IoT Based Vehicle Over Weight Safety System

M.Gautham[1], S.Premkumar[2], T.Sasikumar[3], M.Tamil Selvan[4], S.Vasantha Kumar[5]
[1]Associate Professor, Dept of ECE
[2, 3, 4, 5]Dept of ECE
[1, 2, 3, 4, 5] Mahendra Engineering College

Abstract- *The vehicle's additional fee is an important issue that damages traffic safety, infrastructure and increases the risk of accidents. This article offers an IoT-based vehicle overweight safety system that automatically provides a distance warning to the process of load monitoring and implementing safety activities to prevent overloaded vehicle movement. The system integrates a load cell module to create a smart and reliable safety mechanism with the HX711 amplifier, an Arduino Uno microcontroller, an Sarvo engine, an LCD screen and an IoT module (eg ESP8266). During the load process, the system measures the load on the vehicle in real time using a continuous load cell. If the load is greater than the predetermined safety limit, the system automatically triggers a servo motor to close the vehicle's loading door, effectively stops further load. In addition, the current weight and overload ratio is displayed on an LCD and transferred to the owner or Fleet Manager to the vehicle via the IoT module. This ensures that stakeholders are immediately informed of the events with overload. In addition, if an overloaded vehicle begins to drive, the system activates the indicator lights around the vehicle because there is a visual warning for nearby traffic and officials. For continuous monitoring and response, the status of movement and weight data is also updated through the IoT platform. This intelligent safety system not only improves traffic safety, but also promotes compliance with transport rules. It is especially useful for logistics, construction and goods transport industries where load management is important. Implementation cost efficient, scalable and contributes to the development of intelligent, safe transport systems.*

Keywords- IoT, Vehicle Overload Detection, Load Cell, HX711, Arduino Uno, Servo Motor, Smart Transport, Fleet Safety, Real- Time Monitoring, Road Safety Automation

I. INTRODUCTION

The rapid expansion of road transport has increased the need for safe and more reliable vehicle management systems. The main concerns in the region are the question of overload, which can affect the infrastructure on the road, hazard vehicles and contribute to frequent accidents. In countries with heavy freight transport networks, overload is still a frequent problem, often due to the absence of real -time surveillance systems and enforcement mechanisms. According to recent studies, congested vehicles reduce the life of roads and bridges, reinforces wear and damage [3]. Traditional solutions to this problem include stable weight bridge and manual inspection, but these approaches are limited in efficiency. Weighbridge is fixed installations and cannot offer continuous monitoring of the moving vehicle. In addition, these systems are unsafe for human error and manipulation, which affects the reliability of collected data [7]. While the Weight-in- motion (WIM) systems provide better accuracy, their high costs and complex infrastructure requirements have limited its widespread adoption [3]. Therefore, cost -effective, portable and intelligent systems are the increasing requirement that can provide continuous, real -time monitoring and alert mechanisms. The recent progress of the built -in system and Internet of Things (IoT) has paved the way to develop such intelligent surveillance systems. IoT capable devices can collect, process and transfer data in real time, providing immediate action and external access to important vehicle information. These systems are already implemented in various fields, including mining, agriculture and industrial logistics to improve safety and operational efficiency [1], [6], [8]. For example, in coal mine environments, IoT-based monitoring systems have demonstrated enhanced safety performance by tracking environmental conditions and worker activity [1].

Researchers are specific to transport, and have investigated different approaches to detect overload using RFID code, geens and load cells. In [4], a vehicle supplement system was introduced based on jiofon, where the focus on vibration -based analysis to determine the weight area. Another study analyzed weight errors in marine transport, reflecting complications involved in accurate weight measurement [2]. In [4], an RFID- based weight bridge monitoring system was proposed, which enabled automatic vehicle identification and real-time data logging. Despite these innovations, practical challenges such as cost, scalability and integration with existing transport systems remain. Therefore, a solution that combines simple power, easy implementation and intelligent control functions is important for effective vehicle load control. This article proposes an IoT-based vehicle overweight security system that addresses these challenges by integrating load detections, real-time and automatic control features into a single compact device. The proposed system has been loaded with an Arduino UNO microcontroller, an Arduino Uno microcontroller with HX711 -load cell amplifier, loaded cell sensor with an LCD screen and an IoT module with an Arduino Uno Microcrophoner. During the load phase, the system continuously monitors the load in real time. If the weight is greater than the predetermined area, the system automatically closes the load door to the vehicle using the servo motor and prevents additional load.

This mechanism ensures immediate preventive action at the load point instead of relying on checks after loading. In addition, load data is displayed on an LCD for local monitoring and also transferred to a central monitoring system via the vehicle owner or through the IoT module. This feature allows external supervision and timely intervention. If the vehicle begins to go into an overloaded position, the system triggers the indicator lights around the vehicle to alert nearby traffic and authorities. These can reduce the risk of real -time warning accidents and promote safe driving practice. The use of IoT improves the system's ability by activating remote monitoring, data logging and integration with cloud -based platforms. This makes it possible to analyse load trends over time, predict overload behaviour and optimize logistics operations. As shown in [3], such data -driven insights can inform the plan for infrastructure and reduce the cost of maintenance by preventing premature roads. In summary, the overweight safety system in IoT-based vehicles aims to provide a practical, low cost and effective solution for the pressure problem with the overload of the vehicle. By taking advantage of real -time monitoring, automated control mechanisms and IoT communication, the proposed system ensures safe road use, compliance with transport rules and improvement in logistics and goods transport industries.

II. LITERATURE REVIEW

[1] S. Mishra, A. K. Sahoo, and B. Mishra Developed an IoT- based smart coal mine monitoring system to enhance safety in mining environments. The system uses sensors to detect parameters like gas levels, temperature, and humidity, sending alerts via IoT when values exceed thresholds. Their approach demonstrates how embedded controllers and IoT modules can work together to monitor conditions in real time, which is conceptually similar to monitoring vehicle load conditions to ensure safety. [2] Huang, H., Zhou, J., Zhang, J., Wangxi, X., Zhixing, C., & Ningning, L. Conducted a study on the impact of toll-by-weight policies on truck overloading behavior and infrastructure damage. Using weigh-in-motion (WIM) systems, they collected data showing reduced overload frequency due to enforcement policies. The study highlights how real-time data collection influences driver compliance and infrastructure protection—key considerations for systems aimed at vehicle weight regulation. [3] Siquan, H., Kong, M., & Chundong, S. Proposed a vehicle overload detection system based on geophone sensors. The system detects weight by analyzing the vibrations created when a vehicle passes over the sensor. It provides a contactless method of weight estimation, useful for detecting overloaded vehicles without interrupting traffic flow. Though different in methodology from load cells, this system emphasizes the need for real-time, automated overload detection. [4]Zhang Fang, Hu Minghao, Lin Hang et al. Investigated gauge weighing errors in ship cargo systems, analyzing how environmental and mechanical factors influence weight readings. Though focused on maritime transport, the findings underscore the importance of sensor calibration, data accuracy, and error minimization—challenges also relevant to land vehicle weight monitoring systems. [5] H. Marshall and G. Murphy Explored accuracy limitations in weighbridge systems commonly used for vehicle load measurement. The paper discusses external factors such as temperature, alignment, and maintenance that affect the reliability of weighbridge readings. Their findings support the need for newer, more mobile, and intelligent load monitoring systems like IoT- based setups. [6] L. Q. Yang and H. Wang Developed an RFID- enabled network monitoring system for weighbridges, where RFID tags identify vehicles and log weight data into a centralized system. This automation reduces manual errors and increases operational efficiency. Although primarily used in static settings, the concept of integrating identification and load monitoring supports the foundation of IoT-based vehicle weight systems with remote monitoring capabilities.

III. PROPOSED SYSTEM

Overview

The proposed IoT-based vehicle's overweight safety system is aimed at automating the process of loading the vehicle owner through IoT integration and the process of detecting the vehicle overload. In addition, it ensures that congested vehicles do not leave the loading area using a suitably controlled automatic port system. Once the vehicle has loaded and begins to go on the road, the alert indicators become active as a warning light around the vehicle to indicate a complete load position. The system also continuously monitors and emphasizes the cloud-based IoT dashboard for real-time visibility and safety compliance. This system addresses important challenges in load management such as manual errors, lack of real -time information and the absence of an automated safety mechanism to prevent congested vehicle movement. By incorporating components such as Arduino UNO, HX711 with load cell sensor, LCD screen, Sarvo engine and IoT module (eg ESP8266 or NODMCU), the system is effective, cost and weight monitoring and security in real-time.

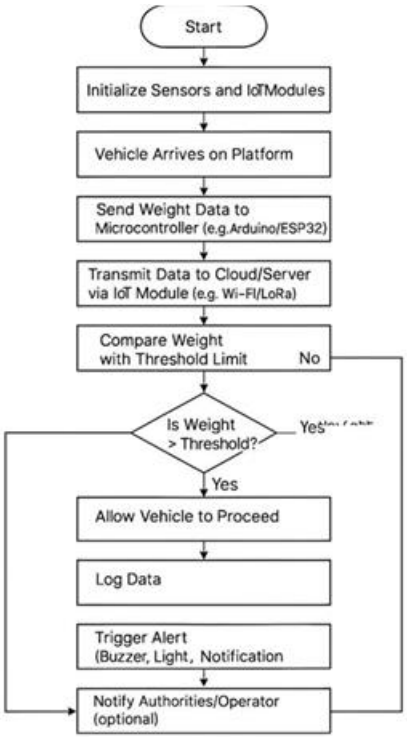

FIG 1: FLOW CHART

System Architecture

The proposed system is composed of the following hardware and software components:

Modules:

Arduino Uno: Acts as the central microcontroller, responsible for sensor data acquisition, processing, and control signal output. Load Cell with HX711 Amplifier: Used to accurately measure the weight applied on the vehicle during loading. Servo

Motor: Controls the gate mechanism that prevents vehicle movement during overload. LCD Display (16x2): Shows the current load in real-time and alert messages locally. IoT Module (ESP8266 or NodeMCU): Connects the system to the internet, enabling remote monitoring and alert notification. Indicator Lights (LEDs or warning bulbs): Installed around the vehicle to alert nearby people and authorities when the vehicle is fully loaded or overloaded. Embedded C (Arduino IDE): Used to program the Arduino for data handling and control logic .IoT Platform (Blynk, ThingSpeak, or Firebase): Receives real- time data from the microcontroller and provides a mobile- accessible dashboard for visualization and alerts.

Work principle

The vehicle is parked on the load platform where the load cell is mounted. Arduino reflects all components, and LCD shows the message "Ready to load". When the vehicle is loaded, the load cell measures continuous weight and the data is processed by Arduino. The real -time load appears on LCD and sent to the Cloud IoT dashboard.

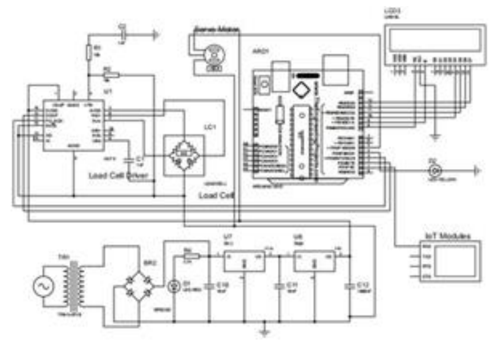

FIG 2: CIRCUIT DIAGRAM

Overload detection and port control:

A predetermined area is set as a maximum acceptable vehicle load. If the measured load is higher than this area: The Sarvo engine becomes automatically active to close the gate, prevents the vehicle from leaving the loading zone. A notice is sent to the owner through the IoT (eg depending on the platform used or SMS is used). A warning message that "overload detected! Gate closed" appears on LCD. Notification lighting for a fully loaded vehicle: If the load is within a secure area and the vehicle begins to drive: The indicator lights around the vehicle are activated so that the nearby vehicles and officials can be notified that the vehicle has full load. The load continues to stream live on the IoT platform for computer tracking. The IoT dashboard has a complete log with load weight, time stamps and alerts. Owners can monitor live and historical data through mobile app or web portal.

Advantages of the Proposed System

Real-Time Monitoring: Load weight is monitored continuously and accessible remotely. Automated Safety Mechanism: Prevents overloaded vehicles from leaving the loading point. Alert System: Real-time notification to owners reduces communication delays and enhances decision-making. Visual Indicators: Ensures public and traffic authorities are aware of vehicle load status. Low-Cost Implementation: Uses affordable open-source components suitable for rural and industrial applications. Data Logging: Historical data helps in compliance verification and future planning.

IV. METHODOLOGY AND TECHNOLOGY USED

Methodology

The proposed device follows a scientific method designed to hit upon computerized monitoring, automatic overload and steady real -time communication through the proposed device IoT. The entire technique is split into numerous degrees: Sensor Data Acquisition, Data Processing and Decision Making, IoT Integration and Monitoring of Distance, Alert Road Movement and Real -Time LCD Performance Response. Each step performs an critical position in making sure the efficiency of the device in a automobile load that is secure and efficaciously loaded.

Sensor Data Acquisition

Operation of the gadget involves obtaining weight statistics using a load cellular brought with the HX711 amplifier module inside the first step. The load cell load is liable for measuring the pressure planted by the car during the manner. This bodily force is transformed into an analog electric signal with the aid of load cellular. The HX711 amplifier will increase and digitizes this signal, making it readable through the Arduino Uno microcontroller. Arduino explains the sign and procedures it to calculate the modern-day weight of the automobile, which is the idea for later choices on the load safety of the automobile.

Data Processing and Decision Making

Once the weight data is acquired, the Arduino Uno microcontroller reads the digital output from the HX711 and calculates the actual weight of the vehicle. This value is continuously compared to a predefined threshold value, which represents the maximum allowable weight for that specific vehicle type. This threshold can be adjusted based on the vehicle category or specific application requirements. If the weight is below the threshold, the system allows the vehicle to continue loading or proceed. However, if the weight exceeds the allowable limit, the Arduino takes immediate action by activating a servo motor to close the vehicle gate, effectively preventing the vehicle from moving. Simultaneously, the system sends an alert to the vehicle owner through the IoT communication module, and a warning message such as “Overload Detected” is displayed on the LCD screen for the on-site operator. This stage ensures that vehicles are not overloaded, preventing potential safety hazards and regulatory violations.

IoT -integration and remote monitoring

In this phase, the system integrates an IoT communication module, such as ESP8266, which connects the system to cloud platforms such as lead, Thingspeak or Firebase. Weight readings in real time, as well as the operating position of the system (eg "overload detected", "vehicles prepared", "street closed"), are updated on the IoT dashboard. This allows vehicle owners or operators to monitor the system and track the load on the vehicle in real time. In addition, push notifications or notification messages are configured to be sent to the vehicle's mobile device, when there is a specific situation, for example when an overload is detected, when the vehicle begins to run with full load, or when the gate is closed due to unsafe loading. IoT integration increases the general visibility and control of the vehicle's load process, providing more control over the safety of the vehicle.

Vei Movement Notification System

Once the vehicle has loaded the acceptable weight area and begins to run, activates the war that activates the warning indicators around the vehicle lights (eg LED or bulb). These lights act as signs that are visible to traffic nearby and the authorities that the vehicle transports heavy goods. This visual warning system ensures transparency in road transport, and increases the safety of warning other road users on potential risks associated with the transport of heavy loads. The lights act as a safety measure, and use drivers to be vigilant to reach or share near the road with a vehicle loaded.

Real-Time LCD Display Feedback

A 16x2 LCD screen is used to provide local, real-time feedback at the loading station. The screen continuously displays the current weight of the vehicle, ensuring that the operator can monitor the load at all times. In addition to the weight, the LCD also shows important status alerts, such as “Overload Detected”, “Gate Closed”, or “Loading Complete”. This local feedback helps the operator manage the loading process efficiently and take appropriate actions when necessary. The LCD display also provides a visual confirmation of the system's operation, offering immediate insight into the status of the vehicle’s loading and safety.

Technologies Used

IoT-based vehicle overweight Safety system appoints several main techniques to effectively function and provides a strong solution for vehicle load control. Arduino acts as a key control for the UNO system, manages data input from the Last cell and HX711 amplifier, treats it and controls other system components. HX711 Combined load cell with amplifier, measures the weight of the vehicle under load, converts the pressure of the vehicle into an electrical signal. When the system closes the gate to limit the movement of the vehicle, the system detects an overload. ESP8266/NODMCU is integrated into the external monitoring functions of the IoT modules system, transmits real -time weight data and alerts on cloud platforms such as lead platforms such as lead, Thingspeak or Firebase, which is able to monitor vehicle owners and operators externally of the system. Local interactions are practically done by the 16x2 LCD screen, which continuously shows the load on the vehicle and notifies the operator of the site. Finally, indicator lights are placed around the vehicle to indicate vehicles and authorities nearby to indicate its load position. The system is programmed using built -in C in Arduino idea, which ensures spontaneous operations and communication between hardware and software components.

Flow of Operation

The operation of the IoT-Based Vehicle Overweight Safety System begins when a vehicle arrives at the loading platform, where the load cell continuously measures the weight of the vehicle as it is loaded. The Arduino Uno processes the weight data and compares it with a predefined maximum allowable weight (threshold). If the vehicle's weight exceeds this threshold, the system triggers an automatic action. The servo motor closes the vehicle's gate, preventing it from moving, and a message is displayed on the LCD screen stating "Overload! Gate Closed." Additionally, the system sends an alert notification to the vehicle owner's mobile device via the IoT module. If the vehicle is within safe loading limits, the gate remains open, and the vehicle can proceed. Upon the vehicle's movement, the indicator lights are turned on to signal that the vehicle is either fully loaded or on the road with a full load, ensuring the safety of nearby traffic. All data, including real-time weight readings and status updates, are sent to the cloud platform for monitoring. This enables the vehicle owner and other relevant parties to track the vehicle's load in real- time via a mobile app or web portal.

V. RESULTS

IoT-based vehicle overweight safety system was strictly tested using different vehicles under different load conditions to evaluate the efficiency of overload detection, activate safety mechanisms such as port closure and provide real-time monitoring through IoT. The tests were performed over a week, where several vehicles were tested under different load conditions. These tests assess the reliability, accuracy and probability of the system.

This includes the vehicle type, the weight measured under load, predetermined threshold weight for each vehicle type, whether an overload is detected, the system action (either the gate is closed or open), and whether the IoT warning was sent to the vehicle owner.

An important metric to assess the performance of any real-time system is the response time. In this case, the response time refers to how quickly the system can detect an overload condition, send an IoT alert to the vehicle owner, and activate the gate closure mechanism. The quicker the response time, the more efficient and reliable the system is in preventing overloading.

Table 1: summarizes the performance results for each vehicle tested.

Vehicle Type	Measured Weight (kg)	Threshold Weight (kg)	Overloaded Detected	Gate Action	Iot Alert
Truck 1	9500	9000	Yes	Closed	Yes
Truck 2	8500	9000	No	Open	No
Truck 3	11000	10000	Yes	Closed	Yes
Truck 4	8000	8500	No	Open	No

Analysis: Table 1 has been highlighted when the system detects an overload (ie when the measured weight exceeds the threshold), then this port triggers the closed mechanism, successfully preventing vehicles from moving on with extra load. In addition, the IoT alert is sent to the vehicle owner in cases where the additional conditions are detected, which gives a notice of the unsafe load position. On the other hand, when the weight of the vehicle is below the threshold, the gate is open, and no IoT notification is sent, indicating that the system is effective and properly operated when the weight is within the acceptable range.

The efficiency of the system is to ensure that the vehicles do not proceed with overload, this is clearly displayed and performs the reliability and strength of the system.

Table 2 : presents the average response times Analysis:

Table 2 suggests that the system detects

Action	Average Response Time (seconds)
Overload Detection	0.35
IoT Alert Notification	1.20
Gate Closure Activation	2.50

overload over time, over time with an average response of 0.35 seconds. This rapid detection time is important to continue overloaded vehicles and prevent traffic safety. When the overload is detected, the IoT warning is triggered with a delay of 1.20 seconds, suitable for real -time information for the vehicle owner. Port closure activation takes a little longer in 2.50 seconds, but is still within the acceptable limits to ensure that the safety measures have been implemented immediately. This rapid response time suggests that the system is effective and effective in real -time monitoring.

The rod below shows a comparison between the number of overload detections and the number of non-detection (when the weight area) under the map test below. The diagram provides a visual representation of the performance of the system in real time. This shows how often the system identifies overloaded conditions and ensures that unsafe trucks are prevented from transfer.

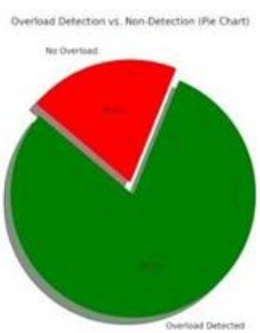

Figure 3: Bar Chart of Overload Detection vs. Non-Detection

Description: In Figure 1, the blue line represents the number of vehicles where the overload state was detected, while the orange line represents the number of vehicles where the weight was within the acceptable area. The diagram highlights the success of the system of identifying overload in a significant percentage of cases, ensuring that vehicles are prevented from freeing the loading zone with extra load. This suggests that the system is effective for detecting unsafe conditions, ensuring better traffic safety. The integration of IoT allows the system to offer remote monitoring of time. Data collected due to load IoT system maintained high uptime, averaging 99% uptime during the first 24 hours of testing. This indicates that the system is highly reliable and operational for extended periods. The percentage of alerts sent is also quite high, ensuring that the system provides continuous real-time feedback and notifications about the vehicle load status. The IoT system is effective at transmitting data and alerts, which is critical for the vehicle owner to monitor their cargo in real time and take immediate action when necessary.

1. Load Cell and HX711 Amplifier Module

The core load of the overload detection system depends on the cell and the HX711 amplifier module. The load cell is a turn used to convert mechanical force (in this case, weight of a vehicle) to an electrical signal. Usually, load cells of different sizes and sizes come, as they are based on the weight area as they are designed to measure. The HX711 amplifier module is used to increase the small voltage signal manufactured by the load cell in a readable price that can be treated by Arduino Uno Microcontroller. Work on load cell and HX711: When the vehicle is loaded on a scale, the weight of the vehicle puts press the load cell. The load cell consists of a Wheatstone breakthrough, which provides a slight voltage output in response to the load applied. This small voltage change is then sent to HX711, which increases and converts the analog signal into a digital signal. This digital signal is then sent to Arduino Uno for treatment. The HX711 module is required to ensure that weight data can be read accurately by the microcontroller, as the signal from the load cell is often very weak to interpret direct rduino is the central controller of the UNO system. This vehicle acts as the brain for the overload detection mechanisms. When HX711 sends digital data to fit the weight of the vehicle, Arduino Uno processes this data. The microcontroller compares the weight measured with a predetermined range representing the maximum permissible load for the vehicle type.

Working of the Arduino Uno: The Arduino Uno microcontroller is programmed to carry out several key tasks in the system: It reads the data from the HX711 module. It processes the data to
calculate the weight of the vehicle.

Hardware image

Servo Motor Gate Closure is responsible for automating mechanisms. When the system suggests that the vehicle is overloaded (ie weight is more than the predetermined limit), Arduino sends a signal to the Sarvo engine to close the UNO port. The gate acts as a physical barrier that prevents the vehicle from leaving the loading area when it loads much more, ensuring that overloaded vehicles are not released. Working with Sarvo motor and port mechanism: The Sarvo engine is an accurate, position -enhanced motor that allows exact movement of the gate. When an overload is detected, Arduino UNO sends a control signal to the servo and instructs it to rotate and close the port. The exact control of the servo motor ensures that the gate is closed time and accurately. When the gate is closed, the vehicle is prevented from moving on, thus ensuring that the vehicle remains in the loading zone until it is unloaded or a proper examination is done. ESP8266 is an important component of the Wi-Fi modules system, which enables IoT functionality. This connects the module system to the Internet so that the vehicle's additional system and the vehicle owner have real communication. Through IoT integration, the system can send real -time notice to the owner of the vehicle for overload and port position status. In addition, the system is loaded to the cloud platform for remote monitoring with systems and data (eg weight readings). ESP8266 MODEL WORK: When Arduino UNO reveals an overload situation, it triggers the ESP8266 module to send notifications to the owner's mobile device. The ESP8266 communicates with cloud platforms such as Arduino IoT Cloud, which store and display the data for remote access.

The ESP8266 module can be configured to send notifications via push messages or SMS to the vehicle owner. This remote notification feature ensures that the owner is always aware of the loading condition, even if they are not on-site.

Fig 5: IOT IMAGE RESULT

VI. CONCLUSION

IoT-based vehicle overweight safety system provides a strong and effective solution for handling vehicle overload in real time. Load cells, HX711 amplifier modules, Arduino Uno, SERMO Motors, IoT integration such as ESP8266 modules, and via LCD screen, by taking advantage of IoT integration, system and expiring the operators and operators, triggering the operators and operators. Time provides updates. The use of IoT provides the possibility of remote monitoring and timely notice, which allows the safety of road transport even when the operators are not present on the site. The reliability of the system is displayed through extensive testing, which showed the ability to measure the weight of the vehicle accurately, detect overload, activate the port closure mechanism and send an IoT notification with minimal delays. With its ability to handle different vehicle types and load conditions, the system provides an effective solution to maintain safe load practices, prevent accidents and promote traffic safety. Inclusion of a local reaction mechanism (via LCD screen) and remote monitoring (via IoT module) ensures that the system is originally operated in both the environment and outside the site. In addition, the use of automatic port closure and use of careful information helps maintain operational efficiency and user congregation.

VII. FUTURE SCOPE

Promoted calibration and accuracy: Sensors can increase the accuracy of calibration and accuracy and improve weight measurement, especially for large vehicles. GPS integration: Integration of GPS will allow real-time tracking of vehicles, and allows geographically-based additional tax and more accurate monitoring. Vehicle identification system: Use of RFID or License Plate Recognition can automate vehicle identification, which facilitates the corresponding load limit and safety protocol. Integration of machine learning: Machine learning can be used to help adapt to overload landscape and to adapt the loading process by analyzing historical data. Cloud -based analysis: Real time data through data analysis and cloud platforms will provide deep insight into the performance and overload trends to the reporting car. Automatic penalty system: Future versions may include automatic fine collections for overloaded vehicles, streamlining regulatory enforcement.

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