Active Safety and Passive Safety Systems for M Category Vehicles

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Abstract: Two vehicles from the M category will be taken and the active safety and Passive safety systems shall be compared. Any three Active Safety Systems and Passive Safety Systems will be taken the parameters chosen are Blind Spot monitoring, Pedestrian Safety and Collision Avoidance system for Active Safety System Based on findings the Automobile safety design ergonomics study is made.

1. INTRODUCTION

The auto industry is facing tough competition and severe economic constraints. Their products need to be designed "right the first time" with the right combinations of features that not only satisfy the customers but continually please and delight them by providing increased functionality, comfort, convenience, safety, and craftsmanship [1]. Based on the author's forty plus years of experience as a human factor's researcher, engineer, manager, and teacher who has conducted numerous studies and analyses, Ergonomics in the Automotive Design Process covers the entire range of ergonomics issues involved in designing a car or truck and provides evaluation techniques to avoid costly mistakes and assure high customer satisfaction [2]. The book begins with the definitions and goals of ergonomics, historic background, and ergonomics approaches. It covers human characteristics, capabilities, and limitations considered in vehicle design in key areas such as anthropometry, biomechanics, and human information processing. It then examines how the driver, and the occupants are positioned in the vehicle space and how package drawings and/or computer-aided design models are created from key vehicle dimensions used in the automobile industry. The author describes design tools used in the industry for occupant packaging, driver vision, and applications of other psychophysical methods. He covers important driver information processing concepts and models and driver error categories to understand key considerations and principles used in designing controls, displays, and their usages, including current issues related to driver workload and driver distractions. The author has included only the topics and materials that he found to be useful in designing car and truck products and concentrated on the ergonomic issues generally discussed in the automotive design studios and product development teams [3]. He distils the information needed to be a member of an automotive product development team and create an ergonomically superior vehicle. Car safety is very important to reduce the occurrence of vehicle accidents. A broader scope of car safety is road traffic safety broadly. Car safety is very important to reduce the occurrence of vehicle accidents and its consequences. A broader scope of car safety which is road traffic safety broadly includes the roadway design. Passenger safety occupies a prime spot in the automobile sector today. Stakeholders across the automobile value chain acknowledge the importance of passenger/occupant safety and are constantly upgrading their offerings to provide fail safe safety technologies that will protect passengers and pedestrians. Proactive policy implementation and consumer awareness has played a key role in making automotive safety systems popular.[4]

ACTIVE SAFETY: An active safety. system works to prevent an accident. These systems always stay active while you drive, and continuously work to keep you from getting into an accident Most active safety features are electronic and controlled by a computer. They include traction control electronic stability control and braking system. These include advanced driver assist system that use sensors such as forward collision warning and Tane departure warning, along with adaptive cruise control. Actively help the driver to reduce the impact of an emergency. To that end, various safety systems constantly monitor the performance and surroundings of a vehicle. Active Safety System play a preventive role in mitigating crashes and accidents by providing advance warning or by providing the driver with additional assistance in steering/controlling the vehicle. Head-Up Display (HUD), Anti-Lock Braking Systems (ABS), Electronic Stability Control (ESC), Tire Pressure Monitoring System (TPMS), Lane Departure Warning System (LDWS), Adaptive Cruise Control (ACC), Driver Monitoring System (DMS), Blind Spot Detection (BSD) and Night Vision System (NVS) are common Active Safety Systems. Passive Safety Systems play a role in limiting/containing the damage/injuries caused to driver, passengers, and pedestrians in the event of a crash/accident.[4] Airbags, Seatbelts, Whiplash Protection System etc. are common Passive Safety Systems deployed in vehicles these days.

PASSIVE SAFETY: Passive safety features are those that help to protect vehicle occupants from further injury once a crash has already occurred. which aim to prevent before or mitigate crashes when they do happen – the main function of passive safety features is to keep the driver and passengers protected within the vehicle from various crash forces. Passive safety systems protect the occupants of a vehicle and other road users if a crash occurs. They do this by reducing the impact of an accident or the level of injury. A passive safety system that does not do any work until it is called to action. These features become active during an accident, and work to minimize damage and reduce the risk of injury during the time of impact. These systems are seat belts, air bags, and the construction of the vehicle. These devices automatically deploy when the car gets into a crash.

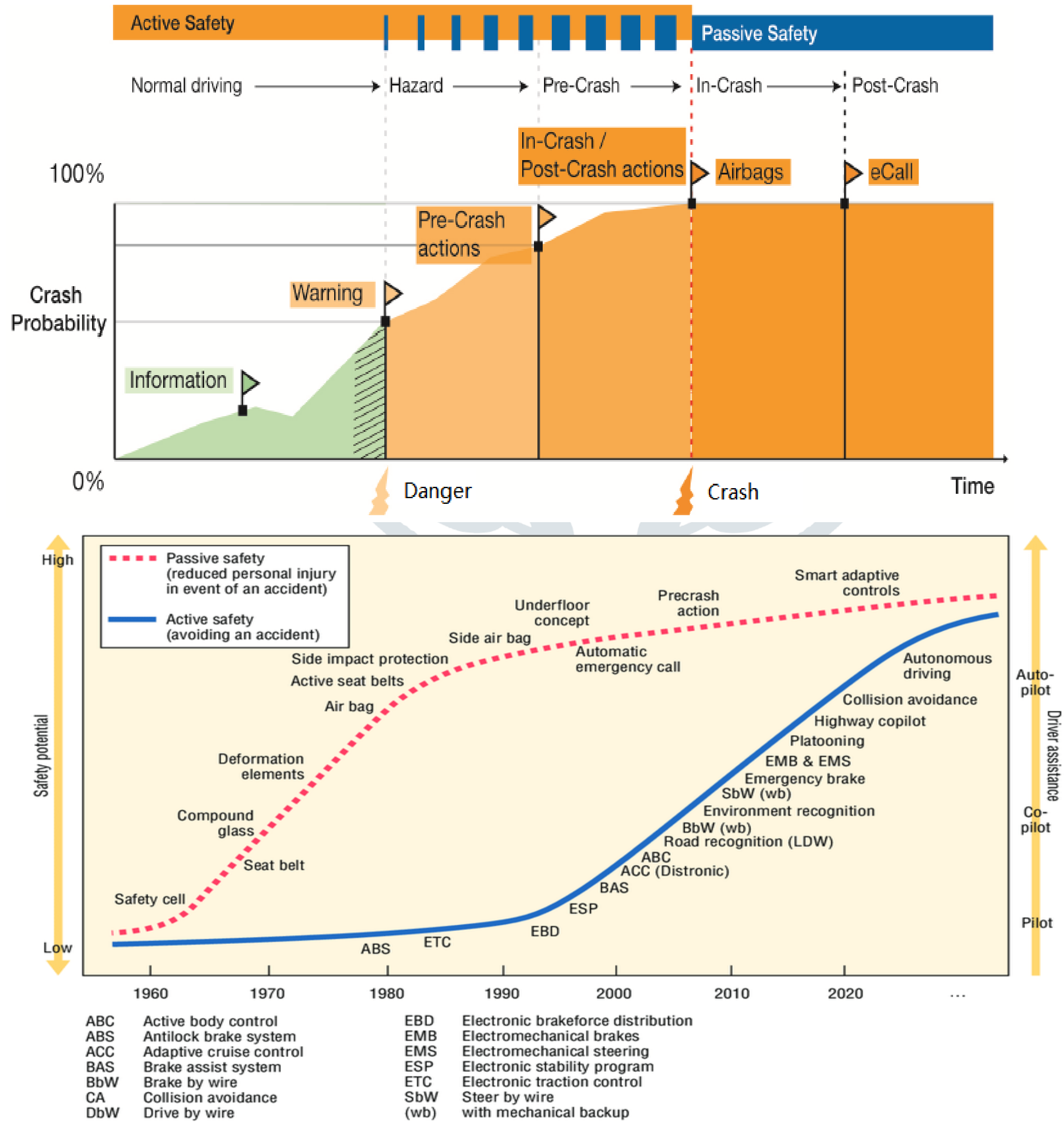


Fig 1. This graph explains about crash probability of active safety ang Passive safety [5]

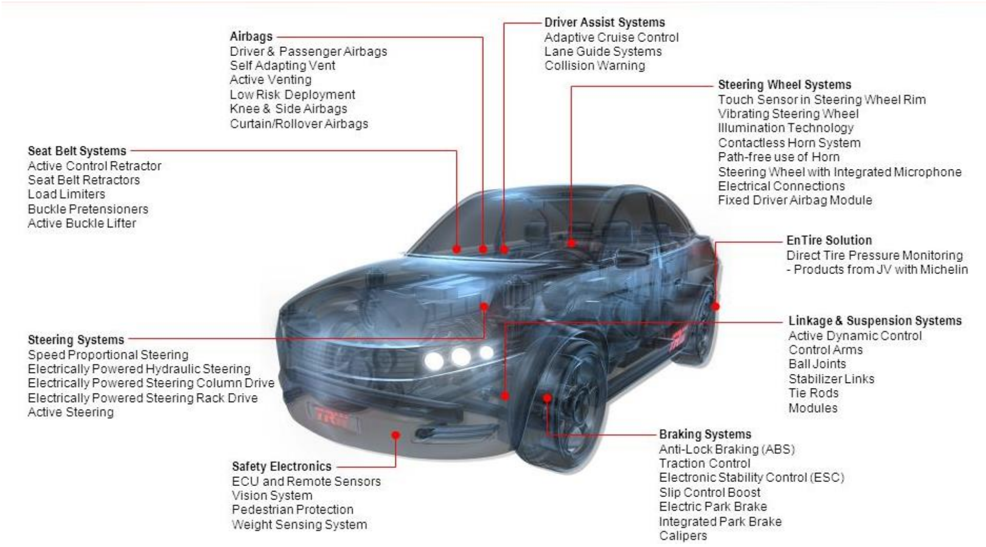


Fig.3 This figure explains about detail mounting place of active and passive safety of the vehicle

VEHICLE CATEGORY

VEHICLE CATEGORY	DESCRIPTION
L	Motor vehicles with less than four wheels [but does include light four-wheelers]
M	Vehicles having at least four wheels and used for the carriage of passengers
M1	Vehicles used for carriage of passengers, comprising not more than eight seats in addition to the driver’s seat = 9.
M2	Vehicles used for carriage of passengers, comprising more than eight seats in addition to driver’s seat and having a maximum mass not exceeding 5 tonnes.
M3	Vehicles used for carriage of passengers, comprising more than eight seats in addition to driver’s seat and having a maximum mass exceeding 5 tonnes.
N	Power driven vehicles having at least four wheels and used for carriage of goods.
O	Trailers including semi- trailers.

Table 1 various list of vehicle category [4]

M category

M: Vehicles having at least four wheels and used for the carriage of passengers

M1: Used for the carriage of passengers, with no more than eight seats in addition to the driver seat, also known as passenger cars.

M2: Used for the carriage of passengers, having a maximum mass not exceeding 5 tonnes.

M3: Used for the carriage of passengers, having a maximum mass exceeding 5 tonnes.

2. Active safety systems:

1. Lane departure prevention technology

Need: A lane departure warning (LDW) system is an advanced safety technology that alerts drivers when they unintentionally drift out of their lanes without a turn signal. a lane departure system warns you with a beep, vibration, or visual cue on the instrument panel.[6] If the vehicle also is equipped with lane keeping assist, it will go beyond just a warning: It will make a minor steering or braking correction to keep the car in its lane.

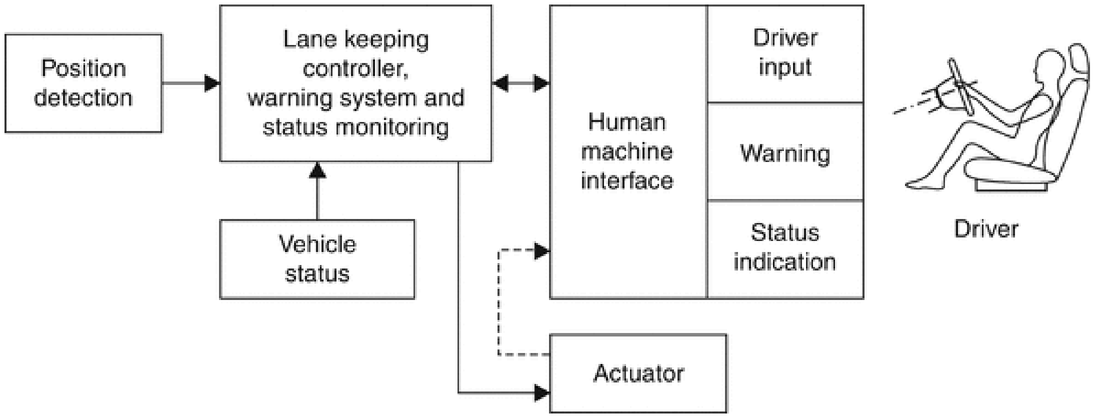


Fig: 4 Lane keeping control system

- Helps to avoid accidents which are caused by unintentional straying from the marked lane.
- Allows to early correct driving mistakes.
- Supports to stay in the lane when being inattentive.
- Helps to avoid accidents which are caused by unintentional straying from the marked lane.
- Records lane markings up to approximately 60 meters ahead
- Warning signal allows the driver to counter steer in time.

Principle: Lane departure warning uses a video camera to detect lane markings ahead of the vehicle and to monitor the vehicle's position in its lane. When the function detects that the vehicle is about to unintentionally move out of the lane, it warns the driver by means of a visual, audible and/or haptic signal, such as steering wheel vibration. These warnings signal the driver that the vehicle is drifting. Allowing him/her to counter steer accordingly. The function does not issue a warning when the driver activates the turn signal to change lanes or turn intentionally.

Fig:5 video camera device

The camera 's lane detection algorithm records and classifies all common lane markings up to approximately 60 meters ahead (or up to 100 meters in excellent visibility conditions), whether the road markings are continuous, dashed, white, yellow, red or blue. The camera can even detect Botts' dots (raised highway markers).

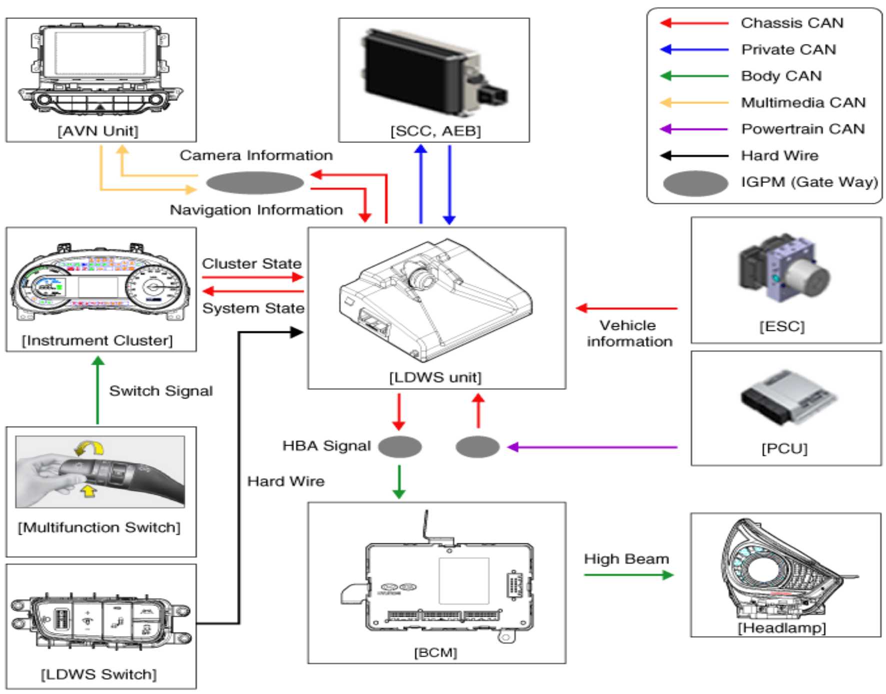


Fig.6 Detail sketch of lane departure in step-by-step process

Testing: The vehicle tires shall be inflated to the recommended cold inflation pressure as specified on the vehicle placard or optional tire inflation pressure label.

- All non-consumable fluids must be at 100 percent capacity. Fuel must be maintained at least 75 percent capacity during the testing.
- The vehicle shall be loaded with one driver and all required equipment during the testing. Where possible, the equipment shall be placed on the passenger side of the vehicle. The vehicle weight should be measured and recorded with the driver and all required equipment included.
- Vehicle dimensional measurements shall be taken. For purposes of this test procedure, vehicle dimensions shall be represented by a two-dimensional polygon defined by the lateral and longitudinal dimensions relative to the centroid of the vehicle using the standard SAE coordinate system. The 12 corners of the polygon are defined by the lateral and longitudinal locations where the plane of the outside edge of each tire contacts the road. This plane is defined by running a perpendicular line from the outer most edge of the tire to the ground. Use of a highly accurate measurement arm (FARO or equivalent) is recommended for making the vehicle dimension measurements.
- The vehicle's wheelbase and the lateral and longitudinal locations where the plane of the outside edge of each tire makes contact with the road shall be measured and recorded[7]. This plane is defined by running a perpendicular line from the outer most edge of the tire to the ground.
- The lateral, longitudinal, and vertical position of the GPS antenna shall be measured and recorded.
- Tests are conducted on a dry, uniform, solid-paved surface. Surfaces with irregularities, such as dips and large cracks, are unsuitable, as they may confound test results. The test surface shall have high contrast line markings defining a single roadway lane edge.

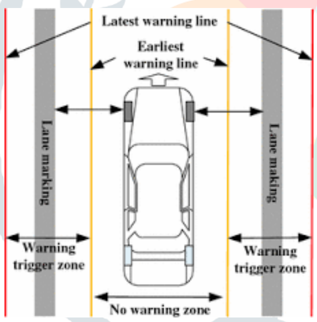


Fig: 7 warning lines [7]

Cameras Required:

CAMERA 1*:* Real-time video inside of the SV.

CAMERA 2: Real-time video camera to one side of the most significant even area of the test.

CAMERA 3: A still camera to document the vehicle.

CAMERA 4: If applicable1, real-time video clearly documenting the LDW driver vehicle interface (DVI) during at least one test sequence (e.g., left departures approaching / driving over a solid white line).

CAMERA 5: If applicable, real-time video clearly documenting the driver-vehicle interface (DVI) during at least one supplemental LKS test sequence.

Potential triggering events identified for the camera sensor.

Triggering Event ID	Triggering Event	Relevant Potential Hazard(s)
CS-1	The camera sensor may not detect the lane boundaries because the lane markings are partially or fully covered.	H1, H2, H3
CS-2	Obstructions may block the camera’s view of lane markings, vehicles, or other objects.	H1, H2, H3
CS-3	The camera may have deteriorated performance in environmental conditions that reduce visibility, such as weather or low lighting.	H1, H2, H3
CS-4	Environmental noise factors, such as light reflection or shadows, may affect the camera’s ability to detect lane markings, vehicles, or other objects.	H1, H2, H3
CS-5	The camera may not detect roadside landmarks, such as concrete barriers or guardrails, if there is low contrast between the landmarks and the roadway or other environmental features.	H1, H2, H3
CS-6	The camera may not detect lane markings if the lane markings have low contrast with the pavement or are below a minimum size or quality.	H1, H3
CS-7	The vehicle or object in an adjacent lane may be outside the camera’s field-ofview.	H2, H3
CS-8	If lead vehicle tracking is used in the absence of clear lane markings, the lead vehicle may exceed the visual range of the camera.	H1
CS-9	The camera may have limitations individually tracking multiple objects that are close together and moving at similar speeds.	H2
CS-10	The camera may not be able to detect certain road surface or environmental conditions, such as black ice.	H1, H3

Table 2: Potential triggering events identified for the camera sensor [5]

LIST OF THE VECHICLES USING LINE DEPATURE

- 2021 Hyundai Sonata
- 2020 Toyota Camry
- 2020 Volkswagen Jetta SE

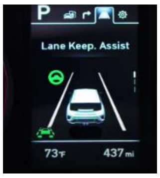
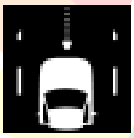
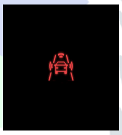
Vehicle	A	B	C
Year and Make	2021 Hyundai	2020 Toyota	2020 Volkswagen
Model	Sonata	Camry	Jetta
Body Style	4-door sedan	4-door sedan	4-door sedan
Lane Departure warning			
Trade Name	Lane Keep Assist	Lane Departure Alert	Lane Asist
Technology	optical sensor	Camera sensor	camera
Sensor Location(s)	windshield	A camera on a windshield	A camera on the interior rear-view mirror
LDW Icon			
Icon Description	Doted two vertical lines in the middle of car symbol	Car symbol with a vertical line	Car symbol with a red colour vertical line
Audible Warning	Beep sound	Beep sound	Beep sound

Table.3 Description view of Lane departure.

Pre-Crash Scenarios

The target crash population was divided into seven pre-crash scenarios (and an additional "Other and Unknown" scenario) based on a combination of the GES Critical Event and Movement Prior to Critical Event variables. The Movement Prior to Critical Event variable describes the vehicle's activity prior to the driver's realization of an impending critical event, or just prior to impact, if the driver took no action to attempt any evasive manoeuvre. These scenarios qualitatively represent the dynamics of the vehicle immediately prior to the collision. Each of these scenarios represents a distinct subset of the lane change family of crashes, characterized by distinct vehicle trajectories and distinct patterns of driver actions. The "other and unknown"[8] scenario includes both crashes in which the pre-crash movement of one or both vehicles could not be determined from the GES data, as well as crashes in which the pre-crash movement could be determined, but there were too few crashes with those characteristics to merit being classified as a distinct scenario.

This Table provides the 95% confidence bounds on GES estimates of crash counts for each of the 8 pre-crash scenarios.

The classification of these seven pre-crash scenarios is needed as a basis for the development of performance guidelines and objective test procedures for appropriate countermeasure systems, and for the collection of drivers. Performance data with and without the assistance of these systems to design better warning algorithms and driver-vehicle interfaces and to assess their impact on safety.

Table 1. Upper and Lower Confidence Bounds on Frequencies of Lane Change Pre-Crash Scenarios.

Scenario Number	Scenario Name	Number of Crashes	Lower 95% Confidence Bound	Upper 95% Confidence Bound
1	"Typical" lane change	207,000	190,000	224,000
2	Turning at intersection	89,000	74,000	103,000
N/A	Other and unknown	64,000	53,000	76,000
3	Drifting	62,000	51,000	73,000
4	Passing combined with turning	46,000	37,000	55,000
5	Passing	27,000	21,000	33,000
6	Leaving parked position	25,000	20,000	31,000
7	Merging	19,000	14,000	24,000
	Entire Target Population	**539,000**	**470,000**	**608,000**

Table:4 Lane Change Pre-Crash Scenarios[8][.

Vehicle Type Distribution for Pre-Crash Scenarios

Knowing the relative involvement of different vehicle types for the various scenarios is useful for many reasons. It is important to know what proportion of the crashes involves light vehicles. (Note, these include crashes in which only one of the two vehicles involved is a light vehicle.) Additionally, it is useful to know a quantitative distribution of the other vehicle types with which light vehicles are colliding in lane change crashes, as well as the relative distribution of light vehicles between the different roles in the lane change crash scenarios (i.e., lane-changing vehicle versus vehicle going straight), to better understand of the dynamics of lane change crashes involving light vehicles, and to prioritize problems that need to be addressed by the countermeasures developed.

This Table shows that a large share (10%) of typical lane change crashes involve trucks changing lanes and light vehicles going straight. In contrast, 4.7% of the crashes in this scenario involve the reverse combination, trucks going straight and light vehicles changing lanes. This is attributed to the fact that trucks are large vehicles, more likely to collide with a vehicle in an adjacent lane while moving over to the next lane.

Table 2. Distribution of Scenario 1 (Typical Lane Change) Crashes by Type of Vehicle Involved

Vehicle Changing Lanes	**Vehicle Going Straight**					**Subtotal**
	Light Vehicle	***Truck***	***Bus***	***Emergency Vehicle***	***Other Vehicle***	
Light Vehicle	75.7%	4.7%	0.5%	0.3%	1.5%	***82.7%***
Truck	10.2%	0.8%	0.0%	0.0%	0.2%	***11.2%***
Bus	0.3%	0.2%	0.0%	0.0%	0.0%	***0.4%***

Emergency Vehicle	0.1%	0.0%	0.0%	0.0%	0.0%	***0.2%***
Other Vehicle	5.2%	0.0%	0.0%	0.0%	0.3%	***5.5%***
Subtotal	***91.5%***	***5.7%***	***0.5%***	***0.3%***	***2.0%***	**100.0%**

Table:5 Typical Lane Change Crashes by Type of Vehicle Involved

A Brief History of Lane Departure Warnings

Back in 1992, Mitsubishi unveiled a very basic camera operated tracking system that could track lane markings on the road. If the driver drifted across those road markings, an alarm would sound to warn the driver. This was available on the Mitsubishi Debonair, and it was the world's first lane departure warning system [6]. In the years that immediately followed other manufacturers scrambled to catch up and develop systems of their own.

The Evolution of the technology:

Throughout the 90's the lane departure warning systems became quite a common feature on many different cars. However, the core system of a tracking camera mounted above the windscreen to scan the road ahead remained. The road would be scanned for dotted and straight-line markings at the left and right of the car. The method of warning developed to lights, soft chimes and even vibrations through the steering wheel Toyota had the next breakthrough in lane departure technology in 2004. They added a system to the Crown Majesta model that would monitor the road conditions and assist the driver. This was achieved by sending commands to the power steering system to subtly encourage the driver to make a steering correction. This is when the terms, such as lane keeping assist, lane assistance, and lane assist began to be used. We were quite a way off from an autonomous car, but some drivers resisted these developments. A vocal minority rejected the idea of losing some of their autonomy, but over time people seemed to get used to the technology. It also helped that many subsequent systems could be turned off completely if the driver wished to do so.

Data Communications

- Communication with ECM: CAN bus

1. Image sensor communication: AV IN*4

- Control Panel (LCD) communication: NTSC/I2C

Actuators

Audible warning alarm, visual indicator, steering wheel vibrator, electronic power steering, brakes

BLIND SPOT:

NEED: Blind spots are the areas to the sides of your car that can't be seen in your rear mirror or side mirrors- to make sure these spots are clear before changing lanes, you'll have to physically turn around and look to see what kind of crazy stuff is going on out there. All it takes is a shoulder check and a mirror check to make sure you're safe to move over. A quick glance is simple enough, right? You don't have to be an advanced driver to master this skill [9].

Anytime you're changing lanes or merging, you'll want to check for any car blind spots in your driver view first. Flip on your turn signal to let other cars know you'll be moving over and check your rear mirrors and side car mirrors. Finally, you'll want to do a quick shoulder check one last time. If you don't see any cars currently in these spaces, or any cars quickly approaching these areas around you, you're safe to flip on that turn signal and change lanes. Be sure to hold your steering wheel steady anytime you're doing one of these checks, so you don't veer out of your lane accidentally while making sure the coast is clear. You will also want to make sure you keep your rear windows clear from any obstructions in your visual field whenever you're driving so you don't create more blind spots for yourself. Keep anything you have loaded in the back of your car away from the windows if possible. If you're driving with passengers, you can always ask for driver assistance from them if they have a better view of your blind spots.

- Monitors the areas beside and diagonally to the rear of the vehicle.
- Identifies vehicles in the vehicle's blind spot and immediately displays a warning in the side view mirror.
- Additional warning occurs when the turn signal is switched on.

- Categorizes detected objects by their relevance to prevent false alarms.

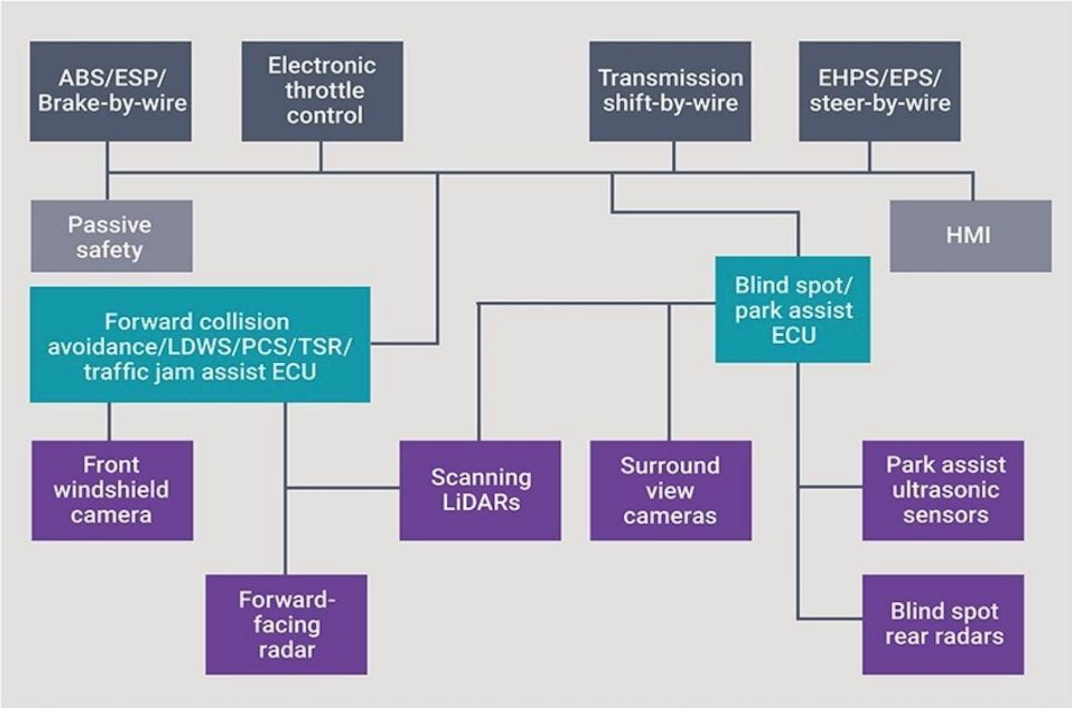


fig.8 Tree diagram of blind spot

Principle: Two ultrasonic sensors on each side of the vehicle serve as electronic eyes and monitor the space in the adjacent lane, allowing the system to cover the dangerous blind spot. If another vehicle is situated in the monitored area, the driver is alerted to the potential danger by means of a warning sign in the side mirror. If the driver fails to spot or ignores this warning and activates the turn signal to change lanes, the system can also trigger an audible warning. The system recognizes stationary objects on or alongside the road, such as guardrails, masts or parked vehicles, as well as the driver's own overtaking manoeuvres – and does not trigger the warning in this case.

Fig.9 **Blind Spot detection sensor**

Testing: The propose BSDWS includes two radars which were installed left and right inside of rear bumper. The radar system can detect the targets which come into rear blind spot area and obtain target relativity distance, azimuth and speed. The system control algorithm determines whether there are any collision risks in the rear blind spot area. The blind spot area was the viewing angle area on the left and right sides behind the vehicle. It was not covered by the external and internal mirrors, The horizontal viewing angle of radar was 130◦ and vertical viewing angle was 18◦.[10] The detection area covered 30–50 m behind the vehicle and 3-3.5 m width on both sides, including behind 3 m and 3 m width blind spot warning area in both sides. The left side blind spot area is smaller than right side blind spot area. Besides, the target vehicle tracking will improve system safety and give driver enough reaction time to avoid collision accidents. The blind spot and target vehicle tracking areas.

The BSDW system required a longitudinal detection distance with a maximum range of 5.5–32.5m. The lane changes assistant system named LCAS was the expansion system of the BSDW system. LCA system could reduce 15% to 40% side traffic collision accident.

- The proposed BSWS is a fully vision-based BSD system by using computer vision techniques, such as dynamic camera calibration and image pre-processing methods. Therefore, the proposed BSWS can be easily implemented only using cameras as sensors.

- This study presents two vision-based BSD algorithms according to daytime and night-time conditions. For daytime and night-time conditions, this study presents an edge-based approach and a paired-headlight-based approach to detect the shadow regions and paired headlights of vehicle obstacles as features for BSD.
- Additionally, the proposed BSWS is implemented on a DSP-based platform for practical demonstration. This study evaluates the proposed system in practical by using only two cameras, which are installed below the rear-view mirror on both sides of our camera-assisted experimental car, a Taiwan iTS-II. The experimental results of the proposed BSWS are evaluated under both daytime and night-time conditions.

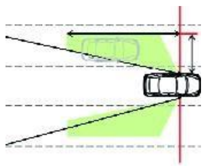
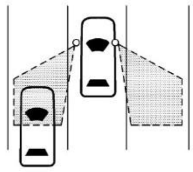
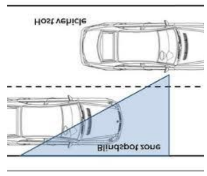
Vehicle	A	B	C
Year and Make	2021 HYUNDAI	2020 TOYOTA	2020 VOLKESWAGEN
Model	Sonata	Camry	Jetta
Body Style	4-door sedan	4-door sedan	4-door sedan
Blind Spot Detection			
Trade Name	*Blind-Spot Collision-Avoidance Assist*	*Blind Spot Monitor*	*Blind Spot Monitor*
Technology	Radar	Radar	Radar
Sensor Location(s)	These sensors are located behind the rear bumper on each side.	Two sensors mounted one in each corner of the rear bumper	Two sensors mounted one in each corner of the rear bumper
BSD Icon			
Icon Description	Yellow Light warning icon integrated into the side mirror face	Lighted warning icon integrated into the side mirror face	Warning lamp integrated into the side mirror face
Audible Warning	Beep sound	Beep sound	Light indicates

***Table* . Description view of Blind Spot Detection**

List of the vehicles :

- 2021 Hyundai Sonata
- 2020 Toyota Camry
- 2020 Volkswagen Jetta SE

HISTORY

This method was first revealed by George Platzer in a 1995 paper presented to the Society of Automotive Engineers, but the method is frequently overlooked in driver's education classes and takes some getting used to. Calculated elimination of blind spots by trained drivers is inexpensive and obviates the need for expensive technological solutions to that problem, provided drivers take the time to set up and use their mirrors properly. Plater received a patent for his blind spot monitor, and it has been incorporated into various products associated with Ford Motor Company. The blind zone mirror has been touted as "an elegant and relatively inexpensive solution" to this recognized problem.

Shield+ by Mobileye is a pedestrian and cyclist blind spot detection system. It utilizes dynamic detection angles to constantly monitor the vehicle's blind spots from the A-pillar and on the right- and left-hand sides of the vehicle. If the driver needs to use caution a yellow signal is given; if there is risk of an imminent collision and the need to take immediate preventative action a red signal is given. In 2011, Infiniti introduced two models offering a feature called "Blind Spot Intervention". In addition to warning the driver about a vehicle in the blind spot, this system actually helps to prevent the car from changing lanes when a collision is likely to occur.[11] The system applies mild braking to the wheels on the opposite side of the vehicle to pull the vehicle back to its original lane when it determines that changing lanes is likely to cause a collision with a vehicle in the blind spot. Different manufacturers use various names to describe the blind spot detection system. Ford, Lincoln, and Volvo use the term *Blind Spot Information System*. Audi calls it *Side Assist*. General Motors calls it *Side Blind Zone Alert*. Infiniti calls it *Blind Spot Warning*.

Data Communications

Some units are self-contained (i.e., no data communication). Others may use CAN or LIN buses.

Actuators

Light or display (usually inside mirrors) sound alert, brakes, haptic warning in the seats or steering wheel.

PEDESTRAIN DETECTIVE SYSTEM

INTRODUCTION

Now a vehicle is having very updated technology in these modern times and having many of sensors are using in different system, and each type of sensor having different type of working principle. Pedestrian detection technology is the one of the active safety systems in car and these active safety systems are to prevent causes of accidents and the pedestrian detective system is prevent the collision of pedestrian and bicycle riders. Pedestrian detection system is detecting the human's motion on the road and also detect the bicycles and cars and these system follows according to that data have and move on the road moreover save the pedestrian and bicycle riders, this system also called as motion detective system. In these pedestrian system having types of components are radar sensor, Visible light camera, and on-board computer.[12]

Problem

In India a greater number of people died in road accidents and this report given by mister of road safety authority in 2019 and in this report more pedestrians are died, and their death rate is very high compare to all types of accidents

Table 2.1 Road user category wise road accidents deaths on different categories of NH during 2019

Road-user category	Road Accident deaths on NH under NHAI	Road Accident deaths on NH under State PWD	Road Accident deaths on NH under other Departments	Total Road Accident deaths on NH
Pedestrian	4,957	2,313	497	7,749
Share in total	13.9	17.1	10.0	14.4
bicycles	1050	472	146	1,668
Share in total	2.9	3.5	3.1	3.1

Table 2.2 Persons killed in Accidents Classified by the type of impacting vehicles (Crime Vehicle by Victim vehicle) during 2019.

Crime vehicles → / Victim Vehicles	1. Bicycle	2. Two-wheeler	3. Auto rickshaws	4. Cars, taxi, van lmv	5. Tractor lorries	6. busses	7. Other Non-motorized Vehicle (e-rickshaw etc)	8. others	9. total
1.pedestrain	195	6,934	1,312	6,458	4,318	2,050	487	4,104	25,858
% share	0.8	26.8	5.1	25.0	16.7	7.9	1.9	15.9	17
2.bicycle	128	941	280	954	802	623	140	328	4.196
% share	3.1	22.4	6.7	22.7	19.1	14.8	3.3	7.8	3

NEED OF PEDESTRAIN DETECTIVE SYSTEM

The pedestrian detective system needs in vehicles to save people and it prevents the pedestrian accidents on the roads and this system detects the people and bicycle rides and other type of vehicles on the road and the vehicle moves according to that data. The pedestrian technology saves people life and prevent the forward collusion of vehicle and also it creates the impact on decrease majority of death rate in pedestrian accidents in worldwide and national level.

WORKING PRINCIPLE AND TESTING OF PEDESTRAIN DETECTIVE SYSTEM

The pedestrian detective system works on the principle of radar senor and light visible camera and on-board computer and this is a radar and camera-based system The function of visible light cameras captures the images and send to the on-board computer, which compile and analyse the pedestrians and objects and VLC works poor in low light condition and bad weather condition and these VLCS unable to detect the children pedestrians on foot. LIDAR uses as scanning laser to measure the distance to surface and producing detailed Fig **10 Pedestrian detective senso**r shapes of three-dimensional objects and lidar detects the objects on the ranges of medium and high and it detects the objects in low light and no light condition and bad whether condition. RADAR sends the radio waves to detect the object and distance and relative speeds, and it works in the darkness and adverse weather condition also if RADAR has poor resolution to difficult to detect the pedestrian children. In the pedestrian detective system consists of VLC (CAMERA) is fitted in the interior rear-view mirror and give warning in the light in the wind screen and lidar is fitted in the top roof of the car and it sends the scanning light to detect the object and RADAR IS fitted front of the car to calculate the distance and speeds of the object [12]

Pedestrian detective system works on the combination of LVC+LIDAR +RADAR and the pedestrian detective system detects object front of the car and give warning to the driver and if the driver fails to respond the warning and the pedestrian detective system is respond and operates to the fully automated brake to stop the car and avoid the collusion or accidents. The system is programmed, and pedestrian motion is calculated by central control unit and respond with virtual condition on the road and car decreases the speed and stop front of the pedestrian on the road

In the emergency the driver receives audible warning and flashing light in wind screen and driver does not respond automatically fully brakes power is applied and stops the car and the system can avoid accidents below 35 km/hr and above 35km/hr focus on reducing the speed of the car much is possible to reduce the serious injuries.

Limitations

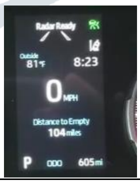
- LVC is poor working under the condition of low and no light condition at that situation accidents is possible
- Lidar is not unable to detect the object under the bad condition weather and pedestrian children on the road these situations there is possible of accidents.
- Radar is unable to detect the object is in stationary position and there is possible of accidents.
- The combination of all three sensors is VLC, LIDAR, RADAR can work to tougher these can eliminate the possible of accidents.

List of the vehicles:

- **2021 Hyundai Sonata**
- **2020 Toyota Camry**

•2020 Volkswagen Jetta SE

Table.3 Description view of Pedestrian Detective System

Vehicle	A	B	C
Year and Make	2021 HYUNDAI	2020 TOYOTA	2020 VOLKESWAGEN
Model	Sonata	Camry	Jetta
Body Style	4-door sedan	4-door sedan	4-door sedan
Pedestrian Detective System			
Trade Name	Forward Collision-Avoidance Assist	Pre-Collision System with Pedestrian Detection	pedestrian monitoring
Technology	Camera, Radar	Monocular camera, Radar	Radar
Sensor Location(s)	Camera on the wind shield, Radar sensor on the lower grill	Monocular camera located on the wind shield; radar sensor located in the front logo of the vehicle	A small radar that discreetly fits behind the Volkswagen emblem
PDS Icon			
Icon Description	warning icon starts blinking on the monitor	warning icon starts blinking on the monitor	warning icon starts blinking on the monitor
Audible Warning	Beep sound	Beep sound	Light indicates

HISTORY OF PEDESTRIAN DETECTION SYSTEM

In 2011, Volvo introduced the first pedestrian detection mitigation system available in the U.S. This system used both radar and image sensors to detect possible collisions with pedestrians as well as rear-end collisions with other vehicles and motorcycles. Current systems typically utilize a radar sensor mounted behind the front grille along with one or two image sensors (cameras) located behind the windshield. Systems that only utilize radar or image sensors are also available; although this configuration is less common. Lidar sensors are beginning to be incorporated into consumer-grade vehicles starting with the Audi A8 for the 2019 model year. Throughout this work, the term “pedestrian detection system” refers to an automatic emergency braking system with pedestrian detection functionality unless otherwise noted. Primary research was conducted on a closed-course to evaluate the performance of pedestrian detection systems on midsize sedans available for sale throughout the U.S. While crossover utility vehicles have eclipsed sedans in terms of overall market share, midsize sedans still represent the fourth bestselling segment, responsible for 10% of total new vehicle market share in 2018.

Despite the challenges, pedestrian detection still remains an active research area in computer vision in recent years. Numerous approaches have been proposed.

Holistic detection

Detectors are trained to search for pedestrians in the video frame by scanning the whole frame. The detector would "fire" if the image features inside the local search window meets certain criteria. Some methods employ global features such as edge template ,[1] others uses local features like histogram of oriented gradients [2] descriptors. The drawback of this approach is that the performance can be easily affected by background clutter and occlusions.

Part-based detection

Pedestrians are modelled as collections of parts. Part hypotheses are firstly generated by learning local features, which include edgeless and orientation features. These part hypotheses are then joined to form the best assembly of existing pedestrian hypotheses. Though this approach is attractive, part detection itself is a difficult task. Implementation of this approach follows a standard procedure for processing the image data that consists of first creating a densely sampled image pyramid, computing features at each scale, performing classification at all possible locations, and finally performing non-maximal suppression to generate the final set of bounding boxes.

Patch-based detection

In 2005, Liebe et al. proposed an approach combining both the detection and segmentation with the name Implicit Shape Model (ISM). A codebook of local appearance is learned during the training process. In the detecting process, extracted local features are used to match against the codebook entries, and each match casts one vote for the pedestrian hypotheses. Final detection results can be obtained by further refining those hypotheses. The advantage of this approach is only a small number of training images are required.

Motion-based detection

When the conditions permit (fixed camera, stationary lighting conditions, etc.), background subtraction can help to detect pedestrians. Background subtraction classifies the pixels of video streams as either background, where no motion is detected, or foreground, where motion is detected. This procedure highlights the silhouettes (the connected components in the foreground) of every moving element in the scene, including people. An algorithm has been developed, at the university of Liège, to analyse the shape of these silhouettes in order to detect the humans. Since the methods that consider the silhouette as a whole and perform a single classification are, in general, highly sensitive to shape defects, a part-based method splitting the silhouettes in a set of smaller regions has been proposed to decrease the influence of defects. To the contrary of other part-based approaches, these regions do not have any anatomical meaning. This algorithm has been extended to the detection of humans in 3D video streams.

Detection using multiple cameras

Fleuret et al.[10] suggested a method for integrating multiple calibrated cameras for detecting multiple pedestrians. In this approach, The ground plane is partitioned into uniform, non-overlapping grid cells, typically with size of 25 by 25 (cm). The detector produces a Probability Occupancy Map (POM), it provides an estimation of the probability of each grid cell to be occupied by a person. Given two to four synchronized video streams taken at eye level and from different angles, this method can effectively combine a generative model with dynamic programming to accurately follow up to six individuals across thousands of frames in spite of significant occlusions and lighting changes. It can also derive metrically accurate trajectories for each one of them.[13]

Data Communications

Control Unit Communication: Typically Control Area Network (CAN) Bus System

Actuators

Brakes, Warning Display, Audible Alarm, Seatbelt Tensioner

ERGONOMICS

Ergonomics which provides fundamental understanding and also a technology applying that understanding to problems of design in their widest sense

There are a number of reasons for a fundamental re-examination of ergonomics at this point in time. First, the steady growth of the discipline in, for instance Europe and North America, may have reached a plateau if professional society membership "gores are any guide. Further growth will require greater clarity about who we are and what we do.[3] Second, at the same time the rapid development of some specialisms within ergonomics in industrially developing countries and elsewhere has brought a danger that limited views of ergonomics will take hold.

. Ergonomists work within a wide range of disparate application domains, with deferent requirements and priorities, emphasising the need for ergonomics to be a clearly, if broadly, dined discipline a number of challenges for the future are proposed.

- The need to position ergonomics as a unique discipline of theory and practice,
- A broad view of ergonomics as an applied and a social science, and as craft and art,
- The need for ergonomics to be context sensitive and to embrace qualitative approaches and methods as well as more traditional quantitative ones,
- The role of ergonomics as the holistic approach to understanding complex interacting systems involving people
- The use of such understanding to improve people's well-being and performance

The understanding of ergonomics findings and their application in practice requires a good grasp of context. This same context will also affect society's view of ergonomics and its value and place in the modern world. Relevant contextual factors can be summarised under headings of "financial, technological, legal, organisational, social, political and professional factors.

At a social level, because ergonomists deal with the interaction of people with and within social and technical systems, developments such as an increasingly unstable and #uid job market on the one hand, but increased interest to provide a stakeholder society on the other, must affect how (and how well) we go about our work. By extension, ergonomists work in a political context.

A significant difference between ergonomics and psychology is the unit of analysis. In psychology, the unit of analysis is the individual, and within this the behaviour of the individual, whether social, cognitive, or affective. Ergonomics has more in common with anthropology, where the unit of analysis is often at the level of interaction

To be clear, models of ergonomics have always highlighted the interactions between people, products and environments. However, this tended to be with the focus on redesign of particular interfaces, equipment, works places or jobs.

a number of issues and problems facing the discipline of ergonomics.

- we need to agree on a view of ergonomics that embraces the richness of its different traditions whilst clearly representing it as a distinct discipline, with its own theories, models and practices.
- Various quality initiatives in higher education across the world may lead to a retreat to core activities within long-established disciplines.
- International consistency on the balance between professionalism and protection on the one hand, and growth and spread on the other, will be difficult to achieve, but vital.
- No ergonomics research can ignore context, whether this is accounted for in thoughtful laboratory research and its interpretation, or as it affects the conduct of "eld research.
- Growth in influence of ergonomics will be greater if its practitioners better understand the international, national and organisational political contexts in which it is applied

- Ergonomics must achieve a balance between its valuable, but retrospective, problem-driven activities, and its prospective life-enhancing contributions.

Patents:

Lane Departure warning system:

S. no	Patent	Link
1	EP1849669 B1-Lane departure prevention apparatus and method for a motor vehicle.	https://patents.google.com/patent/EP1849669B1/en?oq=Lane+Departure+Monitoring\
2	US10688993B2-Vehicle control system with traffic driving control.	https://patents.google.com/patent/US10688993B2/en?oq=Lane+departure+warning+system&page=1
3	US9415776 B2-Enhanced lane departure system.	https://patents.google.com/patent/US9415776B2/en?q=Lane+departure+warning+system&oq=Lane+departure+warning+system+
4	US9193356 B2-Lane monitoring method and lane monitoring system for a vehicle.	https://patents.google.com/patent/US9193356B2/en?page=1
5	US9855945 B2-System and method for responding to driver behavior	https://patents.google.com/patent/US9855945B2/en?oq=Lane+departure+warning+system&page=2

6	CN104517111B- Method for detecting lane lines, system, lane departure warning method and system	https://patents.google.com/patent/CN104517111B/en?oq=6.CN104517111B
7	US8405522 B2- Lane departure haptic warning with compensation for road-caused vibration	https://patents.google.com/patent/US8405522B2/en?oq=US8405522B2
8	CN102785661B- Lane departure control system and lane departure control method.	https://patents.google.com/patent/CN102785661B/en?oq=CN102785661B

Blind Spot Detection:

S.no	Patent	link
1	US7477137B2- Blind-spot detection system for vehicle.	https://patents.google.com/patent/US7477137B2/en?oq=1.US7477137B2
2	JP4921505B2- Vehicle blind spot detection and display system	https://patents.google.com/patent/JP4921505B2/en?oq=JP4921505B2-Vehicle+blind+spot+detection+and+display+system

3	US20200215985A1-Vehicular exterior mirror system with blind spot indicator	https://patents.google.com/patent/US20200215985A1/en?oq=US20200215985A1-+Vehicular+exterior+mirror+system+with+blind+spot+indicator
4	TWI458653B- Blind spot detection system and blind spot detection method thereof.	https://patents.google.com/patent/TWI458653B/en?oq=TWI458653B-+Blind+spot+detection+system+and+blind+spot+detection+method+thereof.+
5	US7161472B2-Blind-spot warning system for an automotive vehicle.	https://patents.google.com/patent/US7161472B2/en?oq=US7161472B2-Blind-spot+warning+system+for+an+automotive+
6	US6927677B2-Blind spot detector system.	https://patents.google.com/patent/US6927677B2/en?oq=US6927677B2-Blind+spot+detector+system.
7	DE102017112788A1 -Systems and methods for detecting blind spots.	https://patents.google.com/patent/DE102017112788A1/en?oq=DE102017112788A1-Systems+and+methods+for+detecting+blind+spots.
8	US7504986B2-Blind spot sensor system	https://patents.google.com/patent/US7504986B2/en?oq=US7504986B2-Blind+spot+sensor+system

Pedestrian Detection:

S.no	Patent	Link
1	US8903640B2-Communication based vehicle-pedestrian collision warning system.	https://patents.google.com/patent/US8903640B2/en?oq=US8903640B2-Communication+based+vehicle-pedestrian+collision+warning+system.
2	US10300875B2-Pedestrian collision warning system.	https://patents.google.com/patent/US10300875B2/en?oq=US10300875B2-Pedestrian+collision+warning+system.

3	JP2005309797A-Warning device for pedestrian.	https://patents.google.com/patent/JP2005309797A/en?oq=JP2005309797A-Warning+device+for+pedestrian.
4	US20060224289A1-Pedestrian detection system.	https://patents.google.com/patent/US20060224289A1/en?oq=US20060224289A1-Pedestrian+detection+system.
5	US20040258279A1-Method and apparatus for pedestrian detection.	https://patents.google.com/patent/US20040258279A1/en?oq=US20040258279A1-Method+and+apparatus+for+pedestrian+detection.
6	US20120008129A1-Object detection system.	https://patents.google.com/patent/US20120008129A1/en?oq=US20120008129A1-Object+detection+system
7	WO2008156378A1-Pedestrian warning system.	https://patents.google.com/patent/WO2008156378A4/en?oq=WO2008156378A1-Pedestrian+warning+system.
8	US9925939B2-Pedestrian collision warning system.	https://patents.google.com/patent/US9925939B2/en?oq=US9925939B2-Pedestrian+collision+warning+system.
9	US20150109148A1-Pedestrian Warning System.	https://patents.google.com/patent/US20150109148A1/en?oq=US20150109148A1-Pedestrian+Warning+System
10	US8537030B2-Pedestrian alert system and method.	https://patents.google.com/patent/US8537030B2/en?oq=US8537030B2-Pedestrian+alert+system+and+method.

Conclusion:

- Active safety and passive safety are the modern ways for safeguarding the passengers in the vehicle.
- Vehicle safety is the priority to reduce the occurrence of collisions.
- Passenger safety plays a vital role in automobile sector.
- Active safety systems help the driver to avoid the accidents.
- Without these systems, the drivers tend to crash scenarios in which the whole dynamics has been crashed and passengers in the car are injured.
- Lane departure warning system (LDWS), Blind spot detection system, Anti-braking system (ABS), Electronic stability program (ESP), Traction control (TC) etc..., All these systems play active key role in the vehicle.
- Pedestrian detection system (PDS), absence of this system according to NHAI 2019 report total 7,749 collisions occurred.
- Adequate Ergonomics leads to less fatigue of the driver.
- A passive safety feature is a system that does not do any work until it is called to action. These features become active during an accident and work to minimize damage and reduce the risk of injury during the time of impact.
- These systems prompt before the accident takes place in order that they might avoid the accident but, the airbags, seatbelts, and other safety functions come into play in the course of a coincidence. As a result, they may be called passive safety systems respond to an bizarre event together with a safety hassle.

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