Arduino Based Vehicle Overload Detection and Prevention System

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ABSTRACT

Overloading of vehicles is a significant issue in transportation systems, leading to various problems such as excessive road wear, increased fuel consumption, mechanical failures, and higher risks of accidents. Overloaded vehicles exert excessive pressure on roads and bridges, reducing their lifespan and contributing to frequent maintenance requirements. To address these challenges, an. Arduino-based Vehicle Overload Detection and Prevention System is proposed, aiming to provide an automated, cost-effective, and efficient solution for monitoring and preventing vehicle overloading.

This system employs load sensors (strain gauges) placed strategically on the vehicle's chassis to measure the weight being applied. These sensors continuously collect weight data and transmit it to an Arduino microcontroller, which processes the data and determines if the vehicle is within the permissible weight limit. If the measured weight exceeds the threshold, the system triggers an alert mechanism that includes visual and auditory warnings, such as LED indicators and buzzer alarms.

Additionally, the system integrates an LCD display to show real-time weight readings and alert messages to the driver. To prevent the vehicle from operating while overloaded, the system can be integrated with the ignition system or braking system, restricting vehicle movement until the excess weight is removed. This preventive approach enhances

road safety and reduces the likelihood of damage to transportation infrastructure. In conclusion, the Arduino-based Vehicle Overload Detection and Prevention System serves as a robust, scalable, and intelligent solution for mitigating vehicle overloading problems.

***Key Words*:** Overload, Suspension system, Ignition.

1. INTRODUCTION

Overloaded vehicles pose significant challenges to road transport operations. They increase the risk to road users, compromise road safety, accelerate the deterioration of infrastructure such as pavements and bridges, and undermine fair competition among transport operators and modes. To address these issues, this paper presents a novel technology aimed at mitigating the problems caused by vehicle overloading. The proposed system utilizes a load sensor installed beneath the vehicle to measure its actual weight. This weight is then compared with the permissible limit and processed by an Arduino microcontroller. If the detected load is within the allowed range, the system permits vehicle ignition by supplying power to the ignition circuit.

2. HARDWARE COMPONENTS

LoadCell:

A load cell is a type of transducer, specifically designed to measure force. It converts mechanical force—such as tension, compression, pressure, or torque—into a corresponding electrical signal that can be measured and standardized. As the applied force increases, the electrical signal produced by the load cell changes proportionally. The most commonly used load cells include hydraulic, pneumatic, and strain gauge types, with strain gauge load cells being the most widely adopted in industrial and automation applications due to their accuracy and reliability

Fig1: load cell

HX711ADC:

The HX711 is a 24-bit high-precision analog-to-digital converter (ADC) specifically designed for weigh scale applications. It features two analog input channels and supports programmable gain, allowing amplification of up to 128 times.

The primary function of the HX711 module is to amplify the small electrical signals generated by the load cell and convert them into digital values. These digital signals are then sent to the Arduino for processing, enabling accurate weight measurement and system control based on load data.

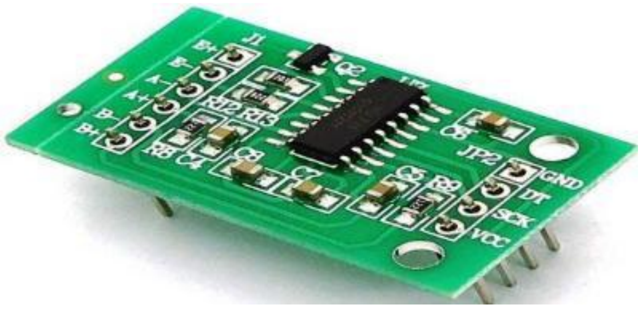

Fig 2: HX711 ADC

ArduinoUno:

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P. Developed by

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Arduino.cc, it features a versatile set of digital and analog input/output (I/O) pins, making it suitable for a wide range of electronic projects and hardware interfacing.

The board includes 14 digital I/O pins (6 of which support PWM output) and 6 analog input pins. It is programmable using the Arduino IDE via a Type-B USB cable. Power can be supplied either through the USB connection or an external power source, such as a 9V battery, with supported input voltages ranging from 7 to 20 volts

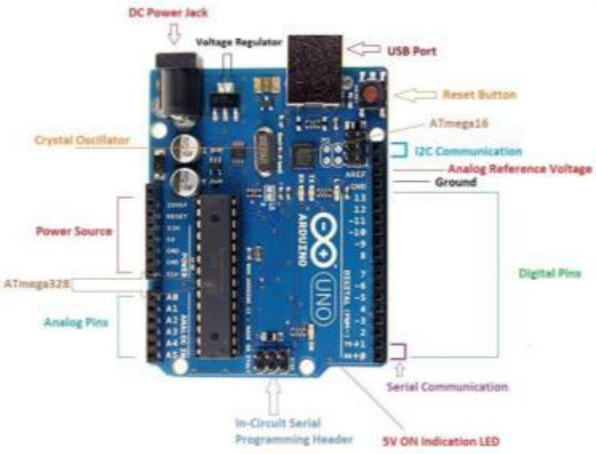


Fig 3: Arduino UNO

DCMotor:

A DC motor is a type of rotary electrical machine that converts direct current (DC) electrical energy into mechanical energy. It is widely used in various applications due to its ability to provide precise speed and torque control.

The speed of a DC motor can be regulated over a wide range, either by varying the supply voltage or by adjusting the current in its field windings. This makes DC motors highly suitable for applications requiring adjustable speed and quick response

Fig 4: DC Motor

Liquid Crystal Display (LCD):

A Liquid Crystal Display (LCD) is a flat-panel electronic display that utilizes the light-modulating properties of liquid crystals to visually present data. Unlike traditional LEDs, LCDs do not emit light directly; instead, they rely on a backlight or reflector to produce visible images.

In this project, a standard 16x2 LCD module is used, which consists of 16 input/output pins. It is capable of displaying 2 lines with 16 characters each, making it ideal for showing real-time data such as weight readings, system alerts, or status messages. The LCD is interfaced with the microcontroller to provide users with a simple and effective visual output.

Fig 5: LCD Display

Buzzer: It is an electrical device, similar to a bell, that makes a buzzing noise and is used for signalling.

Fig 6: Buzzer

3. SOFTWARE DESCRIPTION

The software used in this project is the **Arduino Integrated Development Environment (IDE)**. It is an open-source platform used for writing, compiling, and uploading code to Arduino microcontroller boards. The Arduino IDE provides a user-friendly interface and essential tools for programming embedded systems.

Key Features of the Arduino IDE:

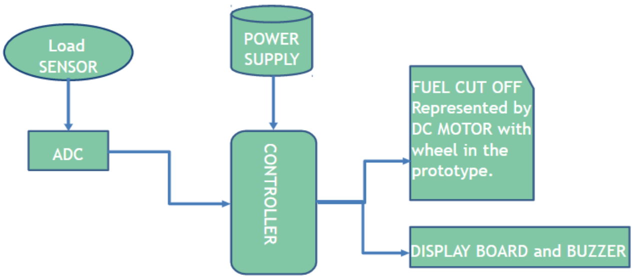
- **CodeArea:**
  The main section where users write their code (also known as a sketch). This is where all logic and instructions for the Arduino are defined.
- **Verify:**
  This function compiles the written code to check for errors in syntax. If there are any mistakes, they will be displayed in the output panel below.
- **Upload:**
  After verification, this feature uploads the code to the connected Arduino board. If the code is error-free, it is transferred to the microcontroller for execution.

The Arduino IDE supports C/C++-based programming and is compatible with various libraries and modules, making it ideal for rapid prototyping and hardware interfacing.

Additional Features of the Arduino IDE:

- **InfoPanel:**
  Displays messages related to the compilation and uploading process. If there are any errors or warnings in the code, they will be shown here to help the user identify and fix them.
- **SerialMonitor:**
  Opens a separate window that facilitates communication between the Arduino and the computer. It allows users to send and receive text-based data in real-time, which is especially useful for debugging and monitoring sensor outputs or system status.

4. BLOCK DIAGRAM



5. WORKING

The system begins with a calibration process to ensure accurate weight measurement. Upon powering up, it automatically enters calibration mode. If manual calibration is needed, the user can press the reset button on the Arduino Uno to restart the process.

An Arduino microcontroller is used to manage the entire operation. A load cell detects the applied weight and produces an analog voltage signal, which is then fed into the **HX711 Load Cell Amplifier Module**. The HX711, a 24-bit analog-to-digital converter (ADC), amplifies and digitizes the load cell's signal.

The Arduino receives this digital data from the HX711, processes it, and converts it into weight values in grams. These values are then displayed on a **16x2 LCD** screen for user reference.

If the measured weight is within the permissible limit, the Arduino sends a signal to allow fuel supply (represented by powering a **DC motor** in this prototype). If the weight exceeds the defined threshold, the system initiates a **fuel cut-off** by turning off the motor, simulating a real-world preventive mechanism against overloading.

A **buzzer** is also interfaced to provide an audible alert to the driver in case of overloading. Since calibration is performed each time the Arduino is reset, the system remains adaptable to different loading conditions and environments.

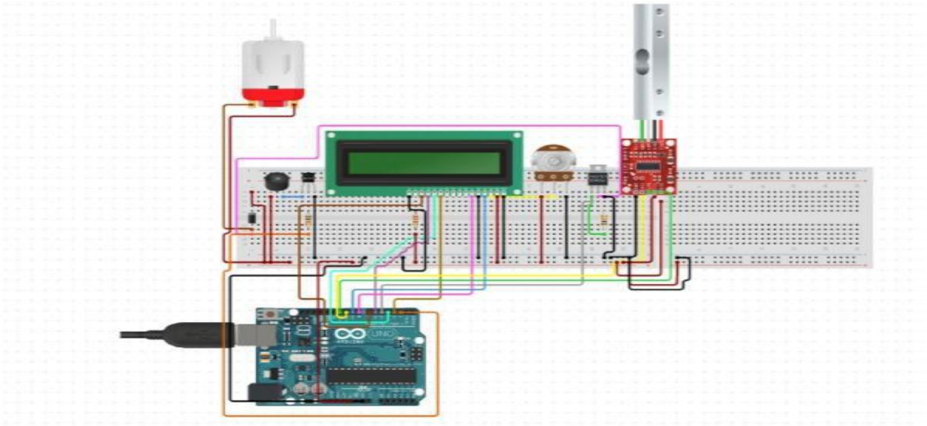


Fig 7: Circuit Diagram

6. CONNECTIONS

The connections for this project are straightforward and are based on the schematic provided above. The key components include the **load cell**, **HX711 amplifier**, **Arduino Uno**, **16x2 LCD**, **DC motor**, and **buzzer**.

Load Cell to HX711 Amplifier:

The load cell is connected to the HX711 module using four wires. Wire colors may vary slightly depending on the module, but the standard connections are:

- **RED** wire → **E+** (Excitation+)
- **BLACK** wire → **E-** (Excitation−)
- **WHITE** wire → **A−** (Signal−)
- **GREEN/BLUE** wire → **A+** (Signal+)

HX711 to Arduino Uno:

- **DT (Data) → Analog Pin A0**
- **SCK (Clock) → Analog Pin A1**

16x2 LCD to Arduino Uno:

- **RS → Digital Pin 8**
- **EN → Digital Pin 9**
- **D4 → Digital Pin 10**
- **D5 → Digital Pin 11**
- **D6 → Digital Pin 12**
- **D7 → Digital Pin 13**

Other Components:

- **DC Motor** and **Buzzer** are connected to digital output pins of the Arduino (e.g., Pin 6 and Pin 7 respectively), and are activated based on the weight condition detected. Make sure to connect the **ground**

(GND) and **power (VCC)** lines appropriately for all components, using a common ground for stability.

7.RESULTS

- The below figure shows the overall prototype of our project Vehicle overload detection and prevention system.

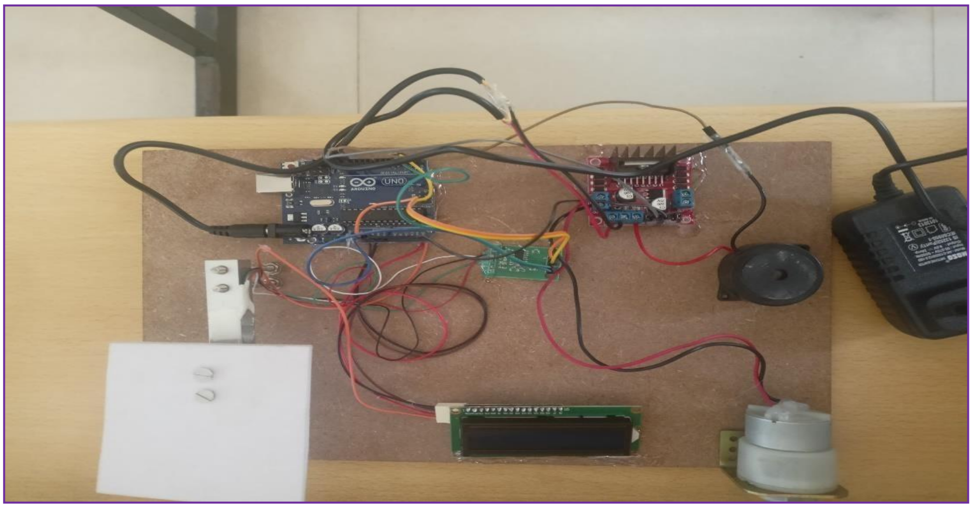
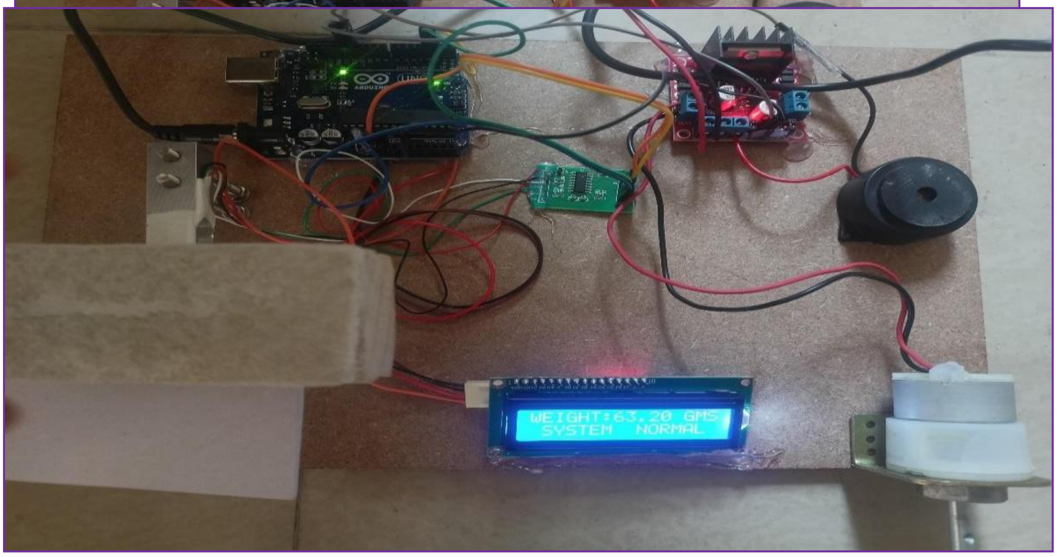


Fig 8 Vehicle overload detection and prevention system prototype

- When no weight is placed on the load cell, it will give an approximately zero value, which is read by the Arduino board and displayed on the LCD. In this state, the motor turns on and runs continuously.

Fig9No weight is applied on the Load cell



- When a material is placed on the load cell, the Arduino measures its weight and displays it on the LCD (63.2gms).

Fig 10 Material is placed on the Load cell and its measures its weight

If the weight of the placed material(63.2gms) is greater than or equal to the given threshold value(400gms), it is displayed on the LCD, the motor stops, and the buzzer turns on.

Fig 11 Load cell Weight is greater than Threshold value

8. ***ADVANTAGES***

- **Improved Truck Stability:**
Enhanced stability on both uphill and downhill routes by preventing overloading.

- **Adaptive Braking:**
Braking performance can be adjusted according to the actual load, ensuring better safety and control.

- **Extended Suspension Life:**
Proper load management reduces stress on the suspension system, increasing its lifespan.

- **Better Fuel Economy:**
Maintaining optimal load levels improves fuel efficiency and reduces unnecessary fuel consumption.

- **Enhanced Safety:**
By preventing overloading, the risk of accidents is minimized—ultimately protecting human life and property.

9. CONCLUSION

This paper primarily aims to address and reduce the number of road accidents caused by vehicle overloading. By integrating a load cell with a microcontroller, the system effectively monitors the vehicle's load and controls ignition based on permissible weight limits.

Modern vehicle manufacturers are increasingly incorporating affordable onboard weighing systems, often utilizing APT (Air Pressure Transducer) sensors. Furthermore, advancements in sensor technology—particularly strain gauge-based solutions—present a promising and cost-effective future for precise and reliable weight monitoring in vehicles.

This approach not only enhances road safety but also contributes to improved vehicle performance, longevity, and overall transport efficiency.

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