ACTIVE SAFETY CONTROL TECHNIQUE TO PREVENT VEHICLE CRASHING

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ABSTRACT
Alertness during driving is a key aspect. Even a small distraction for the driver may lead to genuine mishaps. The possible reasons can be obstacle, inadequate vehicle control system or human reflexes (e.g. shock) during sudden distraction. Therefore "Active" and "Passive" systems for vehicle control play a significant role in automotive safety. In this paper, we have discussed an active control technique to prevent the vehicle from crashing. Three different cases of vehicle speed are considered. The presented technique is designed to evaluate the possibility of collision for both front and rear side. The control action will be taken for safe and smooth driving under different situations like parking, urban driving and highway driving.

KEYWORDS: *Active, Passive, Control system, Vehicle speed*

I. INTRODUCTION

Road accident is one of major issues related to public health. According to WHO, over 1.25 million road traffic deaths occurred each year [1]. The Ministry of road transport and highways Govt. of India published close to 5 lakh road accidents in the year 2015 [2]. There can be multiple reasons for road accidents, however one of vital concern is crashing or collision of automobiles against an obstacle. In order to protect loss of life, vehicle manufactures often implement various safety systems. These safety systems mainly divided into two categories: Active Safety system and Passive Safety system.

The active safety system or primary safety or driver assistance system mainly includes features that work to prevent the risk of a collision or an accident. These features are always active to prevent an accident. Passive Safety systems or secondary safety or crashworthy system, on the other hand, are passive until called into action. The passive features become active during the accident and aim to help minimize the damage from the collision [3].

Active system has a main purpose to assist in the prevention of crashes. It is active "prior" to an accident. Passive system has a main purpose to protect occupants during a crash. It is active during an accident. Different examples of Active and Passive safety control systems which are currently used on a vehicle are shown in Fig. 1.

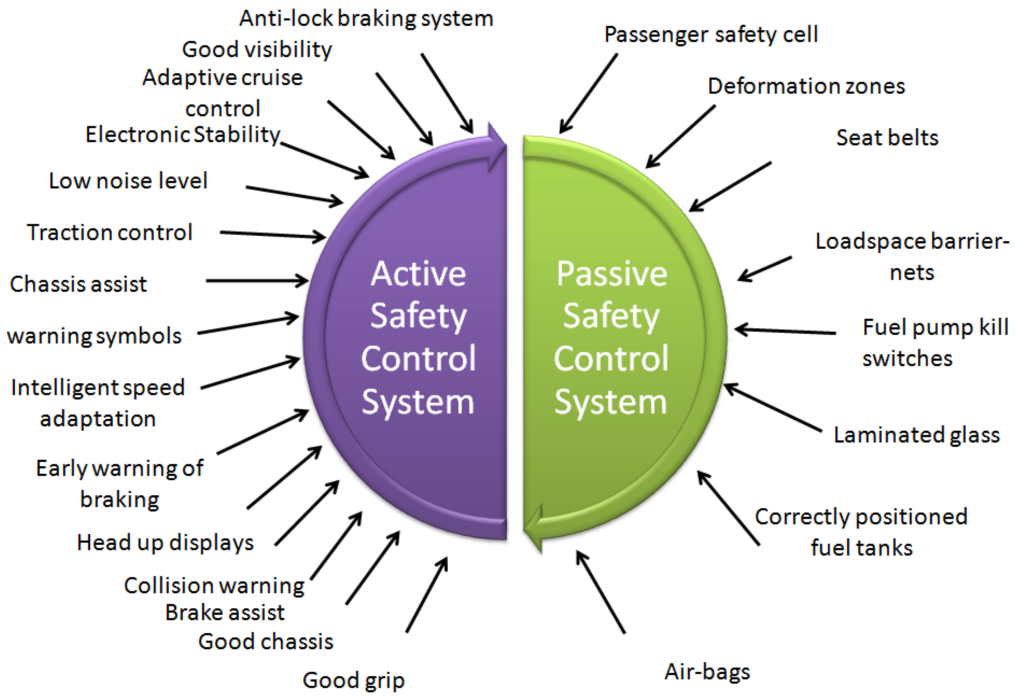


Fig.1: Examples of Active & Passive safety control systems

In this paper, we have proposed an active control technique to prevent the vehicle from crashing. Three different cases of vehicle speed are considered .i.e.
1. Vehicle speed <= 10 KMPH (e.g. Parking)
2. Vehicle speed = 40 KMPH to 60 KMPH (e.g. Urban driving)
3. Vehicle speed >= 60 KMPH (e.g. Highway driving)
The proposed control technique is designed to evaluate the possibility of collision for both front and rear side. As seen before, there are multiple ways to implement an active system. In this paper, we have presented an economical and effective way of control technique with the use of basic systems of the vehicle. The proposed control action will be taken for safe and smooth driving [4].
This paper is organized as follows: Next section presents the proposed active safety control technique. The section details the idea with flowcharts and control system. The last section concludes the findings.

II. ACTIVE SAFETY CONTROL TECHNIQUE

The Adaptive Cruise Control (ACC) (which keeps the automobile at pre-defined safer distance from the preceding vehicle) is already exists where the vehicle control system is combined with cruise control. The vehicle speed control technique in particular zones is already proposed [5,9]. In some systems, vehicle gives a buzzer signal to the intimate driver to slow down vehicle otherwise vehicle speed controlled automatically [6].In this paper, the active control technique is proposed to prevent the vehicle from crashing is presented. When the vehicle is moving with speed more than average speed (40 kmph and above), the reaction by the driver for controlling speed of the vehicle when obstacle come up is very important. Sometimes, the driver may not be able to control the vehicle because of the short time and sudden shock, which results in crash of a vehicle to obstacle.[10]

The proposed active safety system is a helping hand for the driver to control vehicle speed so that vehicle crashing and respective mishaps gets prevented. In this system, the vehicle is controlled by reducing engine speed as well as braking action. For actuation of the system, inputs from wheel speed sensors and ultrasonic wave sensor are important parameters. From these inputs controller will evaluate the possibility of collision and takes corrective action.

An engine control unit (ECU) controls different actuators on an IC engine to ensure optimal engine performance. Fig. 2 shows the layout of the engine speed control system. The basic elements of an engine control system of the kind that led to development of regulators are, 1. A valve which regulates supply rate of compressed air, 2.MAF sensor, 3.An output shaft with flywheel and engine load [7].

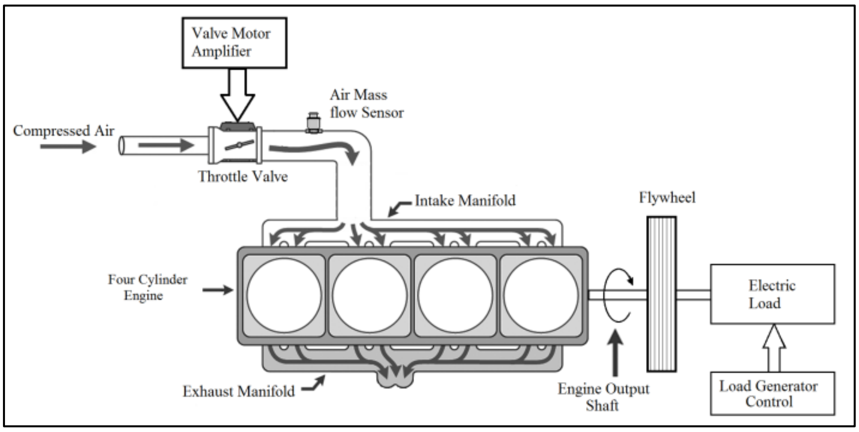


Fig.2: Engine Speed Control System

As shown in Fig. 2, the compressed air can be controlled using the driver motor and throttle valve. If x(t) is defined as the valve position and motor input as u(t). Then, the rate of change of valve position $\dot{x}(t)$is proportional to motor input signal $u(t)$.

$$\dot{x}(t) \alpha \ u(t) \qquad \text{(i)}$$

Similar if p(t) is defined as valve output pressure and $T_E(t)$ as engine torque then valve output pressure $p(t)$ is proportional to valve position x(t). The engine torque is proportional to air pressure. And the angular$\omega_E(t)$ velocity of engine can be calculated from engine torque,

$$p(t) \alpha \ x(t) \qquad \text{(ii)}$$

$$T_E(t) \alpha \ p(t) \qquad \text{(iii)}$$

$$\omega_E(t) \alpha T_E(t) \qquad \text{(iv)}$$

The momentum of the vehicle cannot be addressed only by engine control. So, the automatic braking system is also needed. The brake gets applied through ECU action on ABS and vehicle speed gets controlled as per the requirement [8].

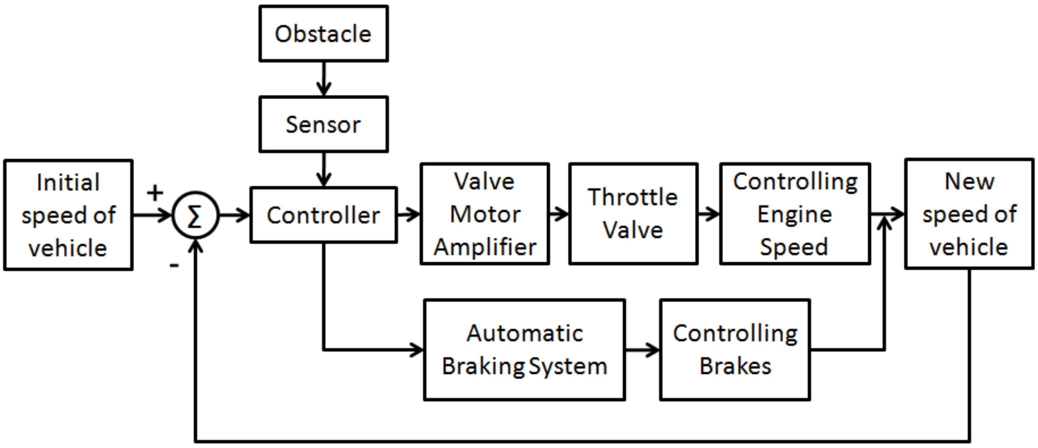


Fig.3: Vehicle Speed Control System

Fig. 3 shows the layout of proposed vehicle speed control system. The system consists of a vehicle wheel speed sensor and obstacle detection sensor (ultrasonic wave sensor, parking sensors at the rear as well as the front side of vehicle) which provides input to the controller (ECU) of speed control system. As per the input provided by obstacle sensor and vehicle speed, the controller will send a signal to valve motor amplifier and automatic braking system through ECU for actuation. The valve motor amplifier controls compressed air entering inside the engine via control valve. Because of air mass flow rate sensor, fuel flow rate also gets modified as per requirement. The automatic braking system actuates the brake. Finally the braking action will help to control vehicle speed.

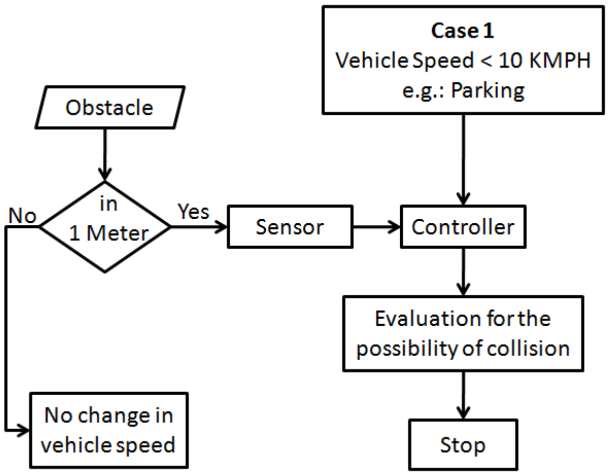
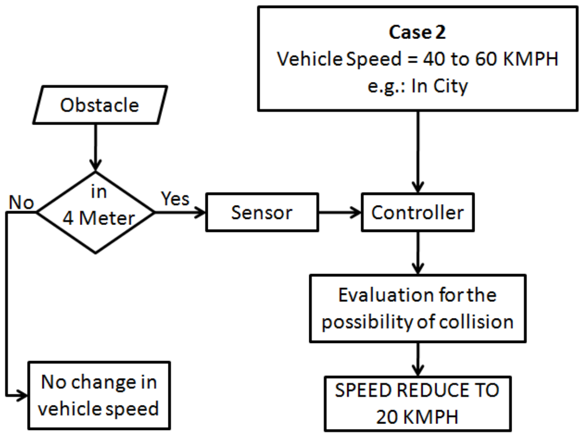


Fig. 4: Flowchart of System for Case-I



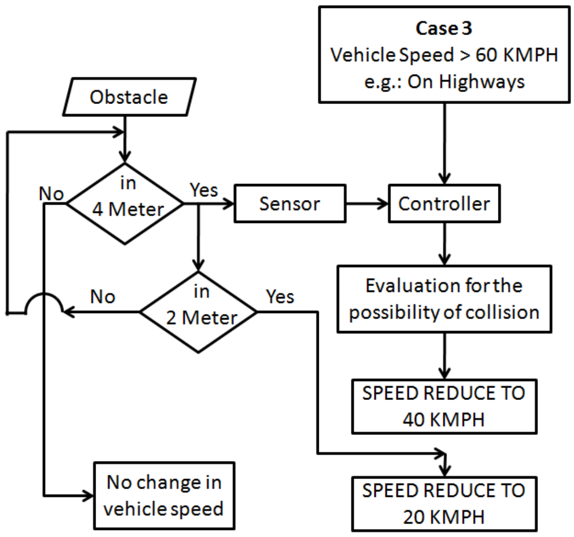


Fig. 5: Flowchart of System for Case-II **Fig. 6:** Flowchart of System for Case-III

In this study three cases of vehicle speed and direction are considered. In case-I vehicle is in crowded areas or parking mode. So the speed of the vehicle is considered less than 10 kmph. For this speed parking sensor will act as obstacle detection sensor. The flowchart for case-I is shown in Fig. 4.When obstacle is at 2m (detected by parking sensor) from vehicle for considering the speed controller will send a signal for controlling engine speed as well as actuation of light braking. Further, if the distance of obstacle becomes 1m from the vehicle, the engine throttle valve gets closed and hard braking action will be there for completely stopping of the vehicle. Due to the closing of the throttle valve, engine may shut off (as per driver's reaction) and hard braking may give a jerk to passengers sitting in a vehicle, but crashing gets avoided.

In case-II vehicle speed is considered as less than 60 kmph while moving in city or urban area. In this case, ultrasonic wave sensors will act as an obstacle detection sensor. The flowchart for case-II is shown in Fig. 5. Because of sensors, distance of the obstacle and vehicle speed is communicated to controller continuously, the controller will take action in reducing the speed of vehicle up to 20 kmph to avoid collision with obstacles.

In case-III vehicle speed is considered as more than 60 kmph while moving at highway. The flowchart for case-III is shown in Fig. 6.In this case action taken by the controller is similar as case II. If an obstacle is at4 meters from the vehicle, the controller takes action to slow down vehicle up to 40 kmph. Further, if the obstacle is at 2 meters from the vehicle, then the controller will again take action for slowdown the vehicle up to 20 kmph.

Table 1: Vehicle speed controller action for different cases.

Cases	Initial Speed of Vehicle	Obstacle Distance	Sensor Signal	Controller Action	New Speed of Vehicle	Remark
Case 1	< 10 KMPH	> 1 Meter	0	No	< 10 KMPH	No Change
		1 Meter	1	Yes	0	Stop
Case 2	40 to 60 KMPH	> 4 Meter	0	No	40 to 60 KMPH	No Change
		4 Meter	1	Yes	20	Speed Reduced
Case 3	> 60 KMPH	> 4 Meter	0	No	< 10 KMPH	No Change
		4 Meter	1	Yes	40	Speed Reduced
		2 Meter	1	Yes	20	Speed Further Reduced

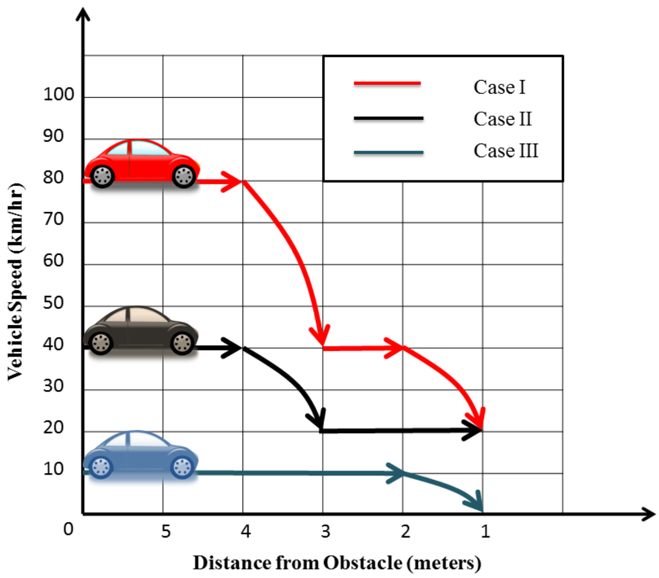


Fig.7: Graphical Representation of case studies.

In second and third case the final speed of the vehicle is 20 kmph. With this speed if vehicle collides with an obstacle, then the possibility of damage to the vehicle or injury to passengers will be less. It shows, even if the driver feels the shock, the active control system will assist to slow down vehicle speed. Table 1 represents actions taken by controller for providing sensor signal for different case studies.

The last two columns of the table represent the new vehicle speed with remarks on controller action. These actions of the controller are represented in fig. 7.

III. CONCLUSION AND FUTURE SCOPE

An active safety control system is presented to prevent the vehicle from crashing. The proposed technique is designed to manage vehicle speed using engine control and braking action against an obstacle. The control system is set to use the sensor output for evaluating the possibility of collision for both front and rear side. The control action will be taken for safe and smooth driving under three different vehicle speed situations like parking, urban driving and highway driving. In addition, the proposed control technique does not need an expensive sensor which otherwise is a common practice for active safety control of the vehicle. We propose, basic system of vehicle with proposed control logic to have an effective safety of the vehicle against crashes. In future scope, the proposed control system will be implemented and prior test will be carried out.

REFERENCES

[1] World Health Organization (WHO), *"Global Status Report on Road Safety 2015"*, Link: http://www.who.int/violence_injury_prevention/road_safety_status/2015/en/

[2] The Ministry of road transport and highways Govt. of India, "*Road accidents in India 2015"*, Link: http://pib.nic.in/newsite/PrintRelease.aspx?relid=146093

[3] Rahul Waghe, Dr. S Y.Gajjal, 2014, *"Study of Active and Passive Safety Systems and Rearview Mirror Impact Test"*, SSRG International Journal of Mechanical Engineering (SSRG-IJME) – volume1 issue 3, ISSN: 2348 – 8360, pp. 10-15

[4] MuntaserMomani, 2012, "*Collision Avoiding System (CAS)"*, Contemporary Engineering Sciences, Vol. 5, no. 7, 341 - 354

[5] GummarekulaSattibabu,, B.V.V.Satyanarayan, VvSatyanarayana Kona, 2014, "*Automatic Vehicle Speed Control With Wireless In-Vehicle Road Sign Delivery System Using Arm 7* ", International Journal of Technology Enhancements And Emerging Engineering Research, Vol2, Issue 8, ISSN 2347-4289, pp 32-34.

[6] Amarnarayan, ChallaSaikumar et all, 2016, "*Automatic Over speed Controlling of Vehicle*", International Journal of Combined Research and Development, ISSN 2321-225, Vol 5, Issue 5, pp 706-709.

[7] ZhenggangXu, XiaopengXie, 2009, *"A method for reducing exhaust pressure of vehicle compressed air powered engine"*, IEEE International Conference onMechatronics andAutomation, ICMA 2009. Changchun, China.

[8] TakeshiWakabayashia, TakushiMatsutoa, KazhuikoTanib, AtsuoOhtaa, 1998, *"Development of motor actuated antilock brake system for light weight motorcycle"*, New Technologies & NewCars, JSAE Review, Volume 19, Issue 4, 1 October 1998, Pages 373-377.

[9] A.Vengadesh ,K.Sekar, 2015, "Automatic Speed Control of Vehicle in Restricted Areas Using RFand GSM", International Research Journal of Engineering and Technology, Volume 2, Issue 9, pp 875-877.

[10] Mr.M.V.N.R.Pavankumar ,Mr. Deepak S. Kesare, Mr. Mangesh B. Pawar, Mr. Pramod R. Khande, "Highway Speed Control and Automatic Breaking System"International Journal of Research in Advent Technology, Vol.3, No.5, May 2015, pp 59-62.