International Journal of Pure and Applied Mathematics
Volume 117 No. 20 2017, 1011-1020
ISSN: 1311-8080 (printed version); ISSN: 1314-3395 (on-line version)
url: http://www.ijpam.eu
Special Issue

AUTOMOTIVE BRAKING SYSTEM FOR PASSENGER VEHICLE TO ENHANCE SAFETY

Dineshkumar C[1] Subramanian M[2]

[1]Assistant professor, Department of Automobile Engineering,
B S Abdur Rahman Crescent University,Chennai, India.
email:dineshauto@bsauniv.ac.in
[2]Professor, Department of Automobile Engineering,
B S Abdur Rahman Crescent University,Chennai, India.
email: ramani@bsauniv.ac.in

Abstract – Today most of the automotive modern vehicles depend on automotive safety to reduce the damage and injury to the drivers and pedestrians. Automated safety systems besides enhancing active safety devices due to increased rate of accidents in India. The results suggested that many of these accidents were caused by inattention. Automatic braking system combine sensors technology and brake control system to prevent high speed impact. Some of the automatic braking systems can prevent collisions altogether but most of them are designed and placed for the luxury and high cost vehicles. Since high-cost vehicles are more likely to be fatal than low-cost automatic braking systems can save lives and reduce the amount of property damage that occurs during an accident in normal vehicles. Some of these systems use lasers others use radar and some even use video data. The IR sensor input is used to determine if there are any objects present in the path of the vehicle. The IR sensor is placed in front bumper, the system can then determine the speed of the vehicle is greater than the speed of the object in front of it. A significant speed of the vehicle may indicate that a collision is likely to occur in which case the system is capable of automatically activating the brakes. The signal from the IR sensor which is connected to the stepper motor through control unit which make the braking system to control at this situation. The speed sensor senses the speed of the vehicle and stepper motor is activated depends on the speed of the vehicle. The braking is activated by programmed in the control unit. The stepper motor which drags the braking cable which is connected to the both front and rear wheels at varying force. However, automatic brakes can save your life if you ever suffer from a momentary lapse in concentration. The concept of this project is cost effective and can be used these in passenger vehicle.

Key words: Infrared sensor, stepper motor, control unit, speed sensor.

I. INTRODUCTION

The brake system is designed to slow down and halt the motion of the vehicle. Various components are used in braking system to convert the momentum(kinetic

energy) in to heat energy using friction two forms of friction play important role in automotive braking:– kinetic friction, static fraction. Braking action creates kinetic friction in the brakes and static friction between the tire and road to slow the vehicle. When brakes are applied the vehicle's weight is transferred to the front wheels and is unloaded on the rear wheels [1]. A car is travelling down a road but the driver has not noticed the van ahead is stationary. Moments from impact cameras on the moving vehicle detect the obstacle and automatically activate the brakes avoiding a collision. The system that prevented the crash is autonomous emergency braking and it is being hailed by safety experts as the greatest new technology in motoring. Improvements to vehicle safety are seen as one of the big contributors to the reduction in road deaths in the EU over the past few years and crucial to its target of halving fatalities between 2010 and 2020[2][3]. There were more than 26,000 deaths on Europe's roads last year and some 199,000 people were seriously injured – a stark reminder that more must be done to reduce those numbers. The European Transport Safety Council recommends that autonomous emergency braking becomes mandatory when the EU revises its vehicle safety requirements in the next year. The organisation is also pressing for the compulsory introduction of intelligent speed assistance which tells drivers when they are breaking the speed limit – and seatbelt reminder warnings. The costs of introducing such technologies drops when they become mandatory say the ETSC. In Sweden which has the world's safest roads, deaths plunged by 59 per cent between 2001 and 2012[4]. One of the reasons was that the majority of new cars sold had a top five-star, safety rating, says Ellen Townsend, policy director at the ETSC. At present autonomous emergency braking is fitted on only a small percentage of cars. In the UK, it is fitted on 29 per cent of new vehicles, slightly ahead of the European average, according to Thatcham, a motor research centre based in Berkshire, England. Vehicle makers say the path to road safety is an "integrated approach", combining better vehicles with improved driver training and input from the road planners. But it is also true that road safety has been a hallmark of the European project. The emergency brake was originally intended for one particular emergency and that was "no other way to stop", as was the case when the footbrake suddenly failed [5-7]. Drivers had to respond when brakes failed, so they were expected to learn how to stop a speeding vehicle using the emergency brake alone. Safety regulations became almost universal by 1980, so modern brake systems are very reliable, using dual-circuit hydraulics and more recently low-brake-fluid sensors. As modern brakes no longer cause emergencies (a brake warning light comes on after the first sign of trouble), it is no longer necessary for the average driver to learn to use this brake for emergencies. Some drivers benefiting from the "park" function on their automatic transmissions do not use this brake at all. After a lack of recent braking emergencies, automakers stopped using the term and started referring it by its other use the "parking brake" even though the ability to function at a high speed was still there. On an increasing number of modern vehicles, the parking brake can only be engaged when the vehicle is at a stop and they no longer have an emergency brake .

II.METHODOLOGY

The main aim of this project is to get vehicle stopped during emergency. Heart beat sensor which is place in the steering wheel and to measure the pulse of the driver. The pulse range falls less than 50 and above 120 is abnormal rate. The range is programmed in control unit of the system. The variation of this range is monitored and when the pulse rate is varied depends on this programmed the signal activates the proposed braking system. The IR sensor which is placed at the front bumper. The sensor senses the object which is at front of the vehicle and measures the distance between the vehicles. The IR sensor senses the object and sends the signal to the control unit which is connected to the system. The speed sensor senses the speed of the vehicle and sends the information to the control unit. The control unit which is connected to stepper motor. The stepper motor which is activated depends upon the speed of the vehicle and distance of the object which is placed at the front. The stepper motor which rotates the handbrake cable which is connected to the front and rear brake shoes. The speed of the vehicle is measured and the cable is activated. The brake shoes are grabbed by using the stepper motor. The handbrake cable which is connected to the both front and rear wheels of the vehicle. The brake is applied during emergency or during impact. The main aim of the proposed system is to slow down the vehicle or reduce the impact from the high speed collision.

A.Flow chart of braking system

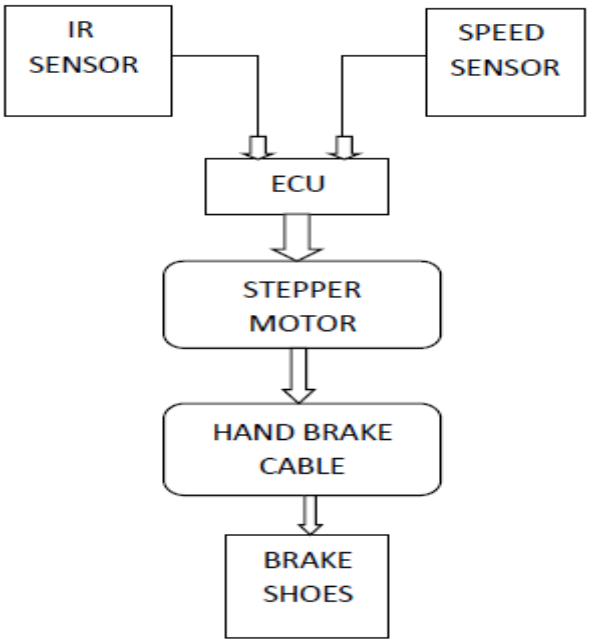

Fig 1.Flow chart of automotive braking system.

B. Layout of braking system.

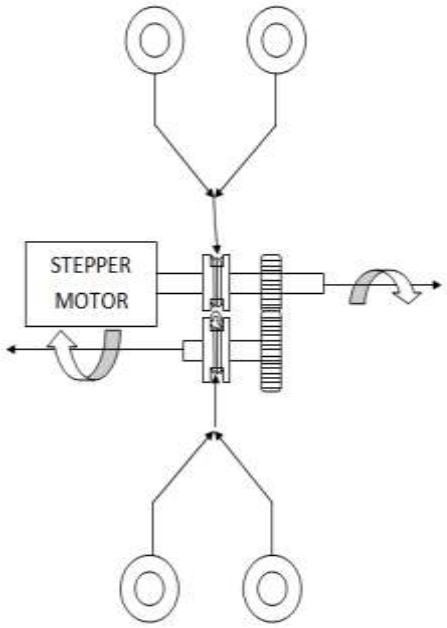

Fig 2. Illustration diagram of braking system.

III. RESULTS AND DISCUSSIONS

The below table shows the braking distance calculation of the vehicle. The reaction distance is measured depends upon the response taken by system and braking distance measures the distance which had been taken for applying the brake. The stopping distance is measured depends upon the reaction distance and braking distance. Highway traffic and safety engineers have some general guidelines they have developed over the years and hold now as standards. As an example, if a street surface is dry, the average driver can safely decelerate an automobile or light truck with reasonably good tires at the rate of about 15 feet per second. Driver can slow down at this rate without anticipated probability that control of the vehicle will be lost in the process.

The energy conversion is more important by considering -

$$mv^2/2\mu g \quad Nm.$$

m- Mass of the vehicle in kg

v- Initial velocity in m/s

μ- co efficient of friction (0.8) for this car

g- Acceleration due to gravity on earth (9.81) in m/s^2

S.No	Speed (Km/hr)	Reaction distance (m)	Braking distance (m)	Stopping distance (m)
1	20	6	2.0	7.7
2	40	11	8	19
3	60	16	18	34
4	80	22	32	54
5	120	33	72	115

Table 1.Braking distance calculation.

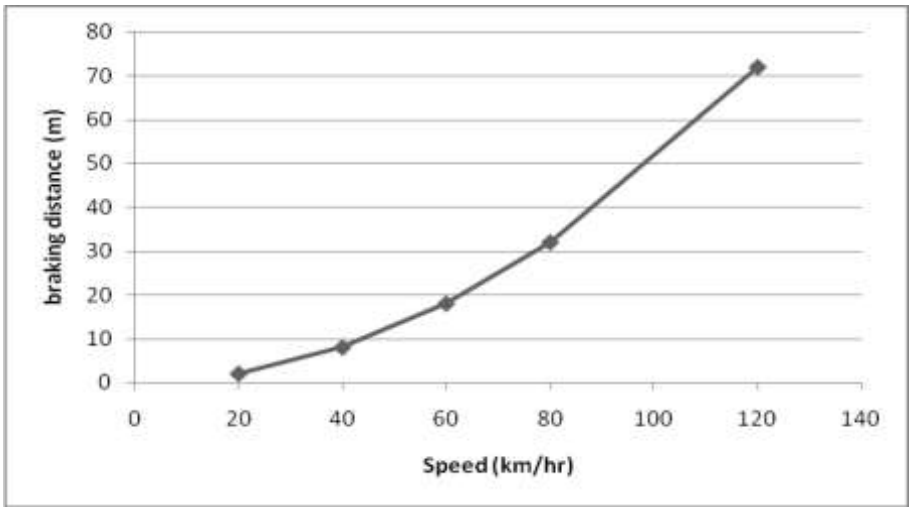

Fig 3. Graph shows the speed vs braking distance.

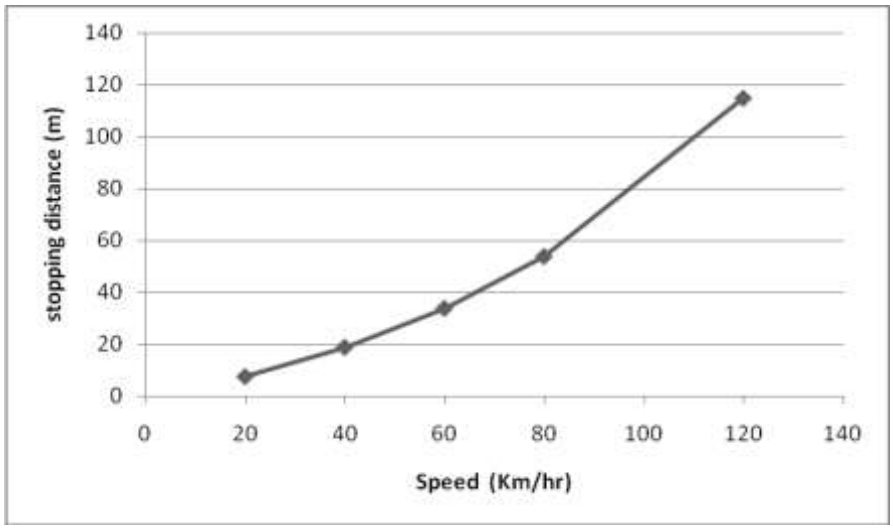

Fig 4. Graph shows the speed vs stopping distance

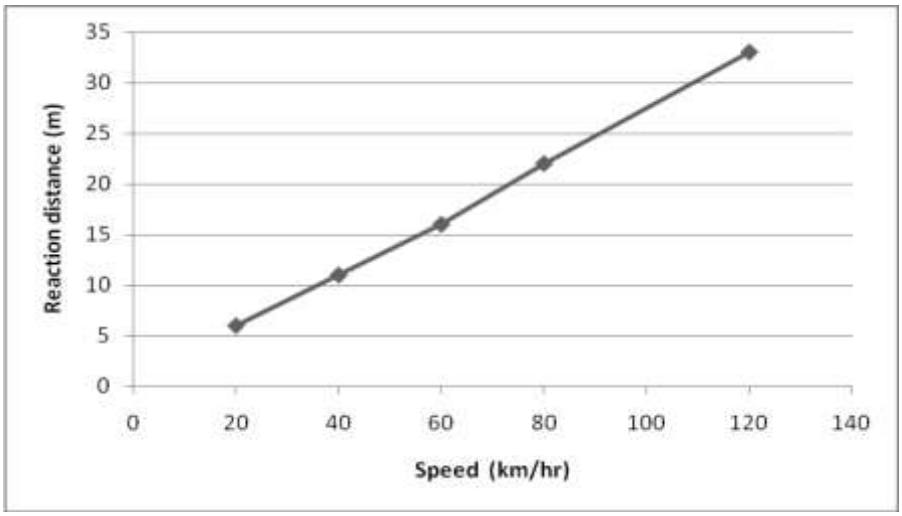

Fig 5. Graph shows the speed vs reaction distance.

Normal stepper motor micro stepping have almost linear characteristics with their speed of rotation being determined by the applied DC voltage and their output torque being determined by the current flowing through the motor windings[18]. The speed of rotation of any DC motor can be varied from a few revolutions per minute (rpm) to many thousands of revolutions per minute making them suitable for electronic, automotive or robotic applications. By connecting them to gearboxes or gear-trains their output speed can be decreased while at the same time increasing the torque output of the motor at a high speed. Micro stepping is a way of moving the stator flux of a stepper more smoothly than in full- or half-step drive modes. This results in less vibration, and makes noiseless stepping possible down to 0 Hz. It also makes smaller step angles and better positioning possible.

The torque (T) developed by the motor is a function of the holding torque (TH) and the distance between the stator flux (fs) and the rotor position (fr)[18].

$$T=TH\times \sin(fs-fr)$$

Where fs and fr are given in electrical degrees.
The relationship between electrical and mechanical angles is given by the formula [18]:

$$f_{el} = (n\div 4) \times f_{mech}$$

Where n is the number of full-steps per revolution.

When a stepper is driven in full-step and half-step modes the stator flux is rotated 90 and 45 electrical degrees respectively every step of the motor. From the formula above we see that a pulsing torque is developed by the motor (see figure 1a, which

also shows the speed ripple caused by the torque ripple). The reason for this is that fs-fr is not constant in time due to the discontinuous motion of fs.

S.No	Speed (Km/hr)	Reaction distance (m)	Braking distance (m)	Stopping distance (m)
1	20	8	6	11
2	40	14	11	24
3	60	20	25	39
4	80	27	39	62
5	120	39	86	126

Table 2.Braking distance calculation of stepper motor.

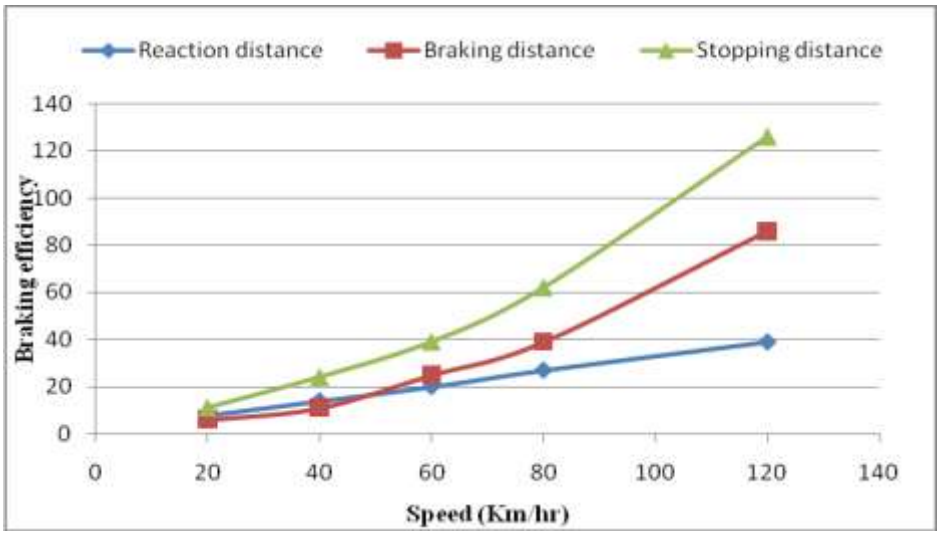

Fig 6. Graph shows the speed vs stepper motor braking efficiency

IV. CONCLUSION

Automated safety systems besides enhancing active safety devices due to increased rate of accidents in India. Accidents systems had been incorporated only in high class vehicles and modern vehicles. The propose system should be useful for the middle class peoples and low end vehicles. The proposed system would be cost effective and the stepper motor is used to operate the brake cable to control the impact. The system is designed to reduce the speeds of the vehicle and to slow down the vehicle before collision. The impact of the vehicle is reduced and the braking efficiency is increased during critical situation. The life of driver and co-passenger is saved and injury is reduced by using this system.

ACKNOWLEGMENTS

This research was supported/partially supported by B S Abdur Rahman crescent university, vandalur, chennai. We thank our colleagues from [Automobile department crescent university] who provided insight and expertise that greatly assisted the research, although they may not agree with all of the interpretations/conclusions of this paper.

We thank Dr. Subramanian, HOD for assistance with particular technique, methodology, and Faculty of B S Abdur Rahman crescent university for comments that greatly improved the manuscript.

We would also like to show our gratitude to the Lakshmanaprabu SK, B S Abdur Rahman Crescent university for sharing their pearls of wisdom with us during the course of this research, and we thank 3 “anonymous” reviewers for their so-called insights. We are also immensely grateful to my team mates for their comments on an earlier version of the manuscript, although any errors are our own and should not tarnish the reputations of these esteemed persons.

REFERENCES

[1] Yi, Jingang, Luis Alvarez, and Roberto Horowitz. "Adaptive emergency braking control with underestimation of friction coefficient." *IEEE Transactions on Control Systems Technology* 10, no. 3 (2002): 381-392.

[2] S.Dharia1, Sachin S. Bhopale, Advancements in automatic hand brake system Vol. 5, Issue 05,2016.

[3] Wakchaure P.B, Prof: Borkar B.R, “Review on Parking Brake Lateral Play in Four Wheeler”, International Journal of Scientific and Research Publications, Volume 3, Issue 4, 2013.

[4] Thivagar, S., and C. NANTHA KUMAR. "Automatic hand brake system." International Journal of Engineering Research and General Science, Vol 4, no. 1 2016.

[5] Aher Gauresh H., Kunzarkar Prasad. P., Agalave Sagar V.,Wagh Chetan V., Prof. Pagar K. R., Prof. Bhane A.B., “Automatic Emergency Braking System”, International Journal of Emerging Technology and Advanced Engineering, Vol 6, Issue 4,pp.199-201.l 2016.

[6] D. L. Shinde1, Mr. Talandage Nikhil M2 Automatic Engagement and Disengagement of Hand brake System Using Pneumatic system, Vol 5 Issue VI, June 2017

[7] SandeepThorat, Sanket Thorve Design and Implementation of Automatic Emergency Braking System Special Issue -4 (March 2016).

[8] Graham, Robert. "Use of auditory icons as emergency warnings: evaluation within a vehicle collision avoidance application." *Ergonomics* 42, no. 9, pp. 1233-1248, 1999.

[9] S.Thivagar, C.Nantha Kumar 'Automatic Hand Brake System' International Journal of Engineering Research and General Science Volume 4, Issue 1, January-February, 2016.

[10] Amit B. Maske, S.B Tuljapure, P.K Satav 'Design & Analysis of Parking Brake System of Car' 'International Journal of Innovative Research in Science, Engineering and Technology' Vol. 5, Issue 7, July 2016.

[11] Prof: Wakchaure P.B, Prof: Borkar B.R,' Review on Parking Brake Lateral Play in Four Wheeler' International Journal of Scientific and Research Publications, Volume 3, Issue 4, April 2013.

[12] Wang Hong-liang, Li Nan, Gao Fan-qin, Dai Xiao-ming, 'Research on the Hill-start Control of Vehicles Based on the Pneumatic Auto Parking Brake System' International Conference on Mechatronics, Control and Electronic Engineering (MCE 2014).

[13] Lakshmanaprabu, S. K., U. Sabura Banu, and P. R. Hemavathy. "Fractional order IMC based PID controller design using Novel Bat optimization algorithm for TITO Process." *Energy Procedia, Vol.* 117, pp. 1125-1133, 2017.