

Intelligent Braking System, Fabrication and Analysis of a Prototype

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Abstract - Recent years have seen a surge in purchasing of automobiles and with this increase in the number of automobiles have resulted in a considerable increase in accident rates. Most of the accident occurs due to the delay of the driver to hit the brake, so in this project work a braking system is proposed such that when it is active it can apply brake on its own if there is an impending delay on the driver's side depending upon the object sensed by the ultrasonic sensor and speed of vehicle. The proposed intelligent mechatronic system uses a pneumatic brake system which is aided by an ultrasonic sensor system provided on the front portion of a car emitting ultrasonic waves. The ultrasonic sensor receives the reflected ultrasonic signal. The reflected wave (detected pulse) gives the distance between the obstacle and the vehicle and RPM counter gives speed of vehicle. The microcontroller is used to control the braking of the vehicle based on this information. Under required conditions microcontroller sends an electrical signal to the solenoid valves which actuates the pneumatic piston resulting in braking action. A prototype was created and the structural analysis of the prototype was performed.

Key Words: Automatic braking, Ultrasonic sensor, Arduino processor, Prototype fabrication and testing, Analysis.

1. INTRODUCTION

Braking systems of commercial vehicles were always given the highest importance concerning safety issues and in particular active safety. Inappropriate braking of these vehicles may cause heavy accidents due to relatively longer stopping distances and higher energy output of brakes. The rapid response time provided by the electronic control can be used for crucially shortening the braking distance by introducing advanced control of braking system operation.

Intelligent braking system has a lot of potential applications especially in developed countries where research on smart vehicle and intelligent highway are receiving ample attention. The system when integrated with other subsystems like automatic traction control system, intelligent throttle system, and auto cruise system, etc. will result in smart vehicle maneuver. The driver at the end of the day will become the passenger, safety accorded the highest priority and the journey will be optimized in term of time duration, cost, efficiency and comfortability. The impact of such design and

development will cater for the need of contemporary society that aspires quality drive as well as to accommodate the advancement of technology especially in the area of smart sensor and actuator.

The proposed intelligent mechatronic system uses a pneumatic brake system which includes an ultrasonic wave emitter provided on the front portion of the prototype producing and emitting ultrasonic waves forward in a predetermined distance. The reflected wave (detected pulse) gives the distance between the obstacle and vehicle, also speed of vehicle is noted. The microcontroller is used to control the braking of the vehicle based on this information. Under required conditions microcontroller sends an electrical signal to the solenoid valves which actuates the pneumatic piston resulting in braking action. A scaled prototype model of an automobile was constructed and structural analysis of the prototype was performed using Ansys analysis software.

2. LITERATURE REVIEW

Braking system with Automatic Pneumatic Bumper. (Thepade,N,et al.,2016) This journal describes an idea to reduce impact on four wheelers during emergency conditions where a collision is imminent. The journal suggests that four wheelers should incorporate an extended bumper to absorb the impact shock. The bumper is extended using pneumatic system which receives input from an electronic proximity measuring system.

Stability Control of Vehicle during emergency braking. (Chen Q, et al., 2014) The journal describes the skidding of automobile tires during emergency braking and the need to apply brakes as in pulses or in a gradually increasing braking force rather than a sudden press.

Research on adaptive cruise control. (Chengwi.S , et al.,2016) The journal describes sharing information between automobiles while they are in motion in order to reduce accidents. The communication could be made possible through proximity sensors and Bluetooth devices. Automobiles when comes within the range of proximity sensors information regarding their speed and vehicle conditions can be shared with each other resulting in an efficient travelling with minimal risk of accidents.

Brake reactions of distracted drivers to pedestrian forward collision systems.(Nils L ,2017) This journal describes that an audio and visual warning with an added

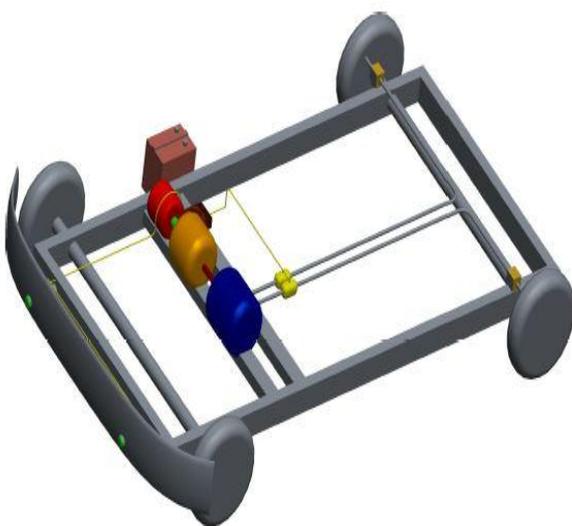
pulse is most effective in preventing collisions thereby reducing accident chances. If a distracted driver does not see a pedestrian beep sounds along with red warning lights are shown to the driver reminding him to look for the pedestrian and apply brakes.

Distance measuring by Ultrasonic sensor . (Koval.L , et al.,2016) The journal describes active and passive ultrasonic sounds and the use of passive ultrasonic for distance measurement. It is seen that ultrasonic sensor has good accuracy . Ultrasonic sensor performs well under rainy and humid conditions unlike other proximity sensors

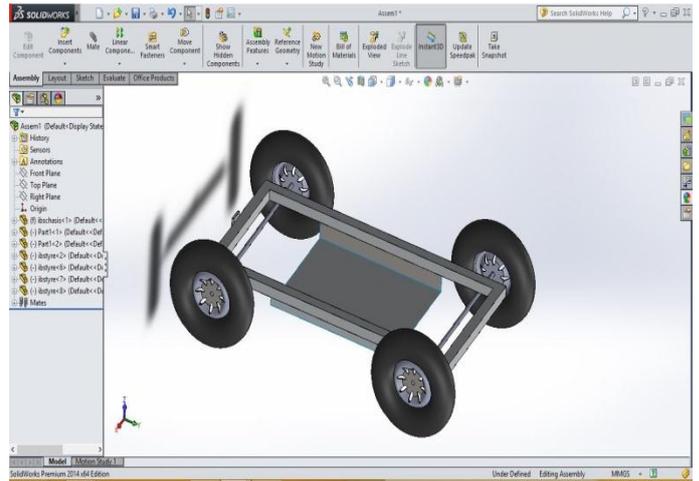
3. METHODOLOGY

The Intelligent braking system uses ultrasonic sensor mounted on the front end of the automobile to detect the distances of obstructions from the automobile. This signal input along with the speedometer input is send to the microcontroller. Microcontroller uses the algorithm provided and the two information signals to decide whether to take braking action or not if the driver does not apply. Brakes are applied by controlling a solenoid valve which actuate pneumatic pistons.

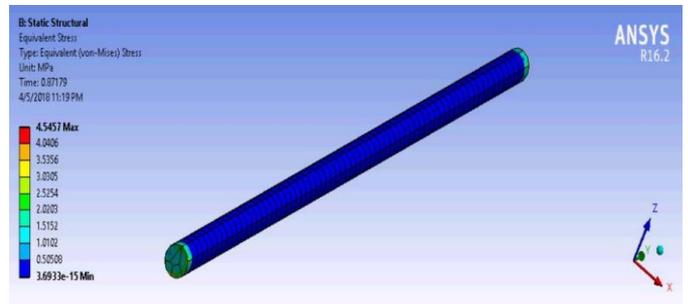
The whole system consists of a prototype of a vehicle which consists of a chassis made of hollow GI square tubes and four tyres of the scooter model Activa attached to it. A 12V motor of 30 rpm drives the system. The pneumatic system consists of two double acting pneumatic pistons and an air regulating valve controlled by the microcontroller. The electronic system consists of a microcontroller, a small display unit and an ultrasonic sensor which senses the proximity of an object and the microcontroller gives out a signal to the solenoid valve to actuate the pistons thus a braking force is applied.



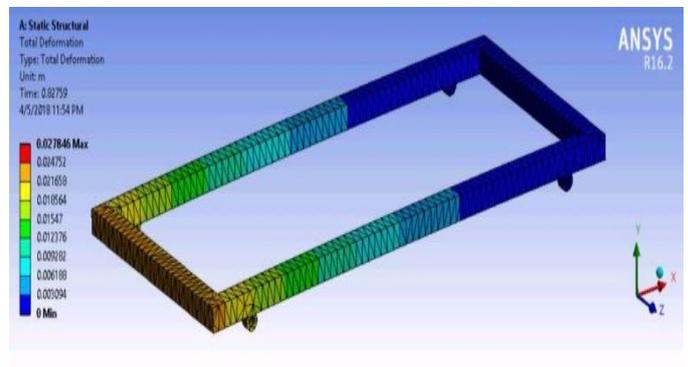
First design made using Creo Parametric 2.0



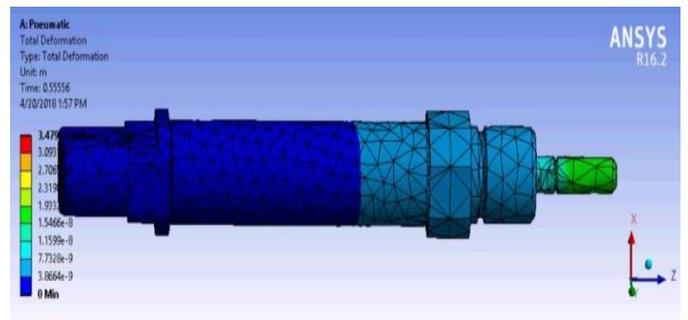
Final Design made using Solidworks



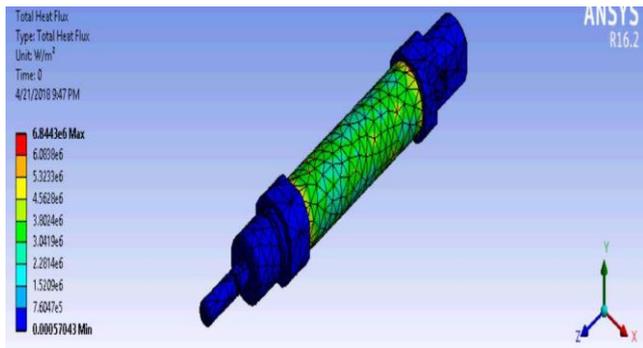
Stress analysis of shaft using ANSYS



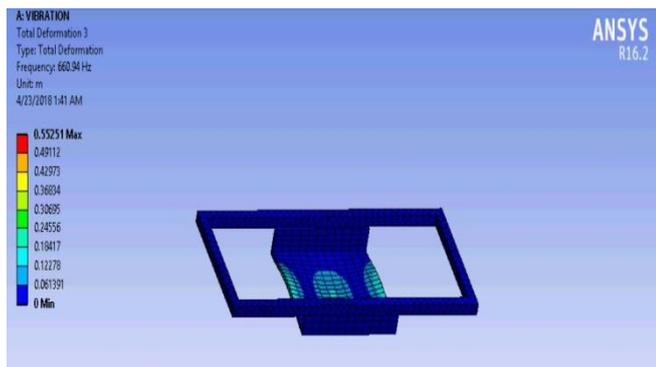
Deformation analysis on chassis using ANSYS



Deformation on the pneumatic piston cylinder assembly



Heat flux in the pneumatic cylinder



Vibrational analysis of the prototype

4. MANUFACTURING

Manufacturing processes are the steps through which raw materials are transformed into a final product. The manufacturing process begins with the creation of the materials from which the design is made. These materials are then modified through manufacturing processes to become the required part. Manufacturing processes can include treating (such as heat treating or coating), machining, or reshaping the material. The manufacturing process also includes tests and checks for quality assurance during or after the manufacturing, and planning the production process prior to manufacturing.

SL NO:	COMPONENT	SPECIFICATION
1	Compressor	901771PSN ,12V , 5psi
2	D C Motor	12 V, 18 W
3	Pneumatic Piston	Double Acting , 16mm bore
4	Ultrasonic Sensor	5 V, 15 mA ,2 cm – 4 m range
5	Microcontroller	Arduino ATmega 328
6	Directional Valve	5/2 valve , 0.25-0.75 bar
7	Shaft	½ Inch
8	Square Tube	113mm , 52mm
9	Sheet Metal	72mm x 55mm
10	Bearing	Bearing No. 6203
11	Pneumatic Hose	0.5 in , blue color
12	Tyre with Wheel Hub	Activa tube type with and without internal shoe brake
13	Battery	12 V, 7.2 Ah

Table 5.1 Components Specification

4.1 Metal cutting

Metal cutting or machining is the process of by removing unwanted material from a block of metal in the form of chips. Cutting processes work by causing fracture of the material that is processed. Usually, the portion that is fractured away is in small sized pieces, called chips. Common cutting processes include sawing, shaping (or planning), broaching, drilling, grinding, turning and milling

4.2 Sawing

Cold saws are saws that make use of a circular saw blade to cut through various types of metal, including sheet metal. The name of the saw has to do with the action that takes place during the cutting process, which manages to keep both the metal and the blade from becoming too hot.

4.3 Drilling

Drilling is a cutting process that uses a drill bit to cut or enlarge a hole of circular cross-section in solid materials. The drill bit is a rotary cutting tool, often multipoint. The bit is pressed against the workpiece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the workpiece, cutting off chips (swarf) from the hole as it is drilled.

4.4 Welding

Welding is a process for joining similar metals. Welding joins metals by melting and fusing 1, the base metals being joined and 2, the filler metal applied. Welding employs pinpointed, localized heat input. Most welding involves ferrous-based metals such as steel and stainless steel. Weld joints are usually stronger than or as strong as the base metals being joined.

4.5 Operations performed at workshop

The hollow square section GI tubes were cut to desired length by sawing operation. The cut tubes were welded to build the required frame work. Holes were drilled on the tubes at the required places to facilitate clamping of different parts. A thin GI sheet was fitted on top of the frame so as to provide a platform for placing the electronic circuit. A thin projection is placed in front of chassis for attaching the ultrasonic sensor. Bearings are welded on to the under side of the chassis for fixing the wheels. A projection is placed to house the motor which drives the prototype. A small cylindrical part is welded onto the frame so as to hold the pneumatic cylinders in position where when the piston is displaced will hit the adjuster of the internal expanding shoe brake and thus cause braking action. Battery along with the microcontroller and other electronic components are fixed onto the earlier fixed GI sheet.



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5. CONCLUSIONS

The prototype incorporating intelligent braking system is designed and fabricated. On testing , prototype applies brake automatically when an obstruction comes in front of the range of sensors and avoid an imminent collision. This is an innovative project on modern and advanced braking system.

The Intelligent braking system is an automatic braking system which can be incorporated in a wide range of automobiles. This braking system can be mainly used to avoid vehicle accident that occurs due to the absent mindedness of drivers or due to lack of sleep for long distance drivers and it also offers efficient vehicle speed control on inclined roads.

The conclusions are summarized as follows :

1. Designed and fabricated a prototype which uses proximity sensor and incorporates Intelligent braking system
2. This system can be installed in any series of automobile and can thus be instrumental in reducing collision rates.
3. There is a large market ahead in India

6. REFERENCES

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