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Load Defender: Solution For Overloaded Trucks and Wagons

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ABSTRACT: The aim of the present study is to prevent damage to vehicles caused by overloading, The consequences of truck overloading encompass detrimental effects on roads and bridges, accelerating infrastructure degradation and necessitating frequent and costly repairs. Furthermore, excessive loads contribute significantly to increased fuel consumption and carbon emissions, adversely affecting the environment and sustainability initiatives. Beyond the physical toll on infrastructure, overloading poses severe safety risks, augmenting the likelihood of accidents and jeopardizing road user safety. Moreover, the economic impact of truck overloading extends to various stakeholders within the supply chain. It introduces unfair competition, distorts market dynamics, and imposes hidden costs that permeate through logistics operations, ultimately affecting consumer prices and economic competitiveness. This abstract underline the urgent need to address the issue of truck overloading through innovative solutions and stringent regulations.[5] Implementing robust detection systems and enforcing weight restrictions are imperative steps to mitigate the adverse effects of overloading, safeguarding infrastructure, enhancing safety, minimizing environmental impact, and fostering economic stability within the transportation sector.

KEYWORDS: Raspberry Pico, load sensor, load monitoring system.

I. INTRODUCTION

The aim of the present study is to prevent damage to vehicles caused by overloading, The consequences of truck overloading encompass detrimental effects on roads and bridges, accelerating infrastructure degradation and necessitating frequent and costly repairs. Furthermore, excessive loads contribute significantly to increased fuel consumption and carbon emissions, adversely affecting the environment and sustainability initiatives. Beyond the physical toll on infrastructure, overloading poses severe safety risks, augmenting the likelihood of accidents and jeopardizing road user safety

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This abstract underline the urgent need to address the issue of truck overloading through innovative solutions and stringent regulations.[5] Implementing robust detection systems and enforcing weight restrictions are imperative steps to mitigate the adverse effects of overloading, safeguarding infrastructure, enhancing safety, minimizing environmental impact, and fostering economic stability within the transportation sector.

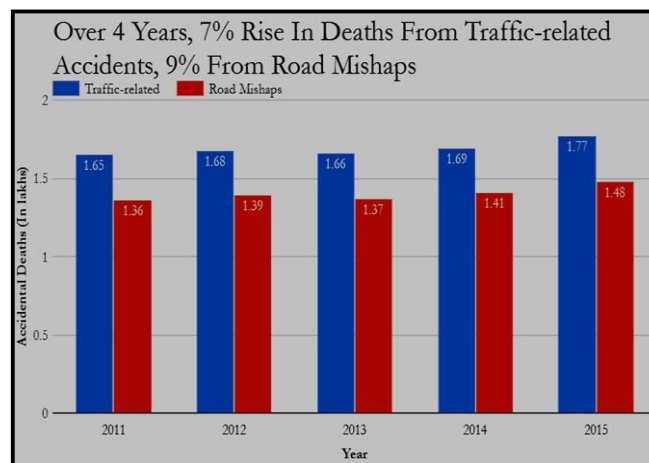
authorities, notably the police, enabling swift intervention and enforcement actions.

The pressing significance of this project lies in its potential to revolutionize the oversight and regulation of truck overloading. By deploying an intelligent system that not only detects overloading instances with precision but also communicates directly with law enforcement agencies, it presents a proactive approach toward mitigating the detrimental effects of overloading on road infrastructure, public safety, and fair market practices.

This introduction sets the context for a pioneering endeavour that amalgamates RASPBERRY PI PICO's computational prowess with GSM's communication capabilities to combat truck overloading effectively. The ensuing project explores the intricacies of sensor integration, data processing, wireless communication protocols, and real-time alert mechanisms, demonstrating a technological solution designed to enhance regulatory compliance and ensure safer and more sustainable transportation practices.

II. PROBLEM STATEMENT

Vehicle overload is a significant contributing factor to road accidents, and it is one of today's harmful practices that results in the loss of human lives, individuals' lives, and the prosperity of nations [2][3]. Despite being challenging to regulate, these practices increase the risk of accidents due to reduced stability, longer stopping distances, and difficulty in steering. Vehicles that exceed their maximum weight limit tend to experience early and costly failure, including blowouts, as the overloaded weight causes the tires to wear and overheat quickly. Furthermore, overweight vehicles limit the driver's control and operating space, increasing the likelihood of accidents. Other literatures [5]-[34] helped to get motivated in this field and technical information has helped in this project.



The above Fig.1 shows the road accidents survey in India

In India, the issue of overloaded trucks stands as a significant challenge impacting road safety and infrastructure integrity. The prevalence of overloading not only strains the country's road networks but also poses severe risks to commuters and other vehicles on the roads.[4] Overloaded trucks contribute to increased accidents and road fatalities due to several factors. Beyond the legal weight limits, these vehicles experience compromised braking efficiency, reduced manoeuvrability, and amplified wear on critical components like tires and brakes. Moreover, overloading elevates the risk of structural damage to roads and bridges, exacerbating maintenance costs and leading to frequent repairs. This situation is compounded by the difficulty in enforcing weight regulations effectively across the vast and diverse Indian road network. Addressing this issue necessitates a multi-faceted approach, including stricter enforcement mechanisms, robust penalties for violations, enhanced infrastructure to support heavier loads, and public awareness campaigns to promote adherence to weight regulations and responsible load management practices. Implementing such measures would not only enhance road safety but also preserve the longevity and efficiency of India's transportation infrastructure.

III. LITERATURE SURVEY

The literature surrounding the integration of load sensors and GSM modules in monitoring overloading trucks encompasses various technological facets. Studies on load sensing technologies, including strain gauges, load cells, and pressure sensors, highlight their efficacy in accurately measuring vehicle weights. Research elucidates how these sensors can be strategically placed within trucks to ensure precise weight detection. Similarly, exploration into GSM module integration emphasizes their role in establishing real-time wireless communication, enabling seamless transmission of load data and overloading alerts to centralized systems or stakeholders. Discussions on IoT-based vehicle monitoring systems provide insights into how such systems efficiently manage data transmission, particularly crucial for monitoring loads in trucks and facilitating remote access capabilities.

Furthermore, investigations into overloading detection algorithms and methodologies shed light on diverse techniques, such as machine learning algorithms or threshold-based approaches, utilized to identify deviations from permissible weight limits. Case studies and implementation reports offer valuable real-world insights, highlighting the challenges encountered and the effectiveness of integrating load sensors and GSM modules in trucks. They showcase the impact on compliance with regulations, improved safety measures, and the overall efficiency of these monitoring systems.

Additionally, the literature emphasizes the importance of aligning these technological advancements with regulatory standards governing vehicle weight limits, ensuring adherence to legal requirements. Addressing security and data privacy concerns concerning remote monitoring systems remains a crucial aspect illuminated in the literature, emphasizing the need for robust security measures to protect sensitive information transmitted through GSM-based networks.

IV. OBJECTIVES

- 1) Accurate Overload Detection
- 2) Real-time Monitoring
- 3) GSM Communication Integration
- 4) Automated Alert System
- 5) Reliability and Robustness
- 6) Regulatory Compliance and Safety
- 7) Documentation and Scalability

V. CIRCUIT DIAGRAM

Numerous more trucks are required due to the population increase and the present rate of expansion in the logistics sector in India. One of the main problems with traffic management in India is the rise in collisions that are brought on by overloaded vehicles. Currently, automobiles are weighed using a standard static weighing system, and there are several issues with the weighing technology that is currently in use, which requires that measuring devices be put in the road's concrete to determine vehicle weight. They are difficult to maintain because of this. In India, heavy-duty trucks cannot readily reach weighing stations. The below Fig.2 shows the weight measurement of the existing system:

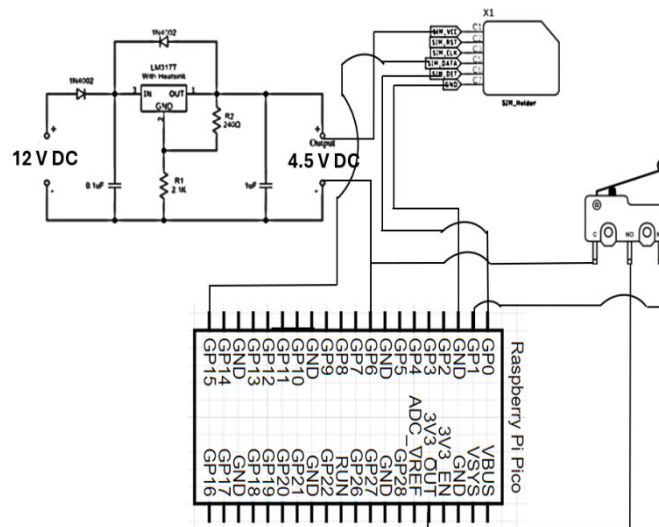


Fig.2: Circuit Diagram of LOAD DEFENDER

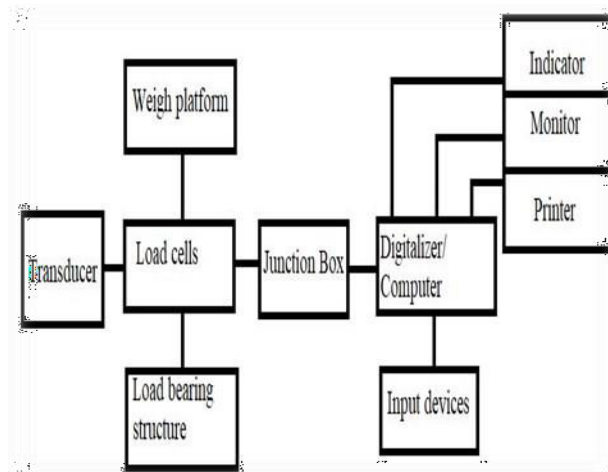
VI. WORKING OF EXISTING MODEL

A set of scales used to weigh goods in bulk is called a weighbridge or a truck scale. The producer of weighbridges mounts a set of scales on a concrete surface. It features a digital or electronic monitor that shows the vehicle's weight being weighed. In situations where items are moved by means of vehicles, such as trucks or rail containers, weighbridges are mostly employed for this purpose. The industry benefits from reliable and accurate weighing by receiving the precise statistics needed to maintain their commodities inward and goods outward. Weighbridges operate on the "Dynamic Axle" theory, which states that axle weights are automatically determined as a vehicle is driven very slowly over a sensor plate affixed to the ground. After that, a computer will record the weight of each axle and show it to you on an external digital display. Before a vehicle is allowed to continue a public road, weighbridges are used to weigh the cargo being transported,

calculate its weight or measure the load on each axle.

The current technologies that are used to regulate vehicle overload have serious flaws, primarily an efficiency issue, which means that the vehicle is merely warned about the overload, not stopped. Static weighing loses its effectiveness and serves only as a temporary deterrent when there is a lot of traffic and a rise in the number of heavy cars on the road. Static weighing takes a lengthy time when multiple trucks are chosen for inspection. The alternative is ineffective.

The below Fig.3 shows the block diagram representation of the existing system of vehicle overload measurement:



VII. PROPOSED SYSTEM

The project involves the integration of load sensors within trucks for continuous weight monitoring constitutes a pivotal step in ensuring road safety and regulatory compliance. These sensors, strategically positioned, collect real-time weight data, processed through a microcontroller equipped with preset thresholds. When an overload situation surpasses these predefined limits, an instant alert mechanism is activated, swiftly notifying both the truck owner and relevant authorities via SMS or a dedicated application. Moreover, the integration of GPS technology enables precise location tracking, while wireless communication systems facilitate rapid transmission of alerts to centralized monitoring stations or law enforcement agencies. Concurrently, a comprehensive database records instances of overloading, enabling subsequent analysis, while a user-friendly dashboard provides real-time monitoring capabilities. Overall, this innovative system aims to proactively identify and promptly notify about truck overloading incidents, contributing to enhanced road safety, adherence to weight regulations, and streamlined transportation management practices.

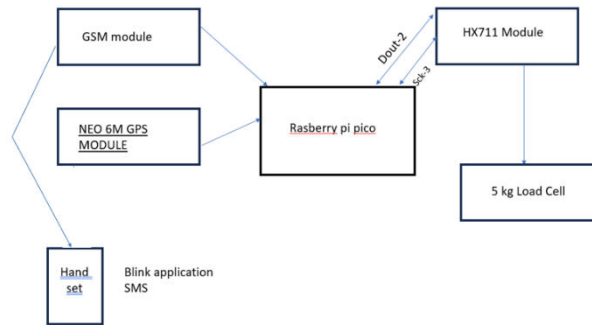
The integration of GPS technology within the system not only enables weight monitoring but also provides precise location tracking of the truck at the time of overloading. By combining load sensors with GPS capabilities, the system can accurately pinpoint the location of the truck when an overload situation occurs. This feature enhances the alert mechanism, ensuring that both the truck owner and authorities receive notifications containing not just information about the overload but also the exact geographic coordinates of the truck's position. This valuable location data facilitates swift responses from law enforcement or relevant personnel to address the overloading issue promptly, contributing to improved enforcement of regulations and effective management of overloaded trucks on the road.

VIII. WORKING OF PROPOSED SYSTEM

The operational flow of the system begins with the load sensors within the truck continuously measuring the weight carried throughout the journey. Upon obtaining the weight data, the system employs a threshold-check mechanism to determine if the current weight exceeds the permissible limit. Should an overload be detected, an immediate alert is triggered, leveraging the GSM module to send notifications to both the truck owner and law enforcement agencies. Concurrently, GPS technology integrated into the system precisely tracks the truck's location in real-time, ensuring accurate information is available to authorities regarding the overloaded vehicle's whereabouts.

Throughout the journey, the system meticulously records and stores data on the load carried by the truck from its starting point. As the truck progresses and reaches its destination, this accumulated load data at the final point is compared to the recorded data from the commencement of the journey. Employing a calculated formula, often

expressed as $L1$ (load from the starting point) - $L2$ (load at the final point) * 100, the system computes the efficiency of the journey. This efficiency calculation aids in assessing the variance in the load carried by the truck from the origin to its destination, thereby evaluating how efficiently the cargo was transported. Such systematic monitoring and comparison of load data contribute to assessing the effectiveness of the transportation process and facilitate insights into the truck's performance in carrying the designated load from start to finish.



IX. SOFTWARE IMPLEMENTATION

Integrating GSM and load sensor functionalities into the Arduino IDE for the Raspberry Pi Pico requires a systematic approach. Begin by installing the Arduino IDE and adding support for the Pico board. Incorporate necessary third-party libraries for GSM modules and load sensors into your Arduino sketch. Initialize the GSM module by configuring communication protocols, such as AT commands, to establish connectivity with cellular networks. Simultaneously, initialize the load sensor by specifying pin configurations and calibration settings as per the sensor's documentation.

Write code to retrieve data from the load sensor, potentially involving analog or digital readings and calibration routines to convert readings into usable weight values. Develop functions to interact with the GSM module, enabling the sending of SMS messages. Establish logic within the code to compare sensor readings against predetermined thresholds to detect overloading instances. Upon detecting an overload, trigger the GSM module to transmit alert messages containing relevant information, potentially including overload status and location details.

Integrate and test the combined functionalities, ensuring accurate sensor readings and appropriate GSM module behavior when detecting overloading situations. Given potential variations among GSM modules and load sensors, it's essential to refer to specific datasheets, libraries, and documentation relevant to your chosen components. While the Arduino environment for the Raspberry Pi Pico might not directly support GSM functionalities, customizing code or leveraging external libraries may be necessary for successful integration. For Second connection UART2 must be unlocked

Unlocking UART2 on the Raspberry Pi Pico via the Arduino IDE involves direct manipulation of hardware registers to configure the RP2040 microcontroller. To achieve this, begin by including necessary libraries like "pico/stdlib.h" and "hardware/uart.h" in your Arduino sketch, enabling access to the RP2040's registers. Define GPIO pins allocated for UART2 (TX2 and RX2) within the code and initialize UART2 by setting baud rates, data bits, stop bits, and parity settings using functions provided by the RP2040 SDK. Assign UART functionality to designated GPIO pins

Top of Form

Software Description: In addition to a text editor for writing code, a message area, a text console, a toolbar with buttons for basic operations, and several menus.

The Arduino Integrated Development Environment

(IDE) also includes a message area. To upload programmers and communicate with them, it connects to the Arduino hardware. The main features we need to know about it are:

- Code Area: All your code should be entered in this section.
- Verify: You may use this to compile your code into a language that the Arduino can comprehend. The info section will display any syntactic issues you made in your code.

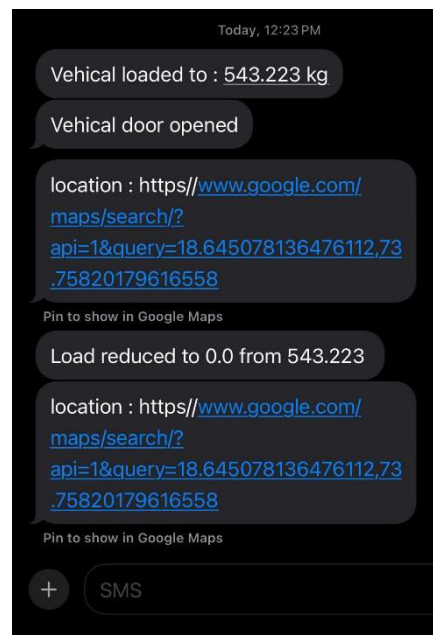
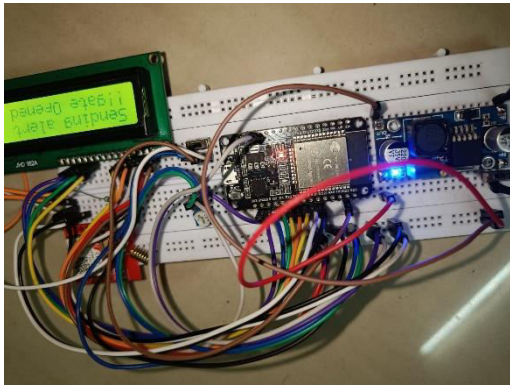
Upload: This accomplishes the same as verify but will transmit your code to your Arduino if the code is properly validated. Any syntax errors you committed will be displayed in the info section.

X. EXPERIMENTAL RESULTS

The truck load monitoring project, leveraging the capabilities of Raspberry Pi Pico and a GSM module, offers an intricate yet efficient solution for real-time tracking and management. At the core of this system, a load cell is intricately connected to the UART 1 port, providing a direct interface for accurate weight measurement. Concurrently, a GSM module is seamlessly integrated into the setup through UART 2, establishing a robust communication channel for transmitting critical information.

To ensure comprehensive monitoring, a sophisticated sensor mechanism is incorporated to detect the opening and closing of the truck's door. This sensor triggers a rapid response system, initiating the immediate dispatch of an SMS notification to a predefined mobile number when the door opens. The message meticulously relays crucial information, including the door status, the current weight of the truck precisely measured by the load cell, and the exact geographic coordinates pinpointed by the GPS module. This holistic data transmission serves as a real-time situational report, enabling stakeholders to stay informed about the truck's status and location promptly.

Upon the secure closure of the truck's door, the system seamlessly transitions to the next phase of communication. A second SMS is promptly sent, encapsulating the event of door closure and presenting the recipients with the updated weight information and the latest location coordinates. This dual-message approach ensures a thorough and accurate representation of the truck's status, empowering decision-makers with the timely insights needed for efficient logistics management. In this intricate orchestration, the Raspberry Pi Pico acts as the central nervous system, adeptly coordinating data acquisition from the load cell and GPS module, while managing the seamless communication flow through the GSM module. The result is a sophisticated and reliable truck load monitoring solution that not only enhances operational efficiency but also fortifies the security and management of the transportation fleet.



XI. CONCLUSION

The Load Defender patent represents a groundbreaking solution

poised to revolutionize the transportation industry's approach to load management and safety. By addressing the inherent challenges of overloaded trucks and wagons through innovative technology and proactive monitoring, Load Defender ensures enhanced safety, efficiency, and regulatory compliance within transportation logistics.

Through the integration of advanced sensor technologies, real-time monitoring capabilities, and data-driven decision-making processes, Load Defender provides a comprehensive solution that empowers fleet operators and drivers to optimize load distribution, minimize risks, and maximize operational productivity.

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