

# Design, Analysis and Fabrication of Automatic Braking System



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**Abstract** In this paper, we have discussed the design, analysis and fabrication of automatic braking system for a vehicle. The design process for a vehicle's braking system has been studied thoroughly. Every step taken for fabrication of this prototype is based on the thorough study conducted. This task was divided into different stages which include analysis, design, fabrication, assembly, trial and finally the approval of the vehicle. This prototype uses batteries and a chain sprocket assembly as a power source to run the vehicle and a braking circuit attached to a pair of IR sensors. The design discussed in this paper increases the braking efficiency of the vehicle effectively. The design and analysis of the disc brake rotor have been conducted to select the suitable material for the disc brake. At the end of the design and analysis, the overall system has been implemented with a constructed work, tested working and perfectly functional prototype.

**Keywords** Automatic brake · IR sensors · Arduino · Relay

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## 1 Introduction

In today's scenario, with the increasing number of road accidents, the safety of the driver and that of the fellow passengers is a major concern for the automobile manufacturers. In Indian markets, the manufacturers are laying more focus towards the safety of the humans both inside and outside of the vehicle. So far, anti-lock braking system, brake assist, etc. are been used to resolve the purpose [1]. In this paper, we have discussed the details of a similar safety system which can be installed in a vehicle. This braking system includes a pair of IR sensors (transmitter and receiver), Arduino, relays, DC motors, brake wires, disc brake rotors, braking callipers and a chain sprocket assembly [1]. All these components are assembled, and a prototype has been developed. The transmitter transmits the IR waves, and when these waves strike an obstacle, the signal is sent back to the receiver [2]. After the receiver interprets the signal, the signal is further sent to the Arduino and then to the relays, which will initiate the braking of the vehicle with the help of DC motor and brake wires [3, 4].

The primary functions of an efficient braking system include:

- Deceleration of the vehicle,
- Stopping the vehicle within the minimum possible distance,
- Absorption of kinetic energy of the vehicle.

In large-scale industries, there are various methods to transport the material within the industrial facility like conveyer belts, pallet jacks, material lifts, etc. As these material handling devices are costly and cannot be used by other industries [5]. Therefore, this braking system can be equipped with the four-wheel trolleys and can be used in small-scale industries as a material handling device as it is efficient as well as cost-effective. Further, in this paper, we have discussed the basic components of the prototype in Sect. 2, in Sect. 3, circuit diagram and specifications of the prototype have been discussed, Sect. 4 includes the working of prototype, and Sect. 5 includes the conclusion.

## 2 Basic Components

The following components have been used in the prototype [6–8].

### 2.1 Infrared Sensors:

Infrared sensor is a module which can be used to sense the presence of any object in its surrounding. In this paper, we are using it to detect an obstacle. Whenever an

**Fig. 1** Infrared sensor module [5]



obstacle is detected by the IR sensor, the receiver modular provides an excessive output which is connected to Arduino. The sensors used are shown in Fig. 1.

### **2.2 Control Unit**

Arduino has been utilized as a control unit within this paper. Arduino is a micro-controller board [9, 10]. Coding of ARDUINO is done in C language. The Arduino dumped C programming calculations have taken place in the PIC controller by including the maximum stopping distance and the distance between the obstacle and the automatic system [7, 8]. The Arduino module is shown in Fig. 2.

### **2.3 Disc Brake**

Disc brake is a type of brake in which callipers are used to squeeze the brake pads inwards so as to stop the vehicle by creating friction [11, 12]. In this paper, we have used a silver steel disc brake which will be run by the DC motor via wire as shown in Fig. 3.

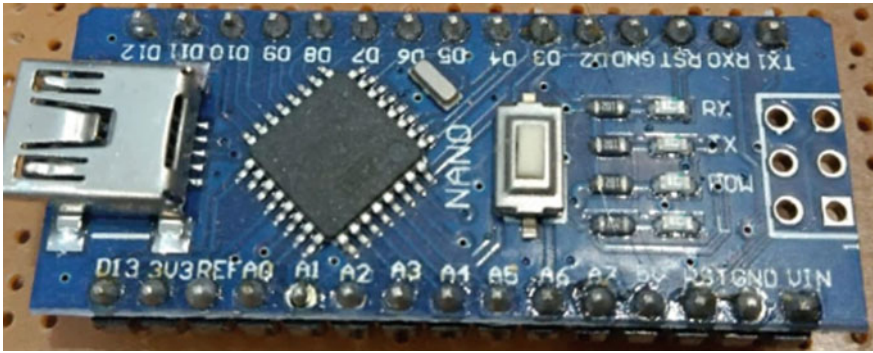
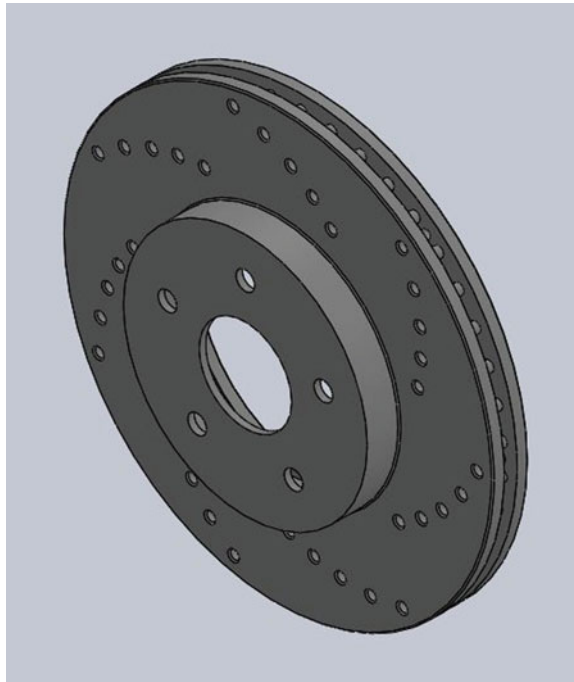


Fig. 2 Arduino [7]

Fig. 3 Disc brake [4]



### 2.4 DC Motor

In this paper, we have used the DC motor to run the brakes. The motor is directed by the relay as when to apply brakes [13, 14]. The motor used is shown in Fig. 4.

**Fig. 4** DC motor [4]**Fig. 5** Relay [4]

## 2.5 Relays

A relay is an electrical switch that opens and closes under control of another electrical circuit. The relay is directed by the ARDUINO whenever receiver sensor provides output [15]. Then the relay directs the motor to apply brakes. Relay used is shown in Fig. 5.

## 3 Circuit Diagram and Specifications

### 3.1 Circuit Diagram of Automatic Braking System

The circuit which is used to control the braking functions is shown in Fig. 6.

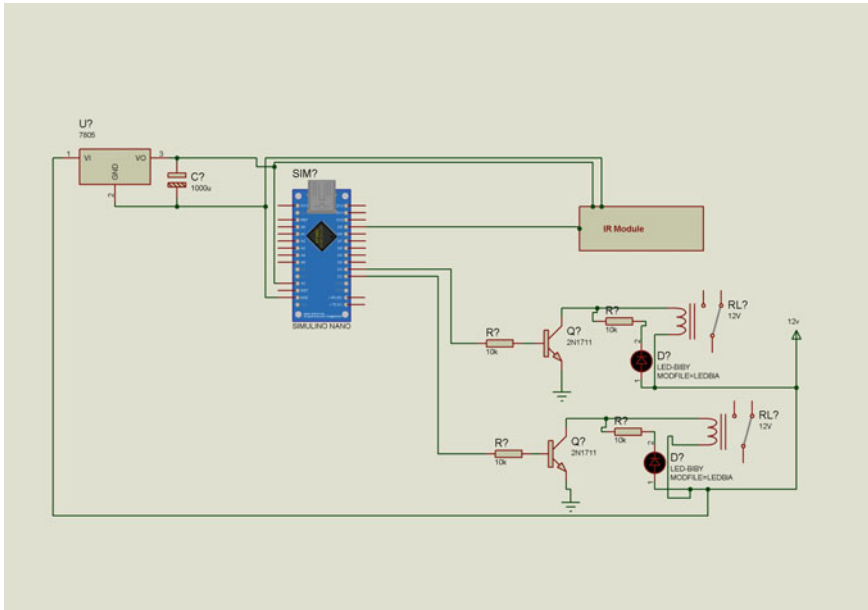


Fig. 6 Circuit diagram

### 3.2 Specification

Material of disc brake used is silver steel. Material of frame fabricated is mild steel, and dimensions of frame are 762 mm \* 457.2 mm.

- Power generated- 3 DC motor 4 V each
- 2 relays 6 V each
- 3 batteries 12 V and 1 A each
- Overall dimension of prototype: 762 mm \* 635 mm \* 330.2 mm
- 2 N-P-N transistors are used
- Wheel size: 330.2 mm diameter; 50.8 mm thickness.

This prototype uses chain sprocket assembly, and silver steel rod has been used for both front axle and rear axle. The circuit of electronic unit has been placed on printed circuit board.



Fig. 7 Actual prototype

## 4 Working

### 4.1 Actual Prototype

This prototype (shown in Fig. 7) is being made as a rear wheel moved prototype which has infrared sensor-based automatic braking system inbuilt.

### 4.2 Construction

The prototype is constructed of a mild steel frame of dimensions 762 mm \* 457.2 mm. There are two wheels in front and two wheels at the rear each of 14 inches diameter. A drivetrain consisting of a chain and a chain sprocket is mounted on the rear axle which is connected by a DC motor of 4 V. The IR sensor is mounted in front of the frame at the centre which is connected to Arduino. Arduino is connected to two relays. Both of the relays and the Arduino are placed over an O printed mustard circuit board which in turn is mounted over the mild steel frame.

Now the relays are connected to the two DC motors of 4 V each which are run by two batteries also placed over the O printed mustard circuit board. The motors are connected to the two silver steel disc brakes on each of the front wheels by a wire. Brake callipers and brake pads are mounted on the disc brakes, respectively. The motor on the rear part of the prototype is also connected to the batteries placed over circuit board.

### 4.3 Working

This prototype runs on DC motor such that when circuit is kept ON the motor (4 V) at the back of the frame gets power. Due to the motor, the drivetrain rotates due to which both the rear wheels move since it is a rear wheel moved prototype. Now whenever an obstacle comes in front of the prototype, it will work automatically rather than any kind of manual force. In this process, two IR sensors will be used. They are transmitter and receiver. Whenever an obstacle will arrive in the path of the prototype, it will be detected by the transmitter as it will send some signals to it and then those signals will be reverted back to receiver. Now the signals received by the receiver module of IR sensor will be sent to ARDUINO which will get activate one of the two relays. After the relay is ON, it will connect the power of both the front motors (4 V each) which are run by batteries of 12 V, and hence, both the motors will work in the clockwise direction. Thus, the brakes are applied. A flow chart for the working of prototype is shown in Fig. 8.

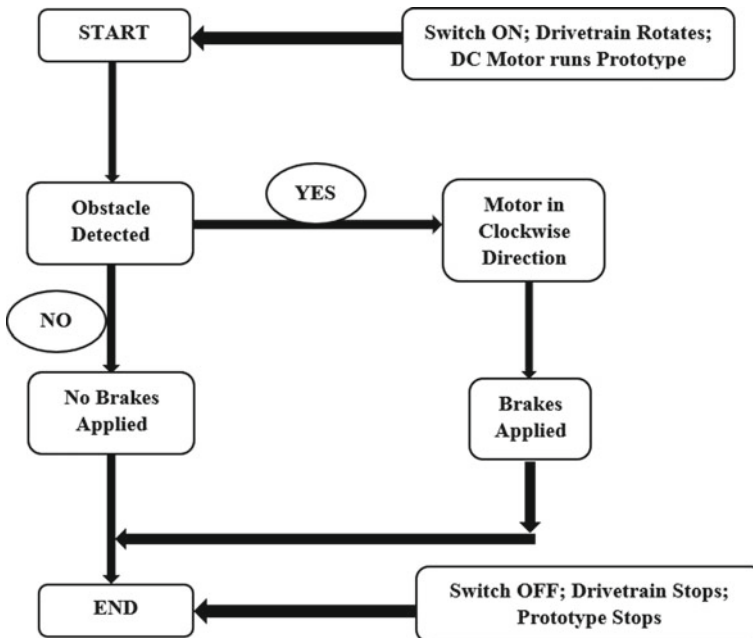


Fig. 8 Flow chart of the system [8]



## 5 Conclusion

All the components required for the automotive braking system were taken into consideration. Each and every component has been studied thoroughly. Then all the components required are chosen accurately. Then assembly of both mechanical unit and electronic unit was done so as to construct the prototype. After successful fabrication of the prototype, certain conclusions have been drawn:-

- The fabricated automotive system is reliable and configurable.
- The installation of IR sensors is easy and is long-lasting.
- This system of applying brakes provided by the combination of Arduino, relays and DC motor is less complicated than the use of solenoid and wiper motor [7].

This arrangement will be an answer to many environmental-related issues existing in our country like air pollution, shortage of energy and parking issues. It can be used in four-wheeler vehicles so as to reduce occurrence of accidents. It is eco-friendly and hence will be a flag bearer of environment conservation process in automobile industry. It also has a great application in the industries as material handling trolley and machinery. Also, it can be in used in defence industry as in spy robots.

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