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Design of seat belt ignition interlock system

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Abstract

Seat belts are the crucial motor vehicle safety device to be developed. Seatbelts are the most effective method of reducing injury severity and road fatalities in a motor vehicle crash. This research work focuses on the construction of a system in which the vehicle will only start when the seatbelt is engaged. This system will increase the safety of the driver avoiding using the seatbelt in their vehicle thus bypassing the existing system. This system will result in the increased passive system of vehicles, which will result in fewer deaths during an accident. In this project work, a design prototype of an ignition interlock system has been constructed. It is a passive safety feature which does now allow the vehicle to start until and unless the seatbelts of passengers are fastened.

Keywords: Ignition Interlock System, Seat Belt, Passive Safety

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1. Introduction

As the human population is increasing, the usage of vehicles is in great demand and along with this the automobile manufacturers are focusing on safer cars. Nowadays, due to the improvisation of the infrastructure of roads, highways, and expressways, the average speed of the vehicles has increased but the safety of the passenger is always a primary concern for everyone, so awareness is required regarding safety. In India, majority of the vehicle does not fasten seatbelts while driving unless a strict regulation in enforced (Kapadnis et al., 2021; Karthik et al., 2014; Patel et al., 2018; Prakash et al., 2016; Rana et al., 2021; Shah et al., 2020; Vijaykumar et al., 2022; Vyas et al., 2017). So with a basic safety system which is the use of seat belt while driving, we are proposing a system in which vehicle will only start when the seat belt is engaged.

This paper is focused on the construction of a seat belt interlock system such that the vehicle will only start the vehicle when the seatbelt is engaged else the vehicle will not start at all. As most of the Indians have the habit of skipping the engaging of seat belt due to which airbags do not deploy resulting in severe injury to the driver as well as to the co-driver which increases death of

people in case of fatal accidents, so, in order to increase the safety of driver this system has been proposed in which the vehicle will only start when the seat belt is engaged.

2. Methodology Adopted

Following methodology has been adopted to achieve the desired output:

i) Use of a 12V battery to power the system.

ii) Use of ignition switch to energize/de-energize the system (Karthik et al., 2014; Prakash et al., 2016; Shah et al., 2020; Rana et al., 2021)

iii) A magnetic sensor/Reed Switch to identify weather the seatbelt is engaged or not.

From here mainly two cases arise (Bhardwaj and Jogdhankar, 2014):

a) If the seatbelt is engaged, the sensor senses it and closes the circuit to the starter motor via the ignition switch (Karthik et al., 2014; Prakash et al., 2016; Shah et al., 2020; Rana et al., 2021).

b) If the seatbelt is not engaged the sensor will not be able to sense it and circuit to the starter motor remains open.

iv) Fabrication of a moving vehicle model with the apparatus stated above.

3. Components Used

i) A 12V Battery
ii) An Ignition Switch (Karthik et al., 2014; Prakash et al., 2016; Shah et al., 2020; Rana et al., 2021)
iii) Magnetic Sensors/Reed Switch
iv) A DC Starter Motor
v) Wirings

For the motion of the Vehicle:

i) Mild steel frame
ii) MS Shaft
iii) Roller Bearings
iv) Wheels

4. Working Principle

The working principle of the seal belt-based ignition system is as follows:

i) It has a seat belt having magnet attached to it which helps in connecting and disconnecting the circuit keeping in mind the position of the seat belt.

ii) This system has a reed switch which supply current by the battery which is main component as it only works when the magnet comes closer to it.

iii) When the seat belt is buckled up the reed switch pass the current and closes the system loop and makes way for the ignition of the car and thus the car starts.

iv) In case if driver or co-driver removes the seat belt the motor will stop because the current will stop flowing through it and the engine will not start until the seat belt is not fastened and the system remains open, thus preventing the starting of engine.

5. Circuit Diagram and Frame Design

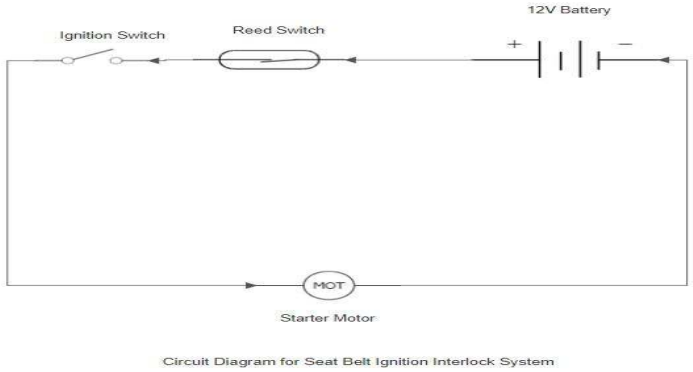

Figure 1. Circuit diagram of ignition interlock system

- The software used to design the frame of the model is Solid works.

- The main commands used in designing of the frame are Extrude, Rectangle, Trim and Fillet.
- Extrude command is used several times to extrude various planes to give a 3-Dimensional look.
- Fillet command is used to give the under components a curved shape.
- Trim command is used to trim the excess surfaces.
- Rectangle command is used to develop the main surface plane for the frame which is further extruded.

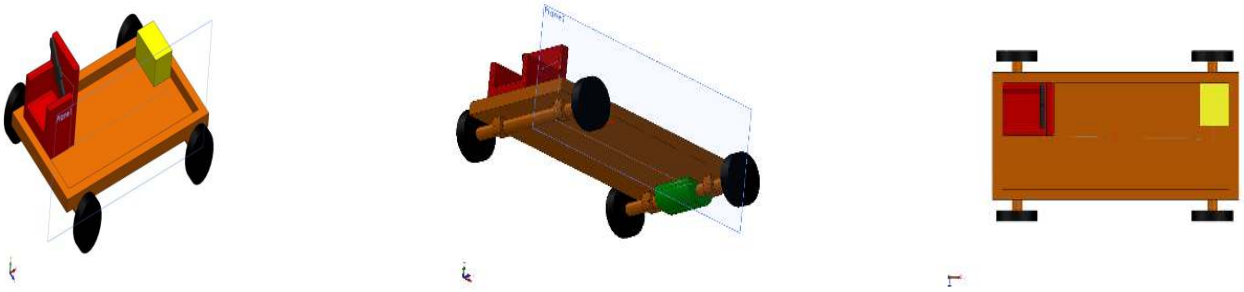

Figure 2. Design of frame of model in solid works

6. Actual Construction

- The Frame is fabricated using mild steel hollow square section tubes to give it a shape of rectangular frame.
- Two DC motors are used to give direct drive to the rear wheels thus making it a rear-wheel-drive vehicle.
- The motors are attached to the frame through mild steel L-shaped brackets.
- The motors are powered by a 1.3 A-h 12V Sealed Lead Acid Battery.
- The front wheels are non-powered and attached to wheel hub attached to the frame via L-Shaped brackets.
- This eliminates the need for shafts and Bearings and reduces vehicle weight.

7. Dimensions and Fabrication of Frame

Dimensions:

- Length= 510mm
- Width =395 mm
- Height from ground Level = 55mm
- Wheelbase =300mm
- Wheel Track=480
- Wheel Diameter = 94mm

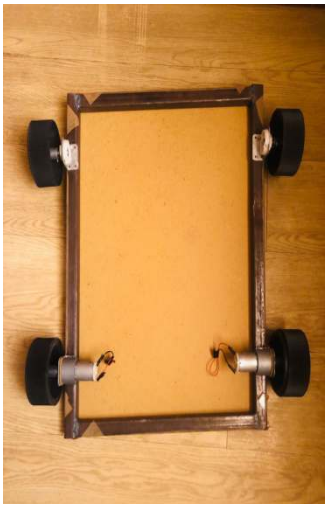

Figure 3. Construction of the frame

Frame Fabrication:

- The Frame is fabricated of mild steel hollow square section tubes gas welded to give it a shape of rectangular frame.
- The motors give direct drive to the rear wheels making it a rear-wheel-drive vehicle.
- The motors are attached to the frame via mild steel L-shaped brackets and are powered by a 1.3 A-h 12V Sealed Lead Acid Battery.
- Front wheels are non-powered and attached to wheel hub attached to the frame via L-Shaped brackets.
- This eliminates the need for shafts and Bearings and reduces vehicle weight.

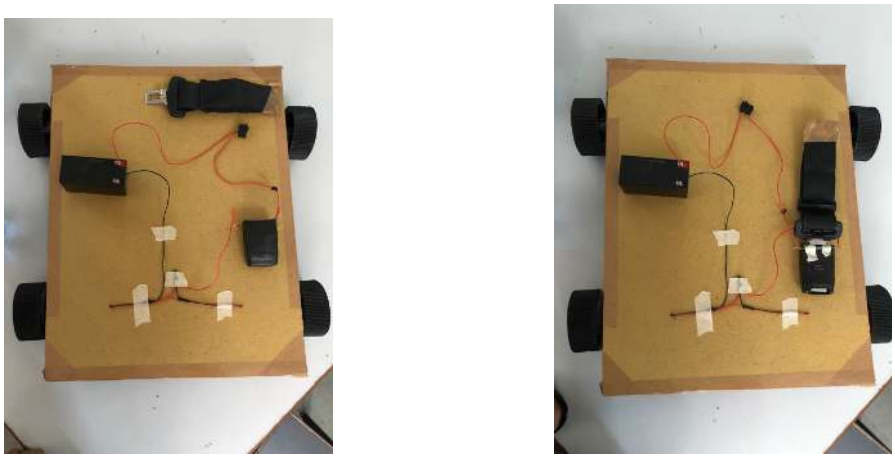

Figure 4: Open Circuit & Closed Circuit

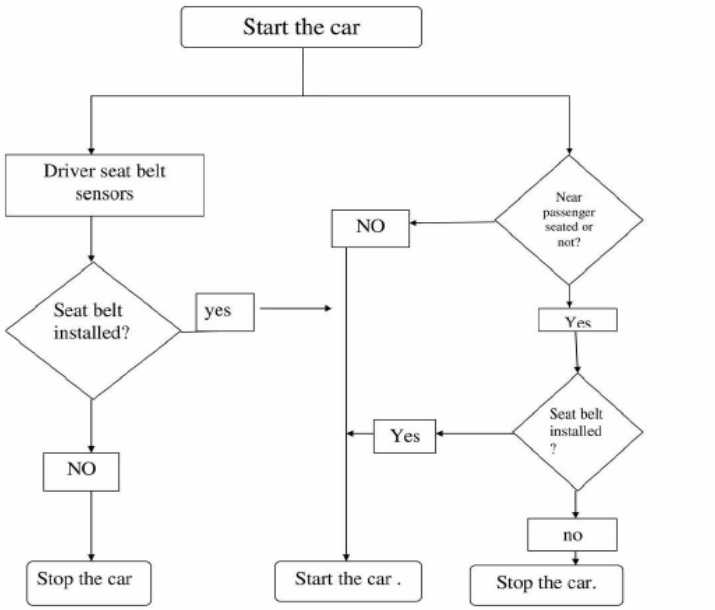

Figure 5: Circuit Flow Chart

8. Calculations

Torque on the driven wheels:

$$T_w = i_g x i_0 x \eta_t x T_p \quad (1)$$

T_w= 1x1x.92x13.59kg-cm

T_w =12.5 kg-cm

Where,

- I_g=is the gear ratio of the transmission
- i_0= is the gear ratio of the final drive
- η_t= is the efficiency of the driveline from the power plant to the driven wheels
- T_p= is the torque output from the power plant

Tractive effort on the driven wheels:

$$Ft = T_w/R_d \quad (2)$$

F_t=12.5kg-cm /4.7cm

Ft= 2.65 kg

F_t=25.97 N

Where,

- T_w=torque on the driven wheels
- R_d= radius of wheel

Maximum Vehicle Speed:

Since the motors are directly connected to the driving wheels the RPM of motor is directly transmitted to the wheels. Therefore, RPM at wheels can be given by:

$$N_W = N_P/i_g x i_0 \quad (3)$$

N_w = 200/1x1

N_W =200 RPM

Translational Speed of wheel center:

$$V = \pi x N_P x r_d/30 x i_g x i_0 \ (m/s) \quad (4)$$

V=πx200x0.047m/30x1x1 (m/s)

V=0.984 m/s

9. Advantages

- This system encourages the drivers to use seat belts.
- Reduce chances of fatal injuries during accident.
- This will help to increase the survivability rate of the passengers in case of an accident.
- This system takes signal from reed sensors and encourages occupants inside the car that in order to start the car they need to wear the seat belt properly.
- It will help to reduce life threatening injuries during the accidents.

10. Results & Discussions

The major aim of the work is to enhance usage of seat belt so that people avoiding using seat belt are forced to use seat belt for the safety of passengers travelling in a car. As road accidents are now proving to be one of major losses of human resources although the accident are not fully solved but the losses from the accident can be avoided by wearing the seat belts. It ensures the person with seat belt engaged to slow down its movement towards front dash and it reduces the impact during accident. By building and testing of the seat belt ignition interlock system which was mostly successful, as ignition of the car was only started when the seat belt was buckled up and it would not start when seat belt was not buckled up.

11. Conclusion & Future Scope

As Road traffic injuries cause considerable economic losses to victims, their families, and to nations as a whole. These losses arise from the cost of treatment as well as reduced/lost productivity for those killed or disabled by their injuries, and for family members who need to take time off work to care for the injured. The design is easy and safe to use with no failure while operating and by fulfilling the objectives and overcoming the problems, seat belt ignition interlock system will work and can be used in the near future. The technology and infrastructure will be improved and the speed of travel of vehicles on the road will increase and that is why this system will be important in future. In Addition to this system:

1. This system could be digitalized and digital sensors with electronic system can improve efficiency.
2. Heart beat sensor on seat belt could be placed, will detect heart beats if worn and will complete circuit.
3. Load cell can be placed inside the seat and will complete the circuit when minimum weight (passenger weight) will be placed on seat.

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Biographical notes

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