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# Parametric Smart City Brake Support System

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*Abstract : In today's fast and busy work driven environment, the most important thing that the automobile industries are concerned about is the increasing number of road accidents that occur and hence generates a need of a "smart brake support system". As the name suggests, it will consist of different sensors to control the speed of the vehicle or stop it on a levelled road or on an inclined plane. The ultrasonic sensor has been used to detect the presence of any obstacle both in front as well as in the rear of the vehicle, an inclinom eter has been used to measure the gradient of the slope and a microcontroller is used to control the r.p.m of the motor. All these sensors has been installed to ensure the safety of the passengers as well as that of the vehicle so that brakes can be applied on the right time on calculating the braking distance and reaction distance.*
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*Keywords: Ultrasonic sensor, inclinometer, microcontroller, breaking distance, reaction distance.*

## 1. INTRODUCTION

Whenever the questions are raised regarding the safety of the passenger and the vehicle, then most likely the answer is related to the braking system. Most likely the accidents occur either due to the failure of the braking system or due to the carelessness of the driver. To minimise the accidents and keeping in mind the need of the future, an attempt has been made to develop a system that deals with this problem by the integrated use of the sensors and the microcontroller. This system will prevent the vehicle to collide with any obstacle or vehicle in the front and also alerts the driver by raising the alarm if any vehicle comes too closer from behind, thus leading to lesser forward collisions.

## 2. SYSTEM SURVEY

The first and foremost task that is to be done is to find the suitable sensor according to our requirements. The two best possible options for calculating distance between two objects are to use either ultrasonic sensor or infrared sensor.

### 2.1 Advantages of ultrasonic sensors over infrared sensors

i. Ultrasonic sensors are completely insensitive to hindering factors like light, dust, smoke, mist, vapour, etc.
ii. Infrared sensors can't detect the darker surfaces, it can detect only the brighter surfaces while the ultrasonic sensors can detect both.

### 2.2 Principal Components of this System

i. Ultrasonic sensors
ii. Microcontroller
iii. Inclinometer
iv. Alarm
v. Battery
vi. DC Motor
vii. Display screen

## 3. METHODOLOGY

The methodology used for the working of this system is as follows:

In this system, detection of an obstacle will be done by the help of two ultrasonic sensors. One sensor is used in the front to prevent front collision and the second one is used at the back to alert the driver by raising the alarm, if any vehicle or obstacle comes too close to it. Basically, the ultrasonic sensor used at the back will come into play while reversing the car. In addition to these, an inclinometer with a gyroscope is also used so as to detect whether the vehicle is moving on a levelled road or on a plane having slope(tilt).

Now, let us see how this system works with the help of some diagrams and tables.

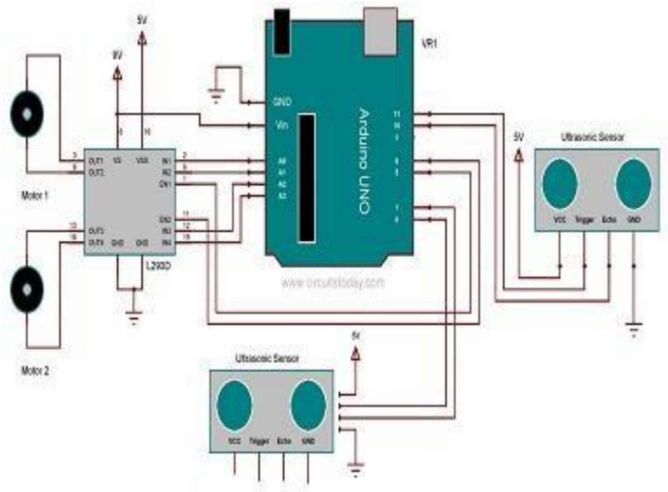



Fig. 1

### 3.1 Ultrasonic Sensor

As the name suggests, the ultrasonic sensor works by emitting short, high frequency sound pulses at regular intervals. If they strike an object, then they are reflected back as echo signals, which itself computes the distance to the target based on time span between the signal and receiving the echo.

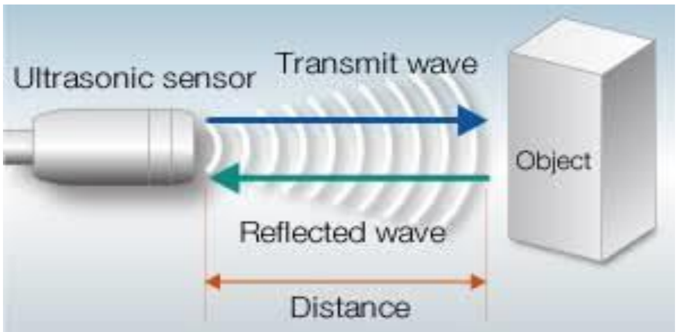



Fig. 2

The computation of the distance between the vehicle and the obstacle is done on the basis of the formula :

$$\text{Distance} = \frac{\text{Speed*Time}}{2}$$

where, speed of sound in air is 343 m/s

### 3.1.1 Braking Distance

The braking distance is the distance the vehicle travels by the time it could actually come to rest on applying the brakes. It can be found by determining the work required to dissipate the kinetic energy of the vehicle.

Braking distance, $s = v^2/(2\mu g)$

where,

'v' is speed of the vehicle in m/s

'μ' is the coefficient of friction between tyre and road μ = 0.8(dry road) μ = 0.6(wet road)

'g' is the acceleration due to gravity(9.81 m/s$^2$)

### 3.1.2 Preception-reaction distance

The perception-reaction distance is the distance the vehicle travels by the time the driver could actually react to the stimuli and apply brakes. It can be found by using the formula given below:

Perception-reaction distance, $d = v*t_{p-r}$

where,

'v' is the speed of the vehicle in m/s

'$t_{p-r}$' is the reaction time of the driver ~ 1.5 s

### 3.1.3 Total stopping distance

The total stopping distance or the actual stopping distance is the sum of the reaction distance and the braking distance.

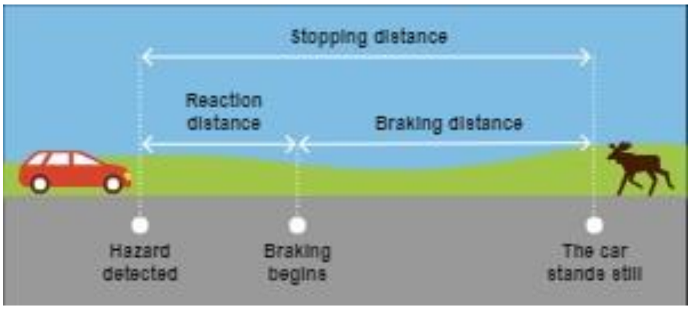



Fig. 3

Thus,

Totalstopping distance = $(v*t_{p-r}) + (v^2/2\mu g)$

### 3.2 Inclinometer

An inclinometer is an instrument that for measuring angles of slope or elevation and depression of the plane w.r.t. the force of gravity. External accelerations like rapid motions, vibrations or shocks will introduce errors in the tilt measurement. To overcome this problem, a gyroscope can be used in addition to that of the inclinometer because the above mentioned accelerations have limited effects on the gyroscope, thus giving the most accurate value of the tilt.

Fig. 4

### 3.3 Microcontroller

The model number of the microcontroller used in this project is ATmega328. Apart from this, an L293D motor driver IC is also used for driving the motor as per the requirement.

### 3.4 Mechanism

As the vehicle is moving on the levelled road, then the total braking distance can be calculated based on the above-mentioned formulae. But, if the vehicle is climbing up the hill or moving down the hill, then inclinometer gives us the value of the slope and the deacceleration to be produced on applying the brakes is to be calculated as follows:

i) When the vehicle is moving down the slope,

$$\alpha = g(\mu\cos\theta - \sin\theta)$$

ii) When the vehicle is climbing up the slope,

$$\alpha = g(\mu\cos\theta + \sin\theta)$$

where, ‘θ’ is the angle of the slope.

Now, on calculating ‘α’, we need to calculate the stopping distance which can be calculated via the following formula:

$$\text{Stopping Distance} = v^2/2\alpha$$

The block diagram shows the mechanism of this system and the use of the microcontroller:

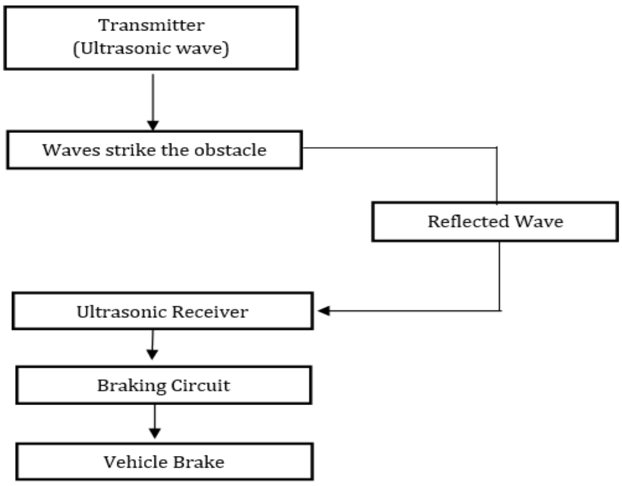



Fig. 5

When all the sensors give their responses to the microcontroller, then depending upon the algorithm feeded, it controls the speed of the DC motor attached and hence, the vehicle is slowed down or stopped completely as per the requirement and also the alarm is raised if the ultrasonic sensor detects an object too close from the back.
In this way, the safety of the passengers as well as the vehicle is ensured.

4. OBSERVATIONS

Based on the above mentioned formulae, the observation and the calculation for the developed braking system is given in the following table:

**Case I (a)** : When the vehicle is moving on the leveled road (without sensor).

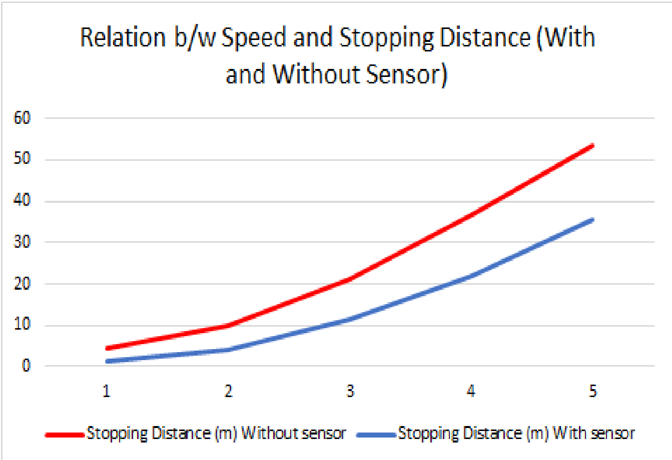
Table 1

| Speed (kmph) | Stopping Distance (m) |
|---|---|
| 10 | 4.64 |
| 18 | 9.81 |
| 36 | 21.37 |
| 54 | 36.83 |
| 72 | 53.48 |

**Case I (b)** : When the vehicle is moving on the leveled road (with sensor).

Table 3

| Speed (Kmph) | Stopping Distance (m) |
|---|---|
| 10 | 1.25 |
| 18 | 4.09 |
| 36 | 11.37 |
| 54 | 21.83 |
| 72 | 35.48 |

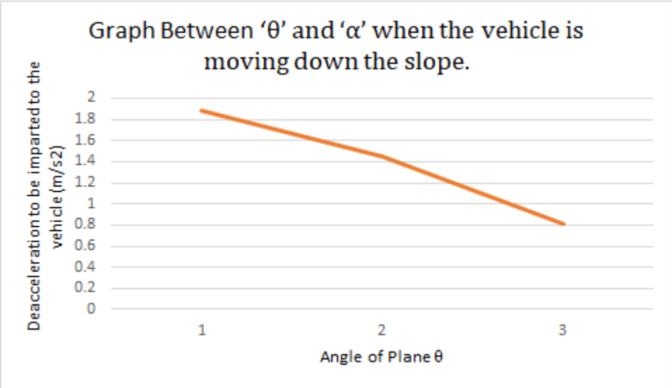



**Case II** : When the vehicle is moving down the slope

Table 4

| Speed (kmph) | Angle of Plane (θ°) | Deacceleration to be imparted to the vehicle ($m/s^2$) | Stopping Distance (m) |
|---|---|---|---|
| 40 | 30 | 1.89 | 32.65 |
| 40 | 35 | 0.81 | 76.19 |

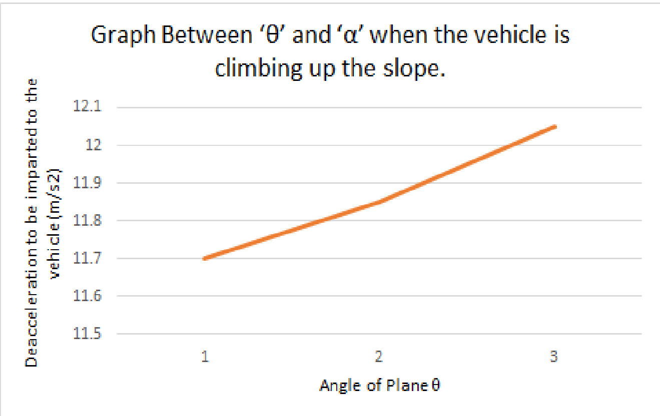
| | | | |
|---|---|---|---|
| 45 | 30 | 1.89 | 41.40 |
| 45 | 32 | 1.45 | 53.87 |
| 45 | 35 | 0.81 | 96.45 |




**Case III**: When the vehicle is climbing up the slope

Table. 5

| Speed (kmph) | Angle of Plane (θ°) | Deacceleration to be imparted to the vehicle ($m/s^2$) | Stopping Distance (m) |
|---|---|---|---|
| 40 | 30 | 11.70 | 5.27 |
| 40 | 35 | 12.05 | 5.12 |
| 45 | 30 | 11.70 | 6.67 |
| 45 | 32 | 11.85 | 6.59 |
| 45 | 35 | 12.05 | 6.48 |




## 5. CONCLUSION

The suggested system, named as "Smart City Brake Support System", is very effective in eliminating the high risk of the accidents that occur due to the carelessness of the drivers. This is because the sensors and the microcontroller will prevent the further collision of the vehicle by applying the brakes either partially or fully, depending upon the need. Also an alarm has been installed in integration with the backward ultrasonic sensor so as to alert the driver at the time of reversing the vehicle or when an uncontrolled vehicle comes too closer to it from the behind.

Thus, we can say that this system will eliminate a majority of the human errors that occur either in haste or due to carelessness.

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