Smart Braking Systems: A Review

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Abstract: Road accidents are the most unwanted thing that happens to its users. There has been a dramatic increase in road accidents across the globe. In India according to a report by NDTV 1214 road crashes occurs every day in India in which 377 people die every day in our country. In light of this critical situation Ministry of Road Transport and Highways (MORTH) has released a notification which makes Antilock Braking System (ABS) mandatory for all cars to be sold from April 2019. But still there is a need of a smart braking system which can anticipate collisions and able to avoid them by applying brakes automatically. The objective of this paper is to discuss & review the available sensor based braking systems in some luxurious and pricey vehicles.

Keywords: *Honda's CMBS, laser radar sensors, laser assisted braking, braking guard, Brake assist System with a preview Function (BAP) etc.*

1. Introduction

With the advancements in Science &Technology it's now possible that some luxurious & pricey cars incorporating automatic smart braking systems can able to detect other vehicles, anticipate collisions, and apply the brakes automatically. Now a day it can also take corrective steering actions. Because at the time of collision drivers become nervous & apply brake without sufficient pressure or sometimes fail to do so**.** But these cars are beyond the reach of ordinary people. Car manufacturers are working more and more on Collision Avoidance Systems so that in future we can reduce accidents to greater extent. Some of these smart braking systems designed by leading car manufacturing industries are Honda's Collision Mitigation Brake System (CMBS), Volvo XC60 SUV has such system called Laser assisted braking, AUDI has such system in Q7 named it as BRAKE GUARD and Nissan's such intelligent braking system is called Brake assist System with a preview Function (BAP).

2. Definition and Role

A smart braking system is a special kind of braking system that can detect other vehicles with the help of advanced devices such as smart sensors; radars etc. to anticipate collisions and avoid them or at least reduce their severity by applying brakes automatically if driver fails to respond. Some of the smart braking systems of Honda, AUDI, and Nissan& Volvo are as follows:

Honda launched its Collision Mitigation Brake System (CMBS) in 2006 in its Legend saloon and also in CR-V 4x4 2007 model cars. It is offered in several vehicles models in Japan & USA. The purpose of design this system is to provide assistance to drive-in avoiding rear end collisions [(1)].

Likewise AUDI Q7 in 2006 introduced BRAKING GUARD radar assisted forward collision warning system to prevent end & side collisions [(11)].

Nissan has an intelligent brake assist, when there is risk of collision it gives warning to driver if require deactivates the brake to decelerate the vehicle with maximum deceleration of 0.5 g, thereby helping to reduce occupant injuries resulting from the collision[(2)].

Volvo launched XC60 SUV which was equipped with laser assisted braking, that was capable of sensing collision sat speeds up to 50 mps and applies brakes automatically [(3)].

3. Models and Working

Different car manufactures have different models of smart braking system. They use variety of sensing devices & control systems to sense objects & apply brakes as and when required. Models used by Honda, AUDI, Nissan & Volvo with their working are as follows:

3.1 Honda's CMBS

Honda's Collision Mitigation Brake System (CMBS) is a unique safety feature which uses radar sensor and a camera on the windshield of car to scan the road for obstacles. If obstacle is detected, the CMBS will try to avoid collision or reduce the severity of collision in case they are unavoidable. It works in following manner [(1)].

I When the distance between the vehicles becomes less than the fixed safe distance for "normal avoidance" system will produce an audio visual warning to driver as primary warning. This Warning

is given approximately 3 sec before collision is expected. At this stage collision can be avoided just by normal braking.

II If the distance between two vehicles goes on decreasing then CMBS applies light braking & simultaneously driver's seat belt pre tensioner is activated by electric motor. Then secondary warning is given approximately 2 sec before collision is expected. At this stage brake assist will be activated to provide maximum deceleration & collision can be avoided if the driver brakes properly but in case of high relative speed or low pressure on pedal collision may not be avoided.

III After issuing the primary & secondary warnings if the system determines that a collision can't be avoided the pre tensioner retracts the front passenger's & driver's seatbelts & also activates brakes with maximum force.

Honda CMBS is effective in detecting, large vehicles, cars, larger bikes in the centre of the Lane, parked vehicles, roadside objects. However, there are some limitation as described followed:-

i The sensor system is can't accurately identify relative speeds less than 15 KM/hr
ii Pedestrians cannot be detected.
iii Small bikes and two wheelers which are running at the side of the road cannot be detected.
iv Diagonally parked vehicles and small objects such as fallen rock may not be detected.
v The system will not function for very short distances between vehicles.
vi When the collision is very sudden such as at junctions.
vii The system may not function in the bad weather conditions.
viii System can display "CHECK CMBS RADR SENSOR" message on instrument panel if there is less or no vehicle ahead of your car.
ix The radar sensor may not scan incase vehicle is tilted because of a heavy load in the rear or from modifications to the suspension.

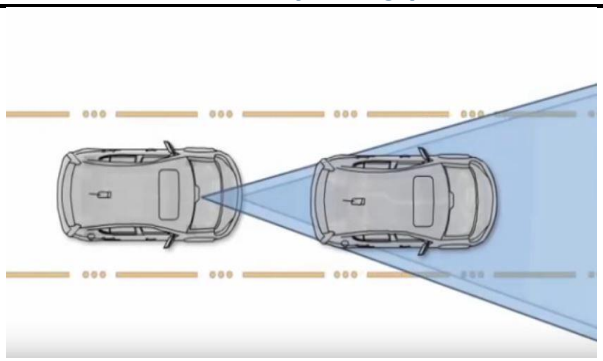

Fig.3.1.1 Honda's Collision Mitigation Braking System [13]

3.2 Audi's Braking Guard

AUDI Q7 in 2006 introduced "BRAKING GUARD" a radar assisted forward collision warning system.Audi radar system is pure hi tech. The radar sensor is fixed right next to the single-frame grille of car, and incorporates four transceiver units behind a plastic lens into its housing. These units send out waves at a frequency of 76.5 GHz in 100 millisecond intervals. The measurement scans a field 180 meters in length with a beam angle of eight degrees.

The computer analyses the differences between successive measurements. Using the Doppler Effect and the time taken by signal to travel, the computer can determine the distance between vehicles or between vehicle & obstacle, as well as whether the distance is changing and by what rate. By comparing the signals from the four individual antennae, it can also ascertain the angle of the vehicle ahead with respect to car's own direction of travel. This in turn is calculated from radar information on lane boundary markers, such as crash barriers, as well as from various signals provided by the ESP stabilization program [11].

3.3 Nissan's Brake Assist System with a Preview Function (BAP)

Nissan has intelligent brake assists which uses laser radar sensors to detect the distance between two vehicles and the relative velocity between them. When there is risk of collision with the vehicle in front then the system sounds a warning to driver so that driver can take avoidance action immediately. If Collision cannot be avoided by the drivers' action the system activates the brake to decelerate the vehicle with maximum deceleration of 0.5 g, thereby helping to reduce passenger injuries resulting from the collision.

Brake assist System with a preview Function (BAP) is helpful in reducing the impact velocity of collisions & their number. However, the objective of this system is to improve the braking response when driver applies brake, itself it is not an automatic braking system. With this braking system driver needs to apply brakes with full pressure as he does

during normal braking. Although the performance of sensors for recognizing the driving environment has been improved significantly in last few years, but still sensors cannot detect objects that suddenly appear from crossroads or from behind some structures. It is expected that drivers will always try to drive carefully and not rely on the system to much [2].

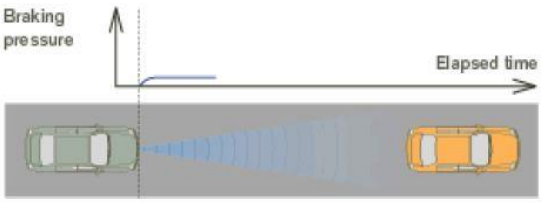

Fig.3.3.1 Nissan's Brake Assists System with Preview Function (BAP) [1]

3.4 Volvo's Laser Assisted Braking

Volvo launched XC60 SUV which was equipped with laser assisted braking system. That was capable to sense a collision at speeds up to 50 mps and apply brakes automatically.

The new model of the car equipped with automated steering with automatic braking to avoid collisions, which was launched in 87th Geneva Motor Show (9 to 19 March 2017), The SUV also will alarm drivers when they're drifting out of their designated driving lane, and will automatically steer them back into their lane.

This model also has an earlier optional blind spot information system which informs drivers about cars that are in their blind spots, but now it can also able to steer the car.

But this system could not work effectively in rainfall and snowfall season and laser is easily affected by atmospheric conditions [3, 5].

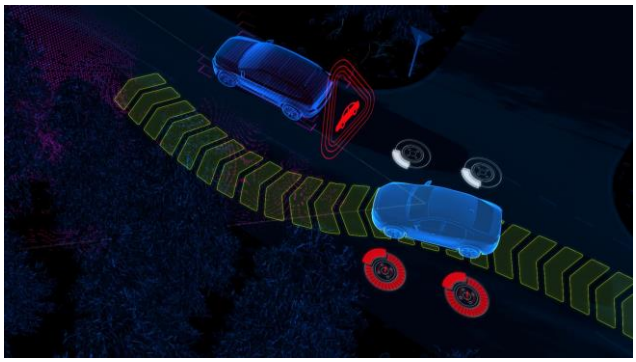

Fig.3.4.1 Volvo's automatic steering assistance to avoid city obstacles. [14]

4. Future Scope

Smart Braking System can be a milestone in the design of driverless vehicles. More inventions and researches in the field of such braking system can made it possible that vehicle is totally able to avoid collisions without any help of driver. With the help of these systems accidents and their severities can be avoided to greater extent. Future researches can eliminate the limitations of current smart braking systems and add one more step towards autonomous vehicle design.

5. Conclusion

In this competitive era car manufacturers are doing more and more work in field for collision avoidance to provide safety to passengers. More work has been done in this field but they still need some improvement & more work to be done in this field. Some of the issues seen in the above systems are that primary aim of the car manufacturers is the safety of occupant. There is a need of work to be done in the field of safety of pedestrians. Also some of these systems are unable to detect objects such as fallen rock which makes driving somewhat uncomfortable in hilly areas. There is also a need to make such a system which can work in any climatic conditions so that vehicles can be derived in any climatic situation with safety. These automatic braking systems are capable in avoiding collisions up to greater extent but still there is a space for improvement.

References

[1] C Grover, I Knight, F Okoro, I Simmons, G Couper, P Massie and B Smith, *"Automated Emergency Breaking Systems: Technical Requirements costs and Benefits"*, Published Project Report. 2008
[2] Minoru tamura, Hideaki tnoue, Takayuki watanable and Nuokimaruko, "*Research on Brake assist System with a preview Function*." Nissan motor co. Ltd.
[3] G.V. Sairam, B. Suresh, CH. Sai Hemanth, K. Krishna Sai, "*Intelligent Mechatronic Braking System"* IJETAEVolume 3, Issue 4, April 2013
[4] A. H. Ingle, Rajesh Kumar Bambal, SanchayShobhane, *"Intelligent Braking System"*, International Journal of Research In Science & Engineering e Volume 3 Issue 2 March-April 2017
[5] https://www.media.volvocars.com/
[6] https://techcrunch.com
[7] https://www.audi-mediacenter.com
[8] www.ndtv.com
[9] Wikipedia//Geneva Motor Show & Volvo XC60
[10] https://www.dowhonda.com
[11] https://www.automobilesreview.com
[12] https://techinfo.honda.com/
[13] https://www.bathursthonda.com
[14] https://startupsventurecapital.com