Active Safety

Meeting accidents on straight roads

Group 4

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Abstract

This report introduces the statistics and scenario and technology relate to the meeting accidents on straight roads because the meeting accident is one of the main reasons of traffic accidents. By the statistics of accidents from 1996 to 2002, the 29% of the accidents are head-on collisions, and also by the statistics of U.S.A, head-on collisions tend to be more severe than most other accident types.

With respect to the meeting accident, loss of control, drift due to road and overtaking are the most common three scenarios. Driver, environment and vehicle speed mainly cause the above three scenarios respectively.

Available technology of the safety system, for instance ABS, TCS, Digital Voice Alert etc, are really helpful to avoid such kinds of accidents of scenarios. Besides these systems, there are also a lot of other safety systems which are being used in the current vehicle to deal with the different complicated conditions such as ASR, MSR, EBA etc.

At the same time, some other safety systems are being developed as well, for instance, ESPII, car to road communication and car to car communication technology. Although they are just concept or still in the lab, they will be beneficial to the safety of vehicle on strait roads accidents once they are available in the market.

By analysis of the alternatives, it is got that the most efficient system which can avoid the scenarios above would be to use car to infrastructure communication against meeting accidents.

Introduction

Nowadays, safety is becoming the most important concern towards road traffic. Several systems have been developed, either in the passive or in the active safety field. There are improvements and innovations to bring in active safety because avoiding accidents is as important as decreasing the effect of crash as in the field of passive safety.

There are a lot of technologies actually available like ESP (Electronic Stability Program), ACC (Adaptive Cruise Control)… and upcoming new technologies. All of these can be used for different road situations and this report will use them (and will introduce new ones) for a hopefully rare but very dangerous case: meeting accidents on straight roads.

Goal of the project

This project work should take into account the most frequent case of head on collisions, then according to the cases, find existing or new active technologies to prevent these accidents.

For that, this report will first of all do study of the cases to determine which ones are the most frequent and dangerous, so the study could be restricted to them and be more accurate. Then, the selected scenarios will be explained and put into situation so the reader can have an overview of all the circumstances of the accidents in different cases:

- loss of control due to the driver or vehicle
- loss of control due to the road
- dangerous overtaking situation

Environment, driver and vehicle issues will be studied and for each scenario, a technical solution will be provided. This includes existing and futuristic systems to prevent crashes in these scenarios.

Finally, this report will be restricted to rural roads. Because of the speed and the quality of the roads, head on collisions are more dangerous on those roads than on urban roads. Therefore most of the statistics are provided for rural roads because of the situations which are with simpler variables than with the urban infrastructure.

However, if interesting cases out of these borders are relevant, they will be included in this report.

Outline

1. Accidents reporting

1.1. Accident statistics

A head-on collision occurs when two vehicles travelling in opposite directions collide at little or no angle. Head-on refers to a collision where the front end of one vehicle collides with the front-end of another vehicle while the two vehicles are travelling in opposite directions.

As with opposite direction sideswipes, features such as horizontal and vertical curves, narrow roadways, varying lane widths, and merging zones tend to increase the frequency of head-on collisions.

Traffic fatalities								Mean
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**1996-2002**
Single vehicle	131	140	127	147	163	152	143	143
Head-on (collision w ith oncoming vehicle)	107	128	110	126	147	134	137	127
Head-on (others)	1	0	1	8	4	4	6	3
Overtaking (collision w ith oncoming vehicle)	12	13	18	8	13	16	14	13
Overtaking (others)	8	4	5	5	12	11	8	8
Totals, Head-on or overtaking	128	145	134	147	176	165	165	151
Rear-End collision	4	6	9	3	6	9	11	7
Turning	19	17	20	26	22	16	13	19
Crossing	53	32	29	34	22	33	55	37
Bicyled/Moped	44	47	51	35	41	34	36	41
Pedestrian	73	69	67	78	70	80	56	70
Game (Moose)	10	11	15	10	8	12	7	10
Game (others)	1	4	1	3	0	2	1	2
Varia	46	36	39	53	57	51	45	47
TOTAL	509	507	492	536	565	554	532	528

Table 1: Fatalities by accident type, 1996-2002

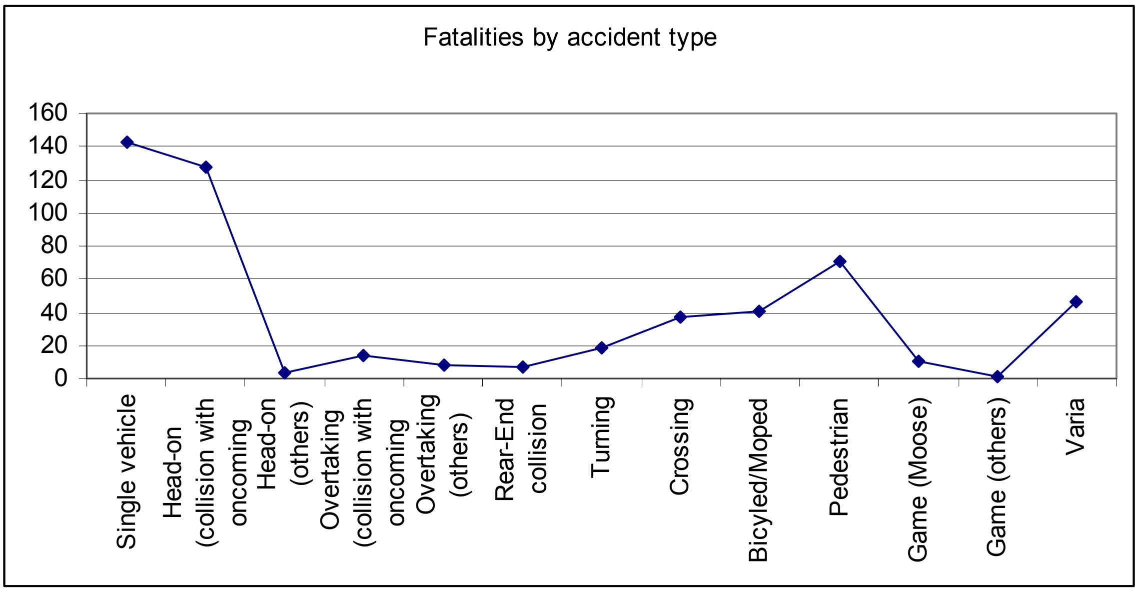


Figure 1: Fatalities by accident type, 1996-2002

From the Table 1, is possible to presume that approximately 29% of the accidents are head-on collisions.

Three percent of the accidents during 2003 were head-on collisions. A total of 68 collisions occurred, with an estimated cost of $3.8 million. A breakdown of these collisions according to severity is shown in Figure 2. As indicated by this figure, head-on collisions tend to be more severe than most other accident types.

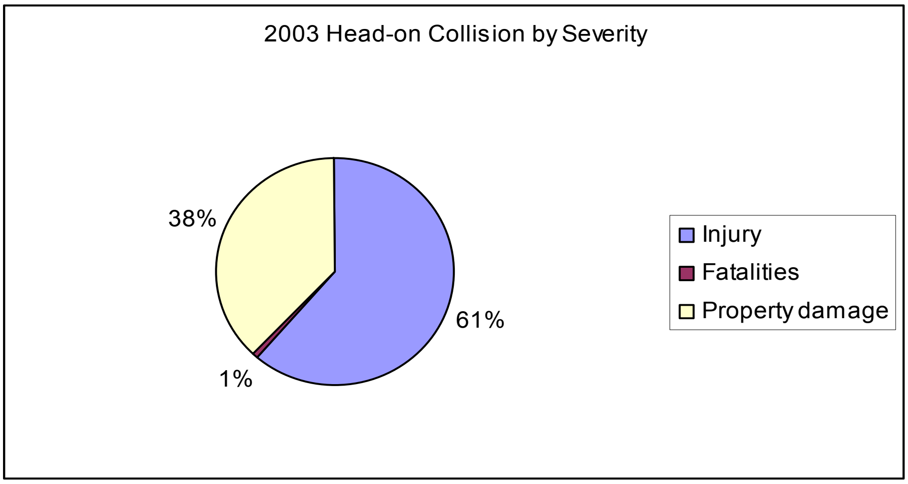


Figure 2: Head-on collisions in U.S.A

Accident patters	Number of fatalities	Number of serious accidents
Right turn	261	4802
Blind intersection	480	8233
Pedestrian	1041	4746
Head-on	**373**	**2112**
Rear End	310	4136
Left turn	57	1689
Lane change	12	179

Table 3: Number of fatalities by accident type in Japan

Of 10 people killed on these roads,

… ***four*** die in a collision with an oncoming vehicle. The most common description of an accident: ”*The car came over onto the other side of the road for no known reason*”. If the oncoming vehicle is a truck, fatalities are very common. In a frontal collision with a car of the same or smaller size, people normally survive, if the collision speed of both vehicles is less than 70 km/h and provided that everyone is wearing seatbelts.

… ***three*** die when they drive off the road. The most common cause of death is hitting a hard object, of which a tree is the most common. Another common cause of death is that the car turns over and people are thrown out because they are not wearing seatbelts.

... ***two*** die in a collision at an intersection. A common accident sequence is that a car that is standing and waiting to turn left or to pull out onto the main carriageway suddenly pulls out in front of another car. The person sitting in the car that is hit from the side normally dies. If they are wearing a belt, they survive if they are hit in the side by a car of about the same size and if the speed is less than 50 km/h.

1.2. Contributing factors

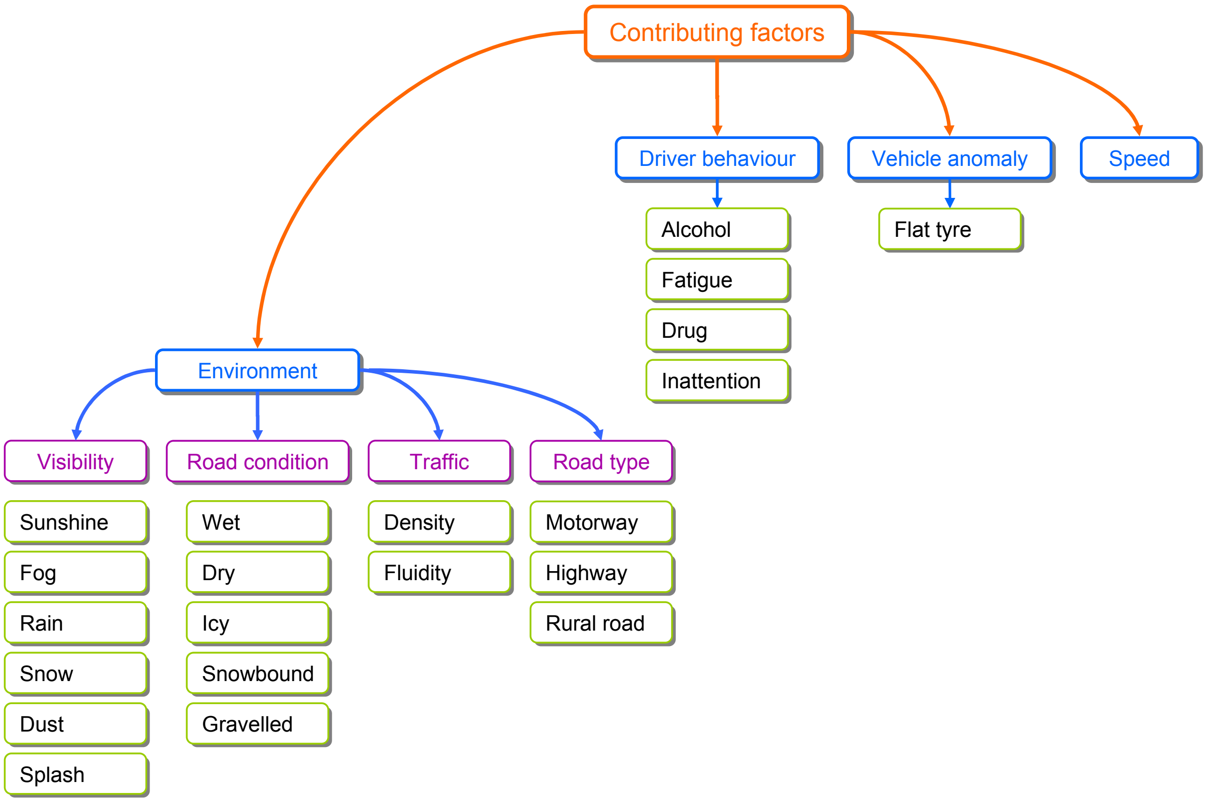


Figure 3: Contributing factors

In order to clarify the reasons behind meeting accidents, we categorised the main contributing factors, as can be seen from the above diagram. We are aware of the main categories we have to take into consideration, and we will discuss them throughout the report.

2. Scenarios

2.1. Loss of control

The majority of accidents is the loss of control of vehicle. The cause can be either the driver or the vehicle. This figure will explain graphically the situation:

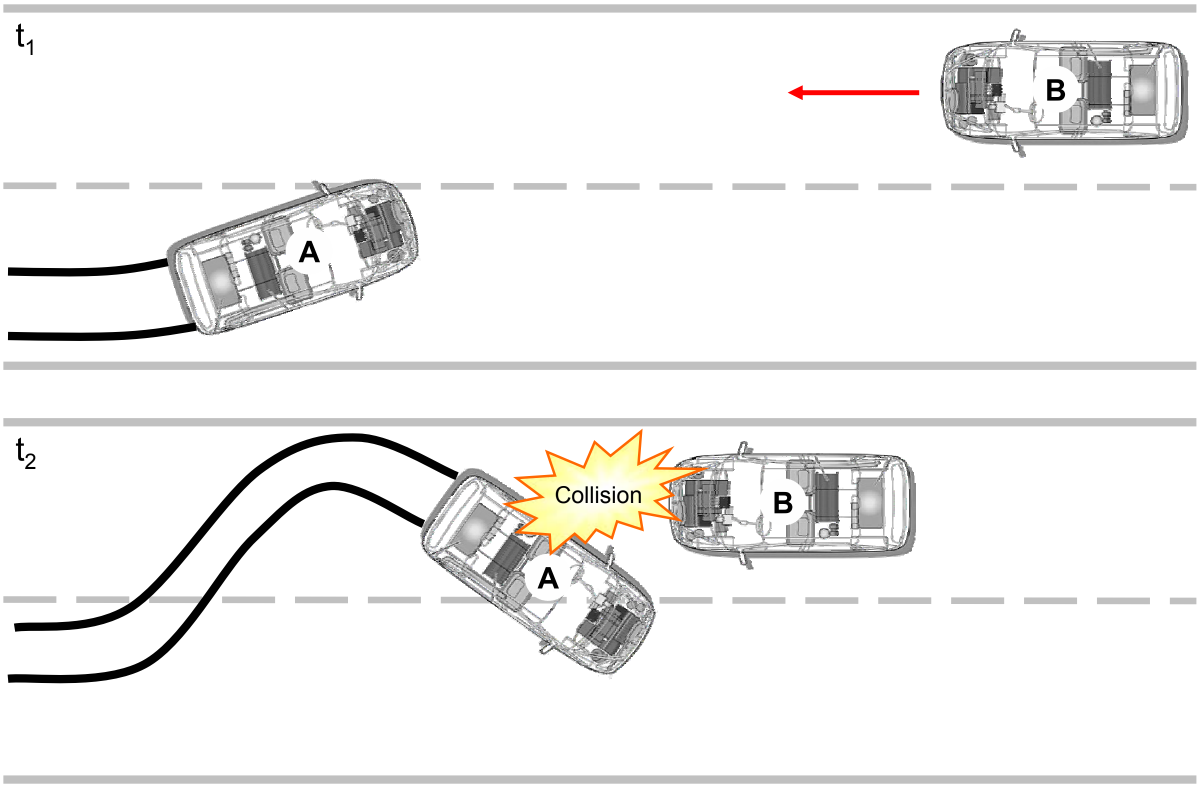


Figure 4: Loss of control

Most of the time, these kind of accidents are due to the driver behaviour. Some causes should be taken into account for the loss of control:

- fatigue of the driver
- if the driver is under influence (alcohol or drugs)
- inattention

As driving is a usual task, the driver looses his focus on the driving or maybe his faculties are less efficient. In that case, it is hard for the driver to steer back properly his vehicle due to his state, and harder if the vehicle is involved. So the active safety system should replace the driver behaviour to help him to regain control or warn him soon enough of the danger.

On the other hand the vehicle may also have a problem, and for example, it can be due to a flat tire or due to another vehicle problem. In that case, the behaviour of the car is slightly changed and can be hardly controlled and a warning about the problem of the car and an effective active control of the vehicle should be implemented.

As a result, the car may drift from its lane to the other lane and then hit another coming car. Such crashes occur on undivided roads, as well as on divided roads provided errant vehicles are not prevented by median barriers, roadside objects or non-traversable median surfaces from reaching the opposite carriageway.

2.2. Drift due to road

Another cause of accidents due to drift is the circumstances of the road. The presence of grave, ice, snow, water or irregularities of the road (differences in height between the paved and unpaved) is an important factor for the drift of the car.

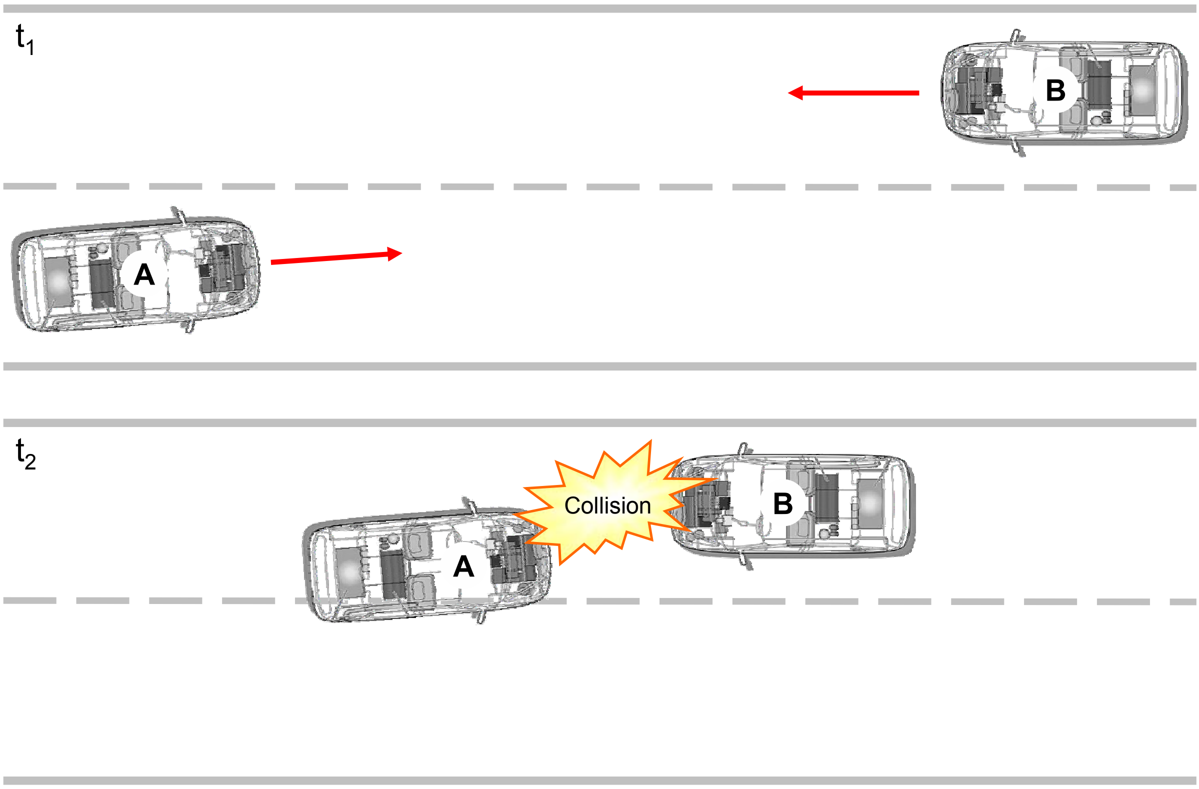


Figure 5: Drift due to road

The environment is a factor too like icy fog or rainstorm which makes the road slippy and moreover reduces the visibility.

So, the active system should be mostly an active control of the vehicle which can take into account the road and help the driver to steer the vehicle. There should be a help to enhance the visibility of the driver in bad weather condition.

2.3. Overtaking

The last situation which can be taken into account is the overtaking. The traffic is an important part in these accidents because the driver could have a misjudgement of the traffic speed.

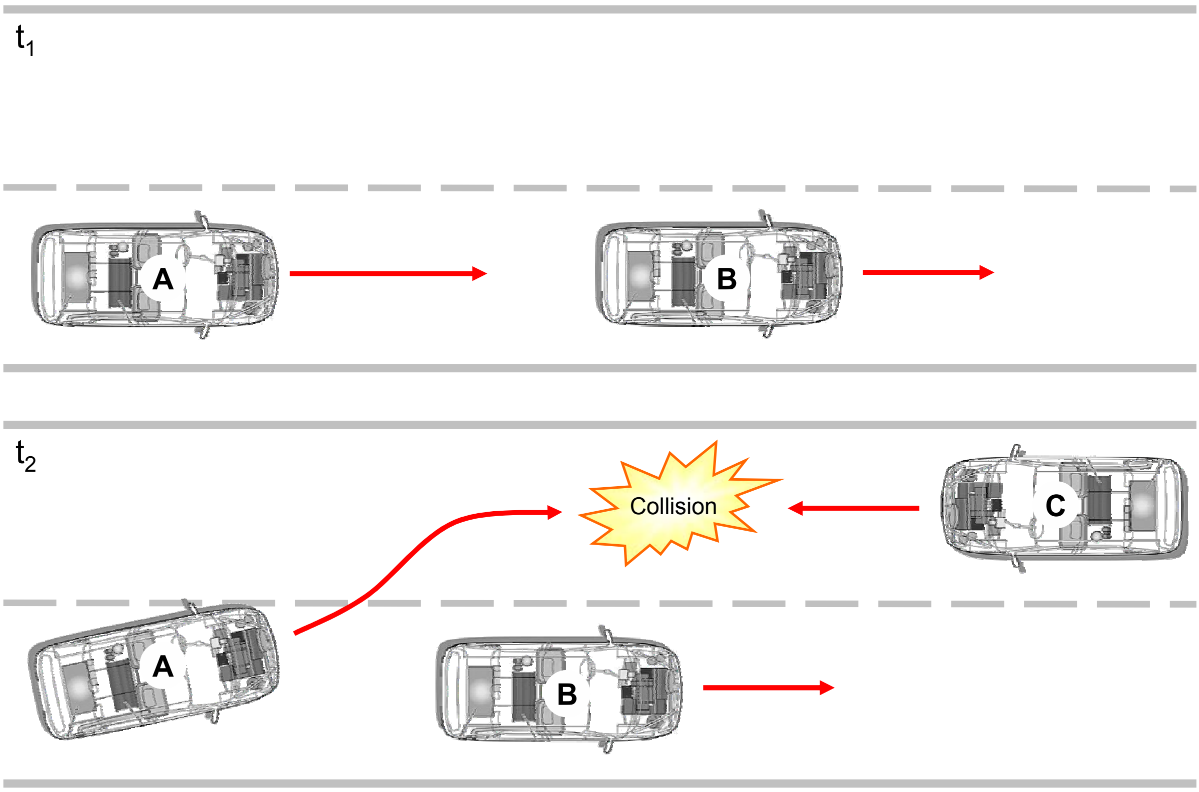


Figure 6: Overtaking

So an effective help can be a system which assists the driver to see if it is safe to overtake or not (measure of the speed, distance of the front coming vehicle, space of gap…) and in emergency, brakes the vehicle.

Another issue is the visibility when overtaking. It could be due to the weather (fog, sun in the front, night) and road traffic (lots of cars, big trucks…).
For this issue, an active system can be used to enhance the vision and which use the road infrastructure for example by reading the lane to see if it is possible to overtake or not.

In all of the above scenarios, passenger vehicles, even those with high standards of crashworthiness, are unable to protect their occupants at speeds above about 70 km/h.
Survivable impact speeds will be greatly reduced if head-on collisions involve cars hitting trucks, buses or other vehicles of incompatible design, or where the more vulnerable road users are involved (e.g., older people as vehicle occupants, bicyclists, motorcyclists or occupants of small vehicles).

3. Technologies (*already available*)

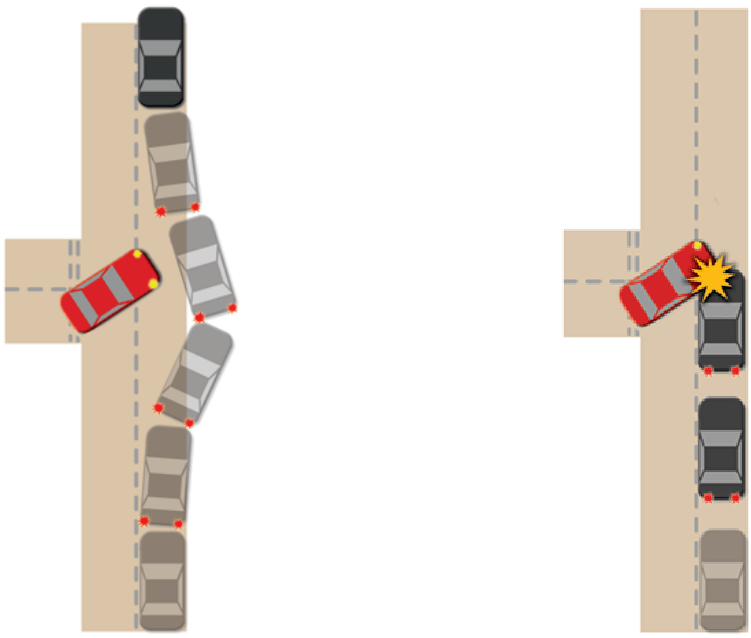
Introduction

There are a lot of active safety systems which are being used in the current vehicles. In this chapter, we will introduce these in details. We categorized the available active systems as two types. First are the systems related to the dynamics of the vehicle, the other one is relate to the drive warning and assistance systems. Vehicle dynamics systems consist of the systems which are mainly used to control the stability of the vehicle, how did your system keep the car in a safe condition and can avoid all the possibilities of crash e.g. ABS, TCS, ESP. Drive warning and assistance systems consists of digital voice warning system, night warning system, adaptive cruise control system, blind spot information system etc. Different to vehicle dynamics systems, these systems only focus on the driver. By the help of warning and assistance devices, the driver can drive in a safe way.

3.1. Dynamic control systems

Anti-lock Braking System: ABS

A skidding wheel (*where the tire contact patch is sliding relative to the road*) has less traction than a non-skidding wheel. If you have been stuck on ice, you know that if your wheels are spinning you have no traction.By keeping the wheels from skidding while you slow down, anti-lock brakes benefit you in two ways: You'll stop faster, and you'll be able to steer while you stop. The anti-lock braking system needs some way of knowing when a wheel is about to lock up. The speed sensors, which are located at each wheel, or in some cases in the differential provide this information.



Without Anti-Lock Braking System With Anti-Lock Braking System

Figure 7: Steering during braking

ABS allows you to maintain control of the vehicle. Since four-wheel ABS prevents all wheels from skidding, it allows you to steer the vehicle and still maintain braking. ABS has proved itself to be the most effective system on meeting accidents on straight roads as the driver is able to steer the vehicle to the direction where he wants and so can avoid the collision during braking.

Dynamic Safety chassis (DSA)

The German manufacturer Opel has introduced the dynamic safety chassis. The DSA chassis provides safe, dynamic driving and excellent road-holding. Specially chosen elastokinematics ensure automatic stabilization of the Dynamic Safety front suspension in critical driving manoeuvres.

Figure 8: Opel's Dynamic Safety chassis

ESP (Electronic Stability Program)

The ESP uses a number of sensors to detect critical driving situations and helps the driver by applying the brakes individually as appropriate or altering the engine settings. ESP goes a step beyond the already high standards offered by the DSA suspension layout, particularly on wet roads, snow and ice.

Figure 9: Opel testing DSP

ESP monitors the vehicle's response to the driver's steering and braking inputs to detect oversteer or understeer. If sensors detect that a skidding condition is developing, ESP brakes individual front or rear wheels and/or reduces excess power as needed to help keep the vehicle going in the direction the driver is steering.

The system extends the technology of the anti-lock braking and acceleration skid control systems with a range of additional sensors which are used principally to detect yaw motion.

The ESP computer continuously compares the actual behavior of the vehicle with the computed ideal values. The moment the car deviates from the direction intended by the driver, specially developed control logic causes the system to intervene with split-second speed to bring the car back on track.

Vehicle dynamic control (VDC)

VDC, the acronym for Vehicle Dynamic Control, is a system providing control of vehicle's dynamic stability. The system senses and makes an estimate of the trajectory wanted by the driver and another estimate of the car's actual trajectory. When the difference between the two exceeds a margin of tolerance, the system intervenes by applying a braking force to each individual wheel and/or by reducing/increasing engine torque, which is converted into a stabilizing yaw movement. It is available on the Alfa 147.
The VDC's system software integrates the braking system and traction control functions, which are ABS, TC, Hydraulic Brake Assist, EDB, ASR and MSR.

Traction Control System (TCS)

http://www.opel.com/corporate/4/422d.html
This system controls skidding of the driving wheels. By comparing the speeds of the two driving wheels, it recognizes skidding when the value exceeds a threshold value. The system brings the situation under control by applying braking torque to the skidding wheel, obtained by increasing the pressure in the corresponding part of the braking circuit. This enables the differential to transfer torque to the gripping wheel, thus returning the car to normal conditions. TC remains active up to speeds up between 40 and 60 km/hr

Electronic Breakforce Distribution (EDB)

EDB is built into the ABS system and spreads the braking force between the front and rear wheels depending on the actual grip conditions for each wheel and on the condition of the brake pads. It is available in the Alfa 147, 156, Sportwagon and 166.

Antislip Regulation (ASR)

ASR, or Antislip Regulation, limits slipping by the driving wheels when accelerating. In the event of slippage, this device slightly closes the throttle until the difference in speed is reduced and the driving wheels regain their grip. It is available on the Alfa 147, 156, Sportwagon and 166.

Modulate System Regulation (MSR)

MSR is a system for regulating engine braking torque when decelerating. Its function is the opposite of the ASR, opening the throttle during sharp deceleration, and thus preventing the driving wheels from locking. It is available on the Alfa 147.

Steering Angle Sensor

Steering angle sensor is very simple, but is becoming more and more important. Several systems rely on this sensor like (ESP, suspension control, active steering etc.). The sensor consists of an encoder and a photo emitter, photo receiver and an optic disc (having opaque and transparent parts) between them. The receiver counts the signals it receives during turning and measures the turning angle. It is usually installed with other sensors such as steering torque, steering angle velocity sensor, steering wheel switches etc.

Active Steering System

Keeping the car in the lane without driver effort is one of the aims of the active steering system. A similar system is currently in use by BMW but nowadays the system only helps to keep the vehicle in a strait line avoiding constant steering wheel corrections on windy days for example. As a next step, the system becomes an active lane keeping assistant, combining the active steering with the lane keeping system. The system measures the vehicle position relative to the lane, but offers active support in keeping the vehicle to the lane. However, the driver always retains the driving initiative, meaning that although he can feel the recommended steering reaction as a gentle movement of the steering wheel, his own decision takes priority at all times.

3.2. Driver assistance / warning systems

Besides the vehicle dynamics control systems, the driver assistance system and warning system are also developed in active safety area. Different with the vehicle dynamics control system which concentrates more on the activity of the vehicle, this type of safety systems focuses more on the driver. It helps and reminds the driver avoid the accident. In this part, the available technology of these two systems will be introduced.

Tire Pressure Monitoring (*Peugeot*)

The most frequent cause of a flat tire is a very gradual loss of air that goes unnoticed by the driver. With DDS (Deflation Detection System), a indirect measuring sensor, gives a warning signal when there is a decrease in tire pressure. DDS requires no extra sensor of its own but evaluates the data gathered via the wheel speed sensors. Any loss of pressure changes the radius of the tires, and results in a specific alteration of the speed signal. Another way of detecting Deflation is to use a small pressure sensor in the tire valve, his transmits to the receiver and the driver can constantly know the pressure of each wheel. This system is being used by Renault.

Electronic Brake Assistance (EBA)

Crash research studies by Mercedes and Toyota, found that although drivers reacted quickly in critical situations, they did not apply the brakes with sufficient force. More than 90 percent of the drivers who participated in the tests either could not make up their minds to brake with full force until it was too late, or simply reacted incorrectly. In dangerous situation, like when a driver detects a pedestrian the reaction can be both a strong brake and sometimes, not rarely, a soft one. If there is a soft brake the consequences can be serious, because the speed of the vehicle is high and when it crashes into the pedestrian it is possible to have serious or fatal injuries.

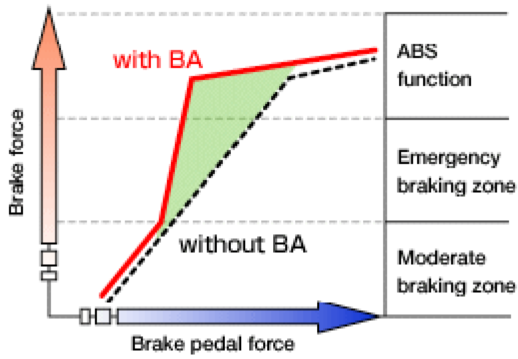


Figure 10: Brake force vs. Brake pedal force

To reduce the speed in these kinds of situations, nowadays the Electronic Brake Assistant (EBA) was introduced in many cars. A sensors measure how fast the brake pedal is actuated, the system deduces from the pedal speed whether the driver intends to make a hard stop and if this is the case, the brake assistant immediately provides full braking pressure in the brake power assist unit.

This system becomes inactive as soon as the driver lets up on the brake pedal .In the feature the successor of the EBA, will be the Predictive Brake Assist, PBA. The system builds up preventive brake pressure by placing the braking pads on the brake disks as a matter of precaution and setting the hydraulic brake assistant into a state of alert. If the driver actually brakes, he gets the fastest possible brake response with optimal deceleration values and the shortest possible stopping distance. When there is no braking action, the alert status is simply cancelled.

Digital Voice Alert (*When travel too close to the vehicle directly in Front*)

This system is an innovative safety solution using digital voice files to alert a driver of hazardous proximity or existence of vehicle in adjacent lanes.

Figure 11: Digital Voice Alert

The system monitors safe distance, which is set such as one vehicle space for every 10 mph, directly in front of the vehicle by its laser sensor complex and computer program protocol and alerts driver of the possibility of impact with digital voice commands. The safety gauge provides a visual indicator of hazardous proximity.

Improving Visibility with Xenon Lights

The evenings drawing in and the long dark nights, and often wet conditions, make driving particularly hazardous. Statistics show that while only 25 per cent of journeys take place at night more than 50 percent of all fatal accidents happen during the hours of darkness. Furthermore it is recognised that a person aged 60 requires up to 10 times more light than a 20 year old. Car lighting therefore is a hugely important contributor to road safety and driving comfort. Xenon lighting could provide the key to increasing safety and improving the lighting visibility for drivers.

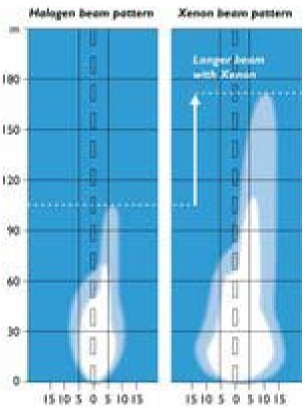


Figure 12: Comparison between the Halogen light and Xenon light

Xenon lights produce on average at least 2.5 times more light than a halogen bulb and only consume around two thirds of the power. Therefore a car driver can see ahead much more clearly and the car has more power for other functions. In addition, the clear blue-white light of xenon is far more like daylight than the conventional yellowish lamps and is easier on the eye with drivers able to concentrate better and not tire as quickly. A further benefit noticed by drivers is that xenon headlamps distribute more light on the road and improve illumination on the verge.

The introduction of the bi-xenon headlamp in 1999, which for the first time produced dipped and main beam light from a single xenon bulb was one of the key initial milestones. This was followed in 2003 by the swivelling bi-xenon system and the approval for new vehicles with dynamic bend lighting to be used on the road. This innovation allows bi-xenon headlamps to follow the car driver's steering movements and to swivel to the side as soon as he steers into a bend. Thanks to the new headlamp technology, the area illuminated by the dipped beam when entering a bend is almost doubled.

With xenon performing exceptionally well in improving the visibility and safety for car drivers it noticeably reduces the risk of accidents during night driving. Vehicles using new advanced headlamp technologies are also providing actively high driving comfort.

Predictive Safety Systems (PSS)

With the aim of reducing accident rates, Bosch is taking a number of driver assistance systems designed primarily for driver comfort and convenience and developing them further into a group of products under the heading of Predictive Safety Systems (PSS). The first level of development is Predictive Brake Assist (PBA): if the ACC identifies a dangerous traffic situation, the system imperceptibly moves the brake pads close to the brake discs and prepares the braking assistance system for a possible emergency braking manoeuvre. This system was fitted as standard to the Audi A6 in 2005.

The second level of development expands the PBA's range of functions: Predictive Collision Warning (PCW) gives the driver timely warning of critical situations. Bosch will start series production of this system in 2006.

The third stage of development, known as Predictive Emergency Brake (PEB), triggers an emergency braking if the driver fails to react at all, or not adequately, to the warning just given. PEB can significantly reduce the force of a collision.

4. Future technologies

Car to car communication

Car to car communication has the potential to be very beneficial to prevent head-on collisions. Vehicles coming from opposite directions can detect each other and when necessary can take the control of the vehicle from the driver and prevent a possible head-on collision. In the future car to car communication will be available and maybe mandatory for all vehicles in traffic. The system may be based on GPS and satellite communication or may be based on direct communication with the vehicles in a certain range. Given that the system is mandatory for all vehicles, the accident figures are more likely to decrease considerably. First generation of car to car communication systems may alert the driver while the others can take the steering and brake controls from the driver and realize necessary maneuvers.

Car to road communication

One of the most important reasons of head-on collisions is the loss of control of one of the vehicles of two which are coming from opposite directions. The reason of loss of control is generally due to violation of rules of the road which are shown by traffic signs. Car to road communication systems has the potential to gather information from the road to get the current rules of the road such as speed limits and no overtaking signs. This information can be used to alert the driver or to take the control of the car from the driver. For example a possible head-on collision can be prevented when the driver was alerted by the car where overtaking is forbidden. This system can be based on signal sources put on traffic signs which are received by the car, or can be based on stored road data coupled with GPS.

Figure 13: Car to road communication

ESPII

Today's ESP's try to keep the car stable by applying different brake torques to wheels. In the future ESPII will be in the market which will also be able to steer. This improvement will decrease the head-on collisions which are due to loss of control. The system will be coupled with steer by wire systems which will be more cost-effective solution to steering than today's mechanical systems.

Lane Reading

Today's lane reading systems alert the driver to prevent the car to get off the road. In the future lane reading will also read the mid-lanes to understand if overtaking is forbidden which is one of the most important reasons of head-on collisions. The car may alert the driver or take the control of the steering. This system can be coupled with car to road communication to gather information about the road such as the number of lanes and if the road is a two-way or one way road.

Concentration Detection

Statistical data shows that a considerably high percentage of head-on collisions are due to driver error which may arise from lapses of concentration. In the future cars will be able to detect lapses of concentration and be able to alert the driver which will inevitably have positive contribution to head-on accidents.

Contribution of hybrid

Hybrid vehicles will become more and more popular in the future which generally have in-wheel electric motors. These motors will be controlled to improve the handling and stability of the vehicle. This improvement will decrease the number of meeting accidents due to drifting.

Black box recording

The reasons behind accidents will be recorded, as it is done in aircraft accidents in today's world, in the vehicles. These data will give very valuable information about the way the accident occurred. In our case, the circumstances preparing meeting accidents will come to surface.

Curve Reading

Meeting accidents due to drifting of the vehicle on a curved road is very common. In the future the car will have the ability to identify the bends of the road and depending on the approaching velocity, it will warn the driver or apply light braking in advance.

Night vision

Visibility is a very important factor in head-on collisions, especially high beam of the coming vehicle lead to meeting accidents due to decreased visibility. In the future the cars will be equipped with special cameras which will filter the image so that high beam will be darkened and obstacles and especially pedestrians will be highlighted.

5. Discussion

Dynamics of the vehicle has been proved to be one of the most reducing factors in meeting accidents on straight roads. Most of the accidents are in relation to the loss of control of the vehicle caused by the vehicle or by the mistake of the driver. So there is the need of the systems that can avoid all such kind of situations. Above mentioned systems are all currently available in the market that is helpful to avoid the guilty situations.

With the respect to the first scenario “loss of control”, ABS, ESP, TCS, DSA, EDV, ASR are the available technology which can keep the vehicle run in the safe conditions.

Considering the second the scenario “drift”, Digital voice warning system and lane departure warning system, are helpful.

Regarding the third scenario “overtaking”, BLIS and ACC are really good at avoiding this kind of accident. The former help the driver know the conditions around the vehicle clearly, so this improves the visibility of the driver when he is going to overtake. The latter always keep the safe distance between the vehicles.

Besides the above three special conditions, there are also some unobvious situations, for instance, in the case of the flattening of the tire, tire pressure monitoring system can warn the driver to pay attention to the pressure of the tire; in case of different weather conditions, night vision system, dynamic LED cornering lights, Xenon lights can give the driver a much better vision in the evening; the windshield cleaning system and rain sensor is also helpful on the improvement of the visibility of the driver. Electronic toll collection is also very useful for avoiding the congestion on straight roads and hence, for avoiding the situations of accidents. All these conditions have the influence on the driving safety of the straight road as well, although they do not seem to be so obvious. Therefore, the above mentioned systems can be useful to avoid the accident situations on straight roads.

Future technologies	Loss of control	Drift	Overtaking	Score
Car to road communication	**2**	**2**	**2**	**6**
Car to car communication	2	0	2	4
Lane Reading	2	0	2	4
Concentration Detection	2	2	0	4
Black box recording	1	1	1	3
Curve Reading	1	2	0	3
Night vision	1	0	2	3
ESPII	2	1	0	3
Contribution of hybrid	2	1	0	3

0 □ useless
1 □ usefull
2 □ very usefull

According to the table above, the best device for our scenarios seems to be “Car to road communication”.

6. Conclusion

This report gives information about the most likely scenarios of meeting accidents with the help of the statistical data presented at the beginning of the report. Some today's available technologies were reported which was followed by possible technologies that we may have on the market in the future such as car to infrastructure communication.

According to the scenarios, we have concluded that the most efficient system would be to use car to infrastructure communication against meeting accidents.

The automobile of the future will have the ability to gather information from the road such as the curvature and the number of lines or position of the other vehicles nearby and fuse this information with sensors for various distances. Since the car will most probably be hybrid and it will comprise in-wheel electric motors, controlling the vehicle with control of the torques of separate motors will be more efficient and drive-by wire systems will ease the car to take control of the steering when needed. The lane reading system may also be fused to the gathered data to accurately position the car on the road.

Whatever the system components will be in the future, their inputs will be gathered from the same centre which will have the ability to brake, to accelerate and to steer the car when needed.

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