T.Mahendran al. International Journal of Recent Research Aspects ISSN: 2349-7688, Vol. 4, Issue 4, Dec 2017, pp. 277-280

Advanced Collision Safety System Using Airbag

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Abstract- **The objective of this project is to develop a concept of grille airbags which is deployed in the bumper for improved vehicle compatibility during front impact. The airbags in the bumper is deployed upon signals from pre-crash sensors will help in reducing the damages during collisions. In vehicles in the case of collision, the major damage occurs severely at the frontal part. Even in the minimal speed, frontal collision results in more damage to the vehicle, especially engine compartment. Here an airbag is used in front of the vehicle bumper, which will inflate prior to the collision of the vehicle. As said, the vehicle tends to acquire damage even in minimal speed, the airbags are set to inflate at a vehicle speed of 30km/hr. Thus in this project, protecting the frontal part of the vehicle in the case of collision using frontal airbags.**

Keywords: Frontal airbags, pre-crash sensors, minimum speed, grille airbags, damage.

I. INTRODUCTION

Automobile safety is the study and practice of design, construction, equipment and regulation to minimize the occurrence and consequences of traffic collisions. There are two types of Safety systems

- Active safety
- Passive safety

Active safety systems are always active. They understand the state of the vehicle to avoid and minimize the effects of a crash.

Passive safety are those systems which remain passive until they become active. They become active only after the collision occurs. [7]

The bumper is the front or rear part, designed to allow the car to withstand low speed collision without damage to the vehicle's safety systems. They are not capable of reducing injury to vehicle occupants in high speed impacts. During a frontal collision, the front portion of the vehicle could be damaged heavily. And during high speed the damage can be lot more severe damaging the entire frontal portion along with the engine. [5]

In general the airbags belong to the passive safety system and by using it as an active safety system is a method which is gaining popularity. And this requires higher accuracy to deploy the airbag before the collision by measuring the speed of the vehicle, the deceleration of the vehicle, and distance between the objects at front. And by using the above data's we can judge whether the vehicle will avoid the collision or not using a controllers (i.e. arduino, raspberry pi, etc...). The controller compares all the data and acts accordingly.

Agyei-agyemang stated to reduce the extent of damage to passengers due to vehicle collisions, a friction damper is built to test its effectiveness in impact energy reduction. The study concluded that the energy absorption capacity of the bumper can be increased with the addition of a friction damper. Bumpers can be designed to absorb higher energy than they usually do with some modification of the design and the use of additional energy absorption devices. [8] This work applies a passive control system which is an uncontrolled damper that requires no input power to operate. They are simple in construction and are low in cost, but are unable to adapt to changing needs after installation. [1]

The development, implementation, and assessment of highway safety the road traffic crash data are very useful tools was studied by Azad Abdulhafedh. Generally, traffic data collection methods can be classified as intrusive and non-intrusive methods. Road traffic crash data can be used by many authorities such as: law enforcements to identify persons at fault in road traffic crashes. [2]

hunke Liu stated that automobile traffic accident methods are as follows: frontal collision, side collision, rear-end collision and rolling etc. The proportion of different forms of frontal crash accounts for about 40% of all the collision accidents according to a survey. [3] The use of the finite element analysis helps the automobile design. Using the results of the finite element analysis, we can obtain the optimal thickness value of each component. The automotive bumper plays a vital role in absorbing the impact. The protection of the hood, trunk, grill, fuel, exhaust, cooling system and safety related

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equipment such as the parking lights, headlamps and taillights. [4]

Saeed Barbat developed a concept of grille airbags for improved vehicle compatibility in frontal impact. The airbags in the bumper is deployed upon signals from pre-crash sensors will help in reducing the damages during collisions. However, a highly reliable pre-crash sensing system is needed to enable a reliable deployment, which is difficult to implement. The airbag relied extensively on finite element simulations of the vehicles that is striking and struck. Most importantly, airbags deployment is irreversible and requires very reliable and robust pre-crash sensors. [10]

METHODOLOGY

Airbag

An Airbag is an automotive safety system. Its purpose is to safeguard the occupants during a crash when they strike interior objects such as the steering wheel or a window. Nylon 6.6 was found to be satisfying the need of the project. Properties:

- Bag material: 2-ply, 420 Denier, Nylon 6.6 (custom woven)
- Bag Shape: Ellipse
- Three internal bulkheads and four internal tethers to maintain bag shape.

ARDUINO

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino language and the Arduino development environment. [6]

Table 1 : Properties of Arduino

PARAMETER	VALUE
CPU type	16-bit AVR
Flash memory	64 kB
SRAM	4 kB
EEPROM	2 kB
Pin count	28-pin
Maximum operating frequency	10 MHz
Number of touch channels	16
Maximum I/O pins	26
External interrupts	2

Arduino UNO – ATMEGA328 is very suitable to process the huge data & to make the function more accurately.

Wheel Speed Sensor

Vehicle speed sensor is a type of tachometer. It is a sender device used for reading the speed of a vehicle's wheel rotation. A wheel speed sensor generates a magnetic pulse in the form of a wave proportional to the speed of the vehicle.

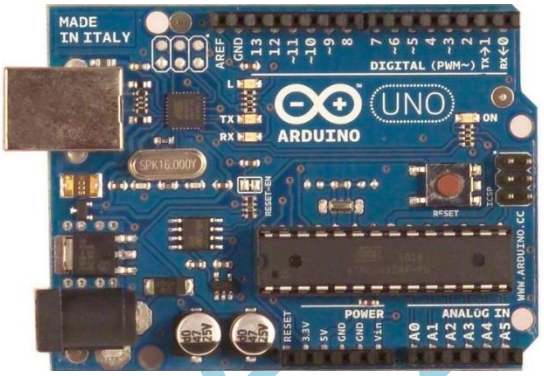

Figure 1 : Arduino UNO

Types of Vehicle Speed Sensor
Hall Effect Sensor
Reed Switch-Type Sensor

RADAR

The RADAR is use to identify the objects around the vehicle using radio frequency waves, it is predominantly used in Automatic Cruise Control vehicles to sense the objects in the rear, front and side of the vehicle. This is further used to control the vehicle. This idea is coupled along with the pre-crash sensor to deploy the airbag before collision. [9]

Table 2 : Properties of RADAR

PARAMETER	VALUE
Range	20 m
Frequency	10.525 GHz
Radiated power	12 dBm
Supply voltage	4.75v – 5.25v
Current Consumption	30 mA

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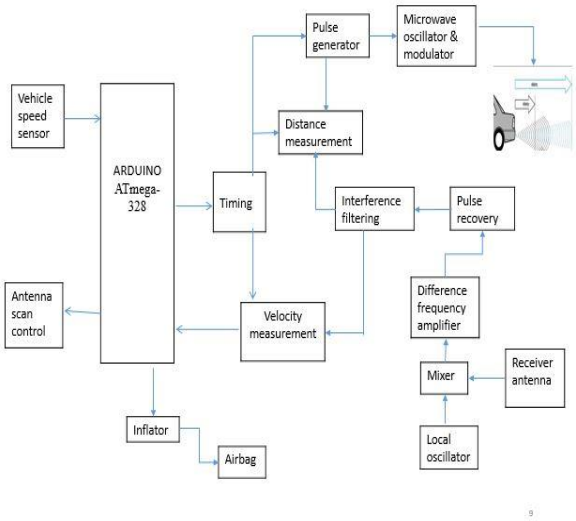

Figure 2: Layout of the system

Working of circuit

Vehicle speed sensor is a type of tachometer. It is a sender device used for reading the speed of a vehicle's wheel rotation. A vehicle speed sensor generates a magnetic pulse in the form of a wave proportional to the speed of the vehicle. A pulse generator is used to generate rectangular pulses. The distance from the target vehicle will be measured by collecting the reflected radio waves. The velocity of our vehicle will be measured to determine whether the vehicle is braking. An inflator is filled with sodium azide in pellet form, which upon igniting releases nitrogen gas.

The nitrogen gas is used to fill the airbag. An Airbag is an automotive safety system. Its purpose is to safeguard the occupants during a crash when they strike interior objects such as the steering wheel or a window. The minimum speed of the vehicle that is needed to open the external airbag is 30 kmph and it is programmed in the arduino. The braking of the vehicle is taken into account, with which we can judge whether the vehicle would stop prior to collision.

EXPERIMENTATION:

The Arduino ATMEGA UNO was programmed using arduino software.

Table 3 : Specifications of Arduino

PARAMETERS	VALUE
Minimum speed of vehicle	30 kmph
Inputs derived	Speed of the vehicle
	Braking of the vehicle
	Distance from the object
Airbag deploying time	0.03ms
Total airbag deployed time	0.1s
Rebound velocity	0.7 m/s

The RADAR was tested and incorporated in the bumper of the vehicle. It will measure the distance of the target vehicle from the targeted vehicle, using the Radiofrequency waves which will be reflected back upon hitting an obstacle. The wheel speed sensor was fitted to the body, it will measure the speed of the sprocket fitted in the shaft. It is used to measure the speed of the vehicle, it can also detect the deceleration of the vehicle thus determining the braking of the vehicle. The vehicle selected was a GO-KART in which all the components mounted. The kart is a 150cc kart which has a top speed of 50kmph. The kerb weight of the kart is 120kgs. The GO-KART was tested under a speed of 40kmph. The airbag deployed in the correct time, it deployed in 0.03s. The total time duration of the event was 0.1s.

RESULT AND DISCUSSION

This project was an idea created to provide an extra safety feature using an unconventional way of implementing the passive safety into an active safety. There were many difficulties arose during the fabrication of the project such as the accuracy of the radar, the deployment of the airbag in the right time, using the speed and the braking of the vehicle was a challenging task. Yet the project was completed successfully

S.No	Speed of the vehicle(kmph)	Distance from the object (m)	Output signal
1	0	-	-
2	15	≤ 10	≤ 10 – 0 ≥ 10 – 1
3	30	≤ 12	≤ 12 – 0 ≥ 12 – 1
4	45	≤ 20	≤ 20 – 0 ≥ 20 – 1
5	60	≤ 30	≤ 30 – 0 ≥ 30 – 1

Table 4: Look up table

NOTE: 0 – Signal isn't sent to the inflator unit.
1 – Signal sent to inflator unit.

The arduino look up table is coded for different speed, the output signal is based on the speed of the vehicle, braking distance, and distance from the obstacle in front. The vehicle won't be damaged heavily if it collides below the speed of 30kmph, which is the threshold limit of our project and if the speed of the vehicle is higher than that and if the brakes aren't applied using the data's we can judge whether the collision will occur or not.

At vehicle speed of 30 kmph the minimum braking distance required is 12 meters and if the distance from the object is

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lower than 12 meters the probability of the stopping of the vehicle is lower and the arduino signals the airbag to open and if the distance from the vehicle in front is greater than 12 meters the probability of stopping the vehicle is high, so the arduino doesn't send signal to the inflator. The airbag in the bumper will be inflated, thus reducing the severity of the collision.

The similar process is for all the different speeds, at every speed the distance required to stop the vehicle is varying and it varies for different vehicles, so this increases the complexity of the project and due to this the accuracy of the system must be very high which is obtained by higher degree of input data and all data's must be analyzed carefully. And while fabricating this project we found that similar process was used in bonnet airbags for pedestrian safety.

CONCLUSION

The airbags generally are used to provide safety for the passengers and more recently for the pedestrians, but it can also be used to absorb the energy during a collision thus reducing the impact of the collision. And by using this the damage caused to the engine compartment can be reduced thus saving lots of money spent to repair the damage. The time taken for repair and the labor for repair is reduced with this project. The ease of changing the airbag, which opened in a vehicle to prevent the collision is just replaced with new setup and few wiring connections.

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