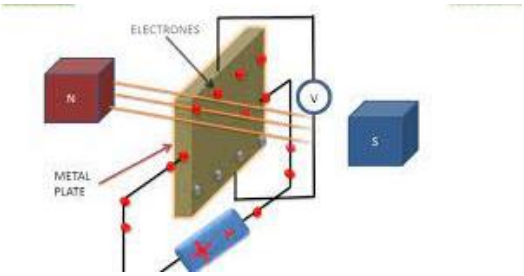

Figure-13(Hall Effect principle)

Effect:

- The hall effect sensors are vertically oriented at 90 degrees allows the system to detect the wheel rotation speed and rotational direction speed. To detect the rotation wheel speed and rotational direction it requires two halls plated. Due to the distance between the two plates the different signals are slightly detected at any time (phase difference).
- The phase change in polarity the rotational direction is detected and the corresponding signal is delivered.
- In addition, the rotation wheel speed can be calculated from the output signal which is triggered by each polarity change in the magnetic field.
- The sensors are sensitive to the magnetic fields in the plane direction which gives flexibility to place into the given space constraint areas.

figure-14(Hall sensor detects rotation wheel and direction)

8. Automotive actuators:

Actuator:

- The actuators is apart which is used to initiate the motion after receiving the feedback or input from the control signals.

Types of actuators:

i. Linear Actuators
ii. Rotary Actuators
iii. Hydraulic Actuators
iv. Electric Actuators
v. Pneumatic Actuators

i. Linear Actuators:

- The linear actuators are the devices that produces movements in the straight direction. These types of actuators can be mostly seen in hydraulic or a pneumatic type of devices.
- The linear actuators can be electrical or mechanical type of actuators.

Applications:

- They are used to control air-flaps for torque and power optimization.
- To maintain the height, angle of seats and steering column to create comfort to the passengers.
- TO activate the seat cushions which is present underneath of the seat surface.
- They are used in the fuel filler flaps. Boot lids, sunroofs, storage compartments.

ii. Rotary Actuators:

- The rotary actuators are the devices that produces the movements in the circular direction. These types of actuators are used to create the turning movements.
- The most of the rotary actuators are electrically powered but rest are powered by pneumatic or hydraulic actuators.

Applications:

- They are widely used to create turning movement in the windshield wipers.
- They are used in AC or DC, asynchronous, synchronous motors.

iii. Hydraulic Actuators:

- The hydraulic actuators is the device used to create linear motions. These actuators consist of a fluid-filled cylinder with a piston in the center, a spring is attached at one end to create a motion (return motion).

Applications:

- They are used in clutch and brake applications.
- They are even used in speed and load sensing devices.

iv. Electric Actuators:

- The electric actuators are the devices which creates the precise motion as flow of electrical power is constant. They transform an input signal to an motion.
- The different types of electric actuators are electromechanical and electrohydraulic actuators

Applications:

- They are used in fuel pump to give fuel for engine at right pressure which is suitable.
- They are used in fuel injectors to provide the fuel in the right operation time.
- They are used in the A/C compressor control in-order to improve the acceleration of the engine by temporary turning of the A/C compressor.

v. Pneumatic Actuators:

- The pneumatic actuators are used to create the mechanical movements. They convert the energy of air or gas which is compressed to a mechanical motion that regulates the control elements.

Applications:

- They are widely used in bus brakes
- They are used in pressure sensors
- They are most used in pistons and ignition chambers in gasoline powered vehicles.

9. Difference between DC motors and AC motors:

	S.NO	Alternating Current (AC)	Direct Current (DC)
PRINCIPLE	▪	The alternating current consists of a wire coil and two fixed magnets surrounding the shafts. When the motor is applied to wire coil which is subjected to the electromagnet then magnetic field is generated. This depends on principle of magnetism.	The direct current (DC) motor converts the DC into mechanical work. The current carrying conductor placed in magnetic field and electric field it experiences the force which is Lorentz force. It works on the principle of Lorentz law.
PROPERTIES	1.	It is powered by AC current.	It is powered by DC current.
	2. .	The AC motor requires the conversion of current.	The DC motor does not require any type of the conversion of current.
	3.	They can be Single-Phase or Three-Phase motors.	They are only Single-Phase motors.
	4.	Armatures in AC current motors do not rotate while magnetic field continuously rotates.	The armature in a AC motors rotates while the magnetic field does not rotate.
	5.	The AC motor does not use brushes.	The DC motor uses brushes.
	6.	The AC motor has long life span.	It has short life span.
	7.	The speed of AC is controlled by varying frequency of current.	The speed of the DC motor is controlled by varying armature windings current.
	8.	It requires capacitor to start the operation.	It does not require any external help.

APPLICATIONS	1.	Rotating the position in electric vehicles.	In electric power steering.
	2.	They used in electric windows.	Used in hybrid-diesel rail cars.
	3.	Used in Door lock mechanisms in vehicles.	They are used in traction motors.
	4.	Used in seat cooling fan motors.	Used in hybrid wheel loader and also, used in hybrid excavators.
	5.	They are used in electric parking brake.	

- The three different electric vehicle motors that they are using as their powertrains-

➢ Tesla model-y:

- The tesla model-y uses Alternating current (AC) motor as their powertrains.

➢ Mercedes Benz-EQS:

- The Mercedes Benz-EQC uses Alternating Current (AC) asynchronous type motor as their powertrains.

➢ Tesla model-X:

- The tesla model-X uses dual motor as their powertrains. The dual motor is type of motor in front and the other motor in rear of the vehicle. One is optimized for power and other one is for range. Even car drives well if a motor breaks down.

➢ Audi e-Tron:

- The Audi e-Tron uses Alternating Current (AC) asynchronous type of motor as their powertrains.

➢ Hyundai Kona:

- The Hyundai Kona uses Alternating Current (AC) permanent magnet synchronous type of motor as their powertrains.

10. Difference of Hot Plugs and Cold Plugs:

	S.NO	Hot plugs	Cold Plugs
PRINCIPLE	▪	A spark plug is said to be hot if it is better heat insulator, keeping more heat in that insulator tip of the spark plug.	A spark plug is said to be cold if it can conduct more heat out of the plug tip and lower the tips temperature. .
PROPERTIES	1.	Large surface area exposed in the combustion gases.	Smaller surface area exposed to the combustion gases.
	2. .	Dissipates the heat slowly and running too hot plugs can cause severe engine damage.	Dissipates heat quickly and the plugs may get easily fouled.
	3.	Hot plugs have long insulator tip.	Cold plugs have short insulator tip.
	4.	They are used to operate in cold weather conditions.	They are used to operate in hot weather conditions.
	5.	More likely to cause pre-ignition.	Less likely to cause pre-ignition.
	6.	Its fitting end heats up quickly.	The fitting end does not heat up quickly.
	7.	The plugs always stay toasty warm even when	The cooler tips operate at lower temperate to allow the plug to remove the

		cold air is bought into the engine.	excess heat more efficiently from the engine.
APPLICATIONS	1. 2. 3.	The hot plus is used to generate rich air-fuel ratios. They are in hot weather conditions. The hot plugs are used in low rpm.	The cold plugs re necessary if the ignition timing has been advanced to near knock level Used in hot weather conditions. The cold plus are used in high rpm.