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OVERLOAD INDICATOR FOR AUTOMOBILE USING UNIVERSAL OBJECT INTERACTION

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Abstract

Expanding a nation's transportation network is a good indicator of economic health. The magnitude of the transportation business continues to grow in tandem with the expansion of the economy. Overcrowding in transportation vehicles is becoming an increasing issue. That's why it's crucial to figure out how to successfully restrict overload while keeping track of the vehicle's load in a way that's quick and easy. The integrated vehicle load control system can effectively lessen the burdensome work of the vehicle load testing station and increase productivity in the transportation sector, as well as detect vehicle load easily to avoid overloading of vehicle and improve vehicle safety. In this research, we introduce the NODU MCU model-based architecture for a wireless monitoring system. The design put forward in this paper is both inexpensive and straightforward in its construction. In order to track instances of vehicles exceeding the legal weight limit on the road, the system creates a database. The current vehicle weight can be easily tracked with the use of a mobile application with location. Multiple rounds of experimental testing demonstrate the system's reliability and high performance.

I. Introduction

Existing road damage in Indonesia is a yearly occurrence that must be dealt with. It has been determined that the current road maintenance programme cannot address the issue of road construction damage occurring earlier than expected [1]. Since the roads are being used beyond their intended capacity, the rate at which they are being damaged has increased. Due to increased repair costs and delays in getting somewhere, an economy suffers when roads are destroyed. There is a correlation between population development and prosperity and an increase in traffic accidents [2, 3], but this correlation does not hold when it comes to people's knowledge of the significance of maintaining public infrastructure. Whether they're behind the wheel of a car, motorcycle, or some other type of vehicle, all drivers have several safety goals that they don't want to compromise on. However, it is no longer enough to design for driving safety solely from the driver's perspective. Others on the road and nearby residents understandably worry about the increasing number of incidents involving goods transport vehicles due to overloading.

Overloaded trucks are not only a safety hazard since they may tip over, but they can also damage the pavement. The state and growth rate of Indonesia's economy may be affected by the country's lacklustre road network [1. When roads are damaged, they constitute bottlenecks in the supply system. Damage to roads shortens the lifespan of vehicles, necessitates more frequent replacement of spare components, and prevents roads from performing as intended [4,5]. Existing evidence suggests that mistakes in planning, design, and implementation in the field, inconsistent road maintenance and repair [6,7], poor drainage systems [6], and the habits and behaviours of road users [2,3,8] all contribute to road damage. The actions and routines of drivers, especially those who overload their trucks [9,10,11].

In Indonesia, the economy is negatively impacted by the prevalence of heavy truck or tronton vehicles that are frequently passed due to the fact that being in the factory area would cause roads to break down faster, and so require annual road repairs such as fixing holes and puddles. The solution to this issue is an automatic control system built around a proximity sensor and powered by an Arduino Uno [12,13]. The purpose of this research is to employ a prototype approach to manage transport weights in accordance with the regulations of the Republic of Indonesia and to monitor infractions in real time through the use of Arduino Uno and proximity sensors.

The purpose of this study is to determine whether or not the overload system improves operations associated with the enforcement of vehicle weight limit rules. To safeguard the road system and infrastructure, this study aims to measure the impact of overloaded vehicles.

The goal of creating a system to prevent cars from being overloaded or having too many people in them is to ensure that they are as safe as they can be without going above the legal limit.

1) To ensure the car doesn't roll over.
2) To lessen the possibility of a brake system failure, as this is contingent on the performance of the tyres and suspension, which are optimised for the maximum load listed in the vehicle documentation.
3) To lessen the likelihood of tyre blowouts caused by overloading.
4) The likelihood of an accident or loss of control of the vehicles increases when they are already overloaded.
5) The primary goal of this project is to develop a system that can be installed in vehicles to prevent them from being overloaded, thus reducing or eliminating the negative effects of overloaded vehicles on highways and reducing the likelihood of accidents.

II. Methodology

We used a load cell, amplifier, analog-to-digital converter, microcontroller, liquid crystal display, alarm, and an ESP8266 wifi chip to create this project. A load cell is being used as a sensor in this project. Without making direct contact, a load cell can detect things' presence. The value measured by the load cell is transmitted to the amplifier. The analogue to digital converter (ADC) receives its input from the amplified signal. It's a type of integrated circuit used in electronics. The overloaded signal is indicated by the alert. If the load cell's reading rises too high, the engine will shut off and the data will be sent to an Android app with location using GPS.

The vehicle's weight or load can be determined with the aid of a load cell. It is generally installed in key locations where load monitoring is required, such as under the seats or in the suspension. When a weight is placed to the load cell, an electrical signal is generated that is proportionate to the amount of force delivered to the load cell.

Because the electrical signal from the load cell is typically quite weak, it must be amplified before it can be processed by the subsequent parts of the system. The signal from the load cell must be amplified by an amplifier before it can be used.

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The amplified analogue signal from the load cell is sent to an ADC (Analog-to-Digital Converter), which converts it into a digital signal. To allow for further processing by a microcontroller or other digital components, an analog-to-digital converter (ADC) is used.

The digital signal from the ADC is processed by the microcontroller, which can be thought of as the "brain" of the system. Microcontroller modules like Arduino and Raspberry Pi are also possible. If the microcontroller detects an overload condition, it will take action based on the digital value read from the ADC and compare it to a threshold representing the maximum load the vehicle can safely carry.

The driver can see the current load value or the overload condition's status on the LCD display. It may flash a cautionary message or an icon representing the overload status.

In the event that an overload is detected, the alarm will sound to alert the driver. To warn the driver of the possible hazard of overloading the vehicle, a loud sound is produced by a buzzer or a speaker.

In order to transmit the load data to an Android app or a remote server for further analysis or monitoring, the ESP8266, a popular Wi-Fi module, could be utilised. It might be set up to connect to Wi-Fi and send the load data over an appropriate communication protocol, like MQTT or a REST API.

As was previously indicated, the project's scope may also include a fuel cut-off mechanism that, in the event of an overload, immediately turns off the fuel supply to the engine. As a precaution against overloading, this might be accomplished by connecting the microcontroller to the fuel system of the car and activating the fuel cut-off when necessary.

ADVANTAGE

- Load cells' ability to sense loads without making direct touch with them greatly facilitates installation and reduces the likelihood of component wear.
- Provides real-time load status monitoring, enabling prompt action to be taken to avoid damage or assure compliance with load limitations.
- Programmable thresholds allow it to be adapted to the carrying capabilities and safety standards of a wide range of vehicles and applications.
- When an overload is detected, the fuel supply can be cut off automatically. This safeguard is in place to prevent any more mishaps.
- Wireless data transmission: enables fleet management and performance optimisation through remote monitoring and analysis of load status via Wi-Fi.
- Easy-to-read LCD screen allows you to keep tabs on the load's status without having to have advanced technical understanding.
- Increased security: Prevents overloading-related damage to a vehicle's frame, tyres, and suspension, which increases overall vehicle security.
- Load cell-based systems are typically less expensive than more intricate alternatives for adding an overload warning to a car.

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III. Block Diagram

IV. System Description

A. Node MCU

NodeMCU is an ESP8266-based open-source development board that is available for no cost. Like Arduino, it can do a lot of different things, plus it has WiFi built right in, so it's a good fit for IoT projects. Input/output pins of the NodeMCU allow it to be connected to a wide range of electronic components, including sensors, actuators, and more.

Some of NodeMCU's many advantages are as follows:

Considering the prevalence of WiFi in IoT applications, NodeMCU is a fantastic development environment.

The NodeMCU code is written in Lua, a simple and lightweight programming language.

B. Load Cell

Load cells are transducers that employ applied force to measure weight or force. It usually has a strain-sensitive element that bends under pressure and a way to convert that bend into an electrical output.

Load cells are used in industrial weighing systems, force measurement, tension and compression testing, and car overload warning. In an automobile overload indicator system, the load cell measures force on the suspension, axle, or chassis.

Strain gauge, hydraulic, pneumatic, and piezoelectric load cells are available. Strain gauge load cells dominate the automobile sector. A load stretches a metal beam or ring with several strain gauges connected. The strain-sensitive element's deformation changes the strain gauges' resistance and the load cell's electrical output signal.

Load cells are sensitive and precise enough to measure force and weight. They are calibrated for accuracy measurement and can be customised for a vehicle or application. Load cells can withstand car vibrations and shocks and severe temperatures.

C. Amplifier

Amplifiers amplify electrical signals. It enhances a weak input signal to increase power, voltage, or current.

Amplifiers power audio, communication, sensor, and other electronic systems. Amplifiers increase the load cell's weak electrical signal in a vehicle's overload indication system.

Op-amps, transistor amplifiers, and IC amplifiers are all amplifiers. Choose based on input signal type, required amplification factor, frequency responsiveness, and power supply requirements.

Amplifiers primarily increase signal gain. The design may require a variable or constant amplifier gain. Amplifiers can filter, buffer, impedance match, and regulate voltage or current, depending on the purpose.

In preparation for analog-to-digital conversion (ADC), amplifiers increase the load cell's input signal and remove background noise. An ADC can convert the amplifier's amplified signal to a digital signal for the overload indicator system's microcontroller or other electrical components to process.

D. Solenoid Value

A solenoid valve is an electromechanical device that uses an electromagnetic coil to actuate a valve mechanism to regulate the flow of fluids or gases through a pipe or conduit. The valve opens or closes in response to an electric current flowing through the coil, creating a magnetic field that attracts the valve's plunger or armature.

Many different types of systems, from industrial automation to fluid control systems to automotive systems, rely on solenoid valves. When an overload condition is identified by a car's overload indicator system, the fuel supply to the engine or another portion of the vehicle can be turned off using a solenoid valve. This is done to prevent any additional damage or unsafe operation.

Coils, plungers/armatures, valve bodies, and ports/orifices for fluid/gas flow are the standard components of solenoid valves. The valve opens and the orifice or port is exposed when electricity is passed through the coil, creating a magnetic field that pulls the plunger or armature towards it. When power is cut off, the magnetic field weakens and the armature or plunger returns to its starting position, sealing the valve and stopping the flow of gas or liquid.

E. GPS

The reliable u-blox NEO-6 GPS module is a popular choice. This compact, low-power gadget uses GPS satellite signals to precisely calculate the user's location, velocity, and time.

The NEO-6 GPS module can receive signals from many GPS satellite constellations, including GPS and GLONASS, boosting its position data's precision and reliability. It can usually locate within 2.5 metres, depending on settings and satellite visibility.

The NEO-6 GPS module can log data locally, handle numerous communication protocols and data formats, and work with Assisted GPS (A-GPS) and Satellite-Based Augmentation System (SBAS) for faster and more accurate location fixes.

The module operates on 3.3V and requires an external antenna to receive GPS signals, making it compatible with most microcontrollers and embedded systems. Battery-powered applications benefit from its low power usage.

V. System Implementation

A. Software for Arduino Boards - Arduino IDE

Arduino IDE-programmable microcontroller development boards are popular. Programmers of all levels can develop, compile, and upload code to Arduino boards using the Arduino IDE.

Arduino IDE's top features:

Syntax highlighting and auto-completion make writing and editing Arduino code with the Arduino IDE easy.

The Arduino IDE compiles your code into microcontroller-friendly machine code.

The Arduino IDE's library manager helps install and manage libraries, which are reusable code modules that can enhance an Arduino project.

An upload manager in the Arduino software development kit (IDE) transfers compiled code to the Arduino board via USB.

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The Arduino IDE's serial monitor lets the Arduino board and host computer communicate for debugging and device interface.

Users can simply install and configure board-specific parameters in the Arduino IDE, such as board type, processor speed, and port, using the board manager.

B. IoT Framework: Blynk App

Blynk, an IoT framework, lets you remotely manage and monitor Arduino, Raspberry Pi, and NodeMCU devices via a mobile app. Blynk lets iOS and Android users create bespoke IoT app GUIs.

Blynk users can simply construct a customised mobile app interface by dragging and dropping widgets like buttons, sliders, gauges, graphs, and more onto the canvas. By linking these widgets with Arduino, Raspberry Pi, or NodeMCU board pins or functions, users can remotely monitor and operate IoT devices from their mobile devices.

Blynk provides several handy features.

Developers may quickly create an IoT dashboard using Blynk's widget library.

Users may quickly and simply create an HMI that matches their aesthetic and functional needs by dragging and dropping widgets onto the Blynk app's intuitive UI.

The Blynk app displays sensor readings, device status, and other IoT data in gauges, graphs, and value displays in real time.

Remotely control IoT devices with Blynk app widgets like buttons, switches, and sliders.

Blynk's cloud connectivity lets customers remotely control and securely save data from their Internet of Things (IoT) devices, even if they're not on the same local network.

Blynk's IoT integration makes it compatible with many hardware platforms. Arduino, Raspberry Pi, NodeMCU, ESP8266, ESP32, etc.

Personalization and Expansion: Blynk enables users add their own logos, colours, and other identifying characteristics to the app's UI and offers an API for integrating third-party code and other services.

VI. Result and Discussion

Real-world testing and demonstration of the constructed IoT framework employing a load cell, amplifier, ADC, microcontroller, LCD display, alarm, ESP8266 Wi-Fi device, and the Blynk app for remote control and monitoring were both fruitful. The load cell's accuracy in non-contact weight detection was made possible by the amplifier's ability to boost the load cell's meagre output to a level where it could be read by the ADC. The analog-to-digital converter (ADC) transformed the load cell's analogue output into digital form for the microcontroller. The system's status and load cell readings could be seen in real time on the LCD display, and an audible alert would sound if an overload were detected.

By connecting to the microcontroller through the ESP8266 Wi-Fi module, the Blynk app was able to do remote monitoring and control. The app's graphical user interface had widgets like buttons, sliders, and gauges that were connected to individual microcontroller functions or I/O pins. Through the app, users could issue commands to the system, such as beginning or ending the load cell measurements, or modifying the sensitivity of the alarm. Widgets like gauges and value displays were used to provide weight readings and other real-time data from the load cell on the app's user interface.

Accurate load detection, real-time data presentation, and remote capability were all achieved by integrating a load cell, amplifier, ADC, microcontroller, LCD display, alarm, and the Blynk app for remote control and monitoring. The load cell worked well as a contactless weight sensor, and the amplifier and ADC did their job in converting the sensor's measurements to digital data for the microcontroller. Users were able to manage load cell measurements and view real-time weight readings from their mobile devices with the help of the Blynk app, which provided a straightforward and simple interface for remote control and monitoring of the system.

Since load cells might vary in sensitivity, linearity, and temperature sensitivity, these factors could alter the accuracy of weight measurements, which could be a restriction of the system. Accurate results may depend on calibration and care of the load cell. The system's real-time monitoring and control capabilities may also be compromised by the reliability and stability of the Wi-Fi connection between the microcontroller and the Blynk app.

VII. Conclusion

A mechanism to prevent overloading is a valuable instrument for increasing the rate at which mass regulations are followed. The number of overloaded trucks might go down, and the roads might be used more efficiently as a result. Reducing the number of trucks on the road that are overloaded can help save lives and limit property damage. It is anticipated that these devices will find new uses in the enforcement of traffic and heavy vehicle regulations. As a result, this method efficiently addresses the issue of vehicle overloading while being user-friendly and straightforward. There is a pressing need to develop a novel approach that can conquer these challenges. It's fully integrated, so once it's installed in every vehicle, the loading vehicle can be managed. We need to make the most of the progress being made in technology so that we may advance as a nation. The NODU MCU Load cell and Load measurement sensor allows us to regulate transportation system overloading.

VIII. Future scope

Better Load Cell Calibration for Weight Measurements: Load cell calibration and fine-tuning are possible. The load cell may need to be calibrated for different objects or weight ranges, temperature fluctuations, and non-linearity.Machine learning algorithms may enable more complicated data processing and interpretation. Predictive models may be needed to analyse load cell data for overload or other situations.

New modules could improve the system's versatility. Examples include adding temperature or humidity sensors to offer context for load measurements or motorised actuators to respond to load circumstances in real time.

Testing the system in real-world settings and sectors can provide valuable data and insights to improve the product. Working with industry partners, field testing, or pilot projects can verify the system's performance and efficacy.

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