IOT powered Transportation Safety and Load monitoring System

[1]Ms.Gautami Shetty, [2]Ms. Rutuja Patil, [3]Ms. Afsana Patel
[1,2,3]Dr. Daulatrao Aher College of Engineering, Karad

***Abstract* - As globalization continues to drive trade and commerce, the volume of goods being transported across the world is experiencing exponential growth. This surge in transportation activities has led to an increased focus on ensuring the safety and efficiency of the transportation network. However, traditional methods of monitoring vehicle conditions and cargo loads are struggling to keep pace with these demands. Traditionally, transportation safety and load monitoring have relied heavily on manual inspections and periodic checks. While these methods have been effective to some extent, they often suffer from limitations such as human error, time delays, and limited coverage. Moreover, as transportation networks expand and become more complex, the challenges associated with monitoring and managing safety and load conditions also intensify. In this context, there is a pressing need for innovative solutions that can provide real-time insights into the condition of vehicles and the status of their cargo. By harnessing the power of IoT technology, this project seeks to address these challenges by deploying a network of sensors and devices that can continuously monitor various parameters such as accident detection, load monitoring, and cargo weight.**

I. INTRODUCTION

Before the IoT-Powered Transportation Safety and Load Monitoring System, the transportation industry faced formidable challenges. Load tracking was inefficient, relying on manual methods prone to errors. This led to difficulties in ensuring the safe and compliant transportation of goods, with operators often struggling to accurately monitor cargo weight, volume, and condition throughout journeys. Moreover, accident detection mechanisms were inadequate, resulting in delayed response times and heightened risks for drivers and cargo alike in the event of collisions. These shortcomings underscored the pressing need for a more advanced and proactive approach to safety management within transportation networks. With the introduction of the IoT-Powered Transportation Safety and Load Monitoring System, however, a paradigm shift occurred. This groundbreaking system revolutionized industry practices by providing real-time monitoring capabilities, empowering logistics operators to optimize load distribution, prevent overloading, and ensure compliance with safety regulations. Furthermore, its sophisticated accident detection mechanisms enabled immediate alerts and swift response measures, significantly enhancing overall safety for drivers and goods being transported. The system's introduction marked a turning point, addressing longstanding challenges and setting new standards for safety and efficiency in transportation operations.

Moreover, the system incorporates sophisticated accident detection mechanisms through a combination of state-of-the-art sensors, including limit switch, GPS modules. In the unfortunate event of an accident or collision, immediate alerts are triggered, enabling swift response measures to be implemented. This rapid response not only minimizes the time taken to address emergencies but also significantly enhances overall safety for drivers and the goods being transported, thereby mitigating potential losses and liabilities.

In essence, the IoT-Powered Transportation Safety and Load Monitoring System present a comprehensive solution to address the critical challenges plaguing the transportation industry. By seamlessly combining accurate load tracking, advanced accident detection capabilities, and a user-friendly application design, this innovative system contributes to the creation of safer, smarter, and more reliable transportation networks. This project signifies a significant leap forward in harnessing IoT technology to enhance safety, efficiency, and user experience within transportation operations, setting a new benchmark for industry standards and paving the way for a more sustainable future.

II. SOFTWARE AND HARDWARE REQUIREMENTS

A. SOFTWARE REQUIREMENTS:

1. ARDUINO IDE:

The Software that's been used to make the project into happening is Arduino IDE. The Arduino Integrated Development Environment also known as Arduino Software (IDE) is been used here to provide the software requirements for this project.

2. EMBEDDED IN C PROGRAMMING:

Embedded C is a programming language specifically designed for programming embedded systems, which are computing devices that are part of larger systems and perform dedicated functions

3. MIT APP INVENTER:

MIT App Inventor is an intuitive, web-based platform developed by the Massachusetts Institute of Technology (MIT) that allows people without extensive programming experience to create mobile applications for Android devices

B. HARDWARE REQUIREMENTS :

1. LOAD CELL:

In this system, load cells are placed strategically within the transportation vehicle to accurately measure and monitor the load it carries. The load data is essential for load tracking and ensuring the vehicle operates within safe weight limits.

2. ESP32:

ESP32 serves as the brain of the system, collecting data from the load cells and other sensors. It processes this data and communicates with the user interface, ensuring real-time monitoring and data transmission.

3. OLED Display:

The OLED display provides a user-friendly interface within the vehicle, showing real-time load data, system status, and alerts. It offers clear visibility and enhances the user experience.

4. BUZZER:

The buzzer is used for generating audible alerts or alarms in case of overload situations, accidents, or system errors. It ensures that the users and nearby personnel are promptly notified of any critical events.

5. SWITCH:

Switches are incorporated for user interaction, allowing manual control over certain system functions. For example, a switch can be used to turn the system on/off or reset alerts after they have been addressed.

6. HX711:

HX711 amplifies and digitizes the small electrical signals from the load cells. It provides accurate and reliable weight measurements, crucial for load monitoring and ensuring transportation safety

7. GPS :

GPS, or Global Positioning System, is a navigation system that provides location and time information anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.

8. GSM:

GSM (Global System for Mobile Communications) is a standard for mobile telecommunications systems. It provides several key functionalities that enable voice and data communication over cellular networks.

III. BLOCK DIAGRAM OF THE SYSTEM

The project's block diagram illustrates the interconnected components and functionalities of the IoT-Powered Transportation Safety and Load Monitoring System. At the core of the diagram lies the IoT infrastructure, which serves as the backbone of the entire system. This infrastructure comprises IoT sensors and devices strategically deployed within transport vehicles to gather crucial data throughout the transportation journey.

The first component depicted in the block diagram is the load monitoring system. This system utilizes IoT sensors to accurately track cargo weight, volume, and condition in real-time. By integrating with the IoT infrastructure, it continuously collects data and transmits it to the central processing unit for analysis and interpretation.

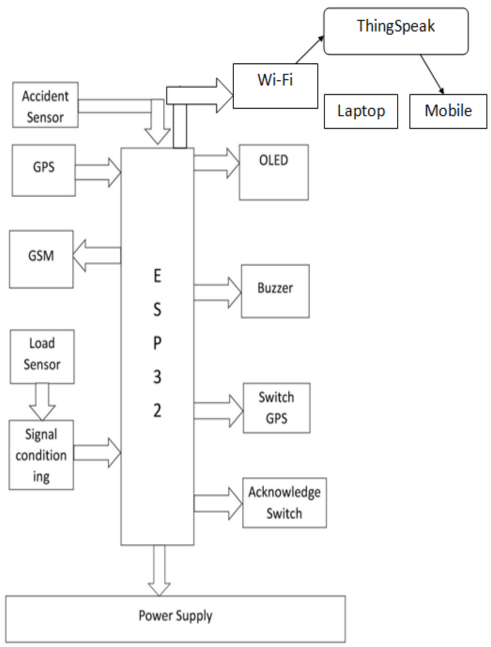


Fig 1. Block Diagram

Next, the accident detection mechanism is highlighted. This component employs a combination of sensors, including accelerometers, gyroscopes, and GPS modules, to detect and respond to accidents or collisions promptly. Upon detecting an incident, the sensors trigger immediate alerts, signaling the need for swift response measures to mitigate potential risks.

The central processing unit serves as the brain of the system, receiving, processing, and analyzing data from both the load monitoring system and the accident detection mechanism. It performs various tasks, including load optimization, compliance monitoring, and incident response coordination, to ensure the seamless operation of the entire system.

The mobile application interface represents the user-facing aspect of the system, providing stakeholders such as drivers, logistics managers, and administrators with access to pertinent information and functionalities. Users can monitor cargo status in real-time, receive instant accident notifications, optimize routes, and analyze historical data through the intuitive interface.

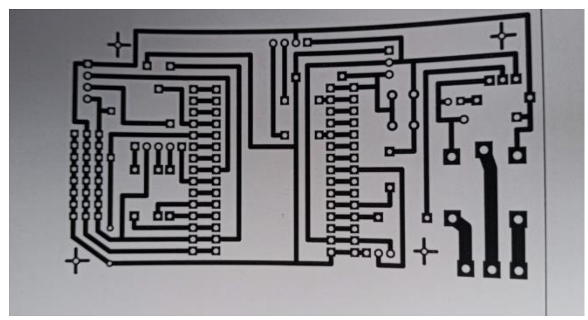
Finally, the communication network facilitates seamless data exchange between the IoT infrastructure, central processing unit, and mobile application interface. This network ensures that data is transmitted efficiently and securely, enabling timely decision-making and action-taking across the transportation network.

In summary, the project's block diagram illustrates how the IoT-Powered Transportation Safety and Load Monitoring System integrates various components and functionalities to enhance safety, efficiency, and user experience in transportation operations.

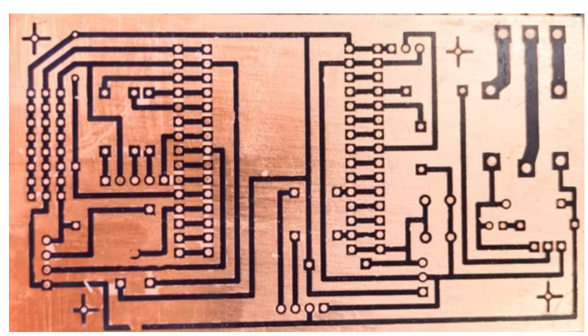
IV.HARDWARE PROCESS

1. EVALUATION OF COMPONENTS:
We have explored the different electronic shop in the market as well as online platforms to evaluate the cost of components.

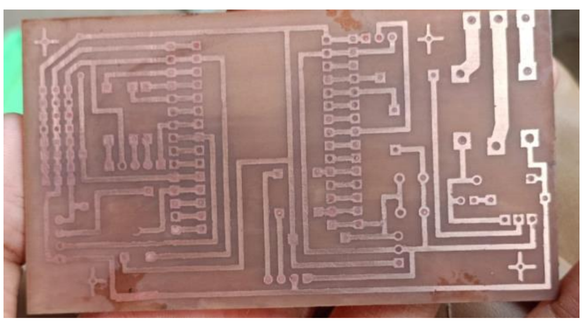
2. PCB DESIGNING:
We have used Express PCB software to design the circuit.



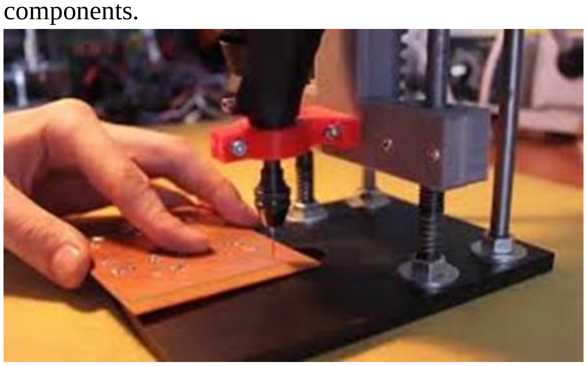
3. PATTERN TRANSFER:
In this process the circuit diagram is transferred to the copper side plate of the PCB using domestic press for applying heat.



4. ETCHING:
In this process removing of unwanted copper from PCB chip using Ferrus Chloride (fecl3).



5. DRILLING:
The process of creating holes in the printed circuit board is carried-out to facilitate the positioning of the components.



6.SOLDERING:

After component mounting, Soldering is a process used for joining metal parts to form a mechanical or electrical bond.

V. SOFTWARE PROCESS

Our code is designed for a microcontroller-based project for a system that involves monitoring and controlling various aspects of transportation or a similar application. It's structured around two main functions: **setup()** and **loop()**, which are fundamental in Arduino programming.

In the **setup()** function, which runs once when the microcontroller boots up or resets, several important initializations take place. First, it establishes communication with an external device, probably a computer or another system, through a serial connection. This allows the microcontroller to send and receive data, which is crucial for debugging and interacting with the project.

Next, the code configures certain pins on the microcontroller as either inputs or outputs. These pins are likely connected to external components such as switches, sensors, or actuators. For example, there's a pin configured as an input to detect the start signal for the project, another input pin to monitor the status of a GPS switch, and an output pin to control a buzzer.

After configuring pins, the code proceeds to initialize various modules connected to the microcontroller. This includes setting up communication with a GPS module and a GSM (mobile network) module, probably for location tracking and sending/receiving SMS messages. Additionally, it initializes a load cell, likely for measuring the weight of cargo or some other component in the system.

Finally, the **setup()** function concludes with some housekeeping tasks, such as assigning initial values to variables and triggering certain actions like sending a welcome message via SMS and activating a buzzer sound.

Once the **setup()** function completes its tasks, the microcontroller enters the **loop()** function, which runs repeatedly for the duration of the project's operation. Here, the main workflow unfolds:

1. Reading GPS status: The code checks the status of the GPS module, likely to ensure it's functioning correctly and acquiring location data.
2. Reading weight: It reads the weight from the load cell, which is crucial for monitoring the cargo or other components in real-time.
3. Displaying status: The code displays the current status, which could include information such as GPS coordinates, weight measurements, or system health indicators. This might be shown on a display screen or sent via serial communication to a connected device.
4. Updating on the internet: It updates data on the internet, possibly sending gathered information to a remote server or cloud platform for storage or further analysis.
5. Checking weight: The code checks whether the measured weight is within specified thresholds or ranges, possibly to ensure compliance with safety regulations or operational requirements.

This iterative process continues indefinitely, allowing the system to continuously monitor and manage transportation-related tasks based on real-time data and inputs from external sensors and devices.

In essence, this code orchestrates a complex interplay of hardware and software components to create a functional system capable of monitoring, controlling, and communicating various aspects of transportation or a similar application. It leverages the capabilities of a microcontroller to perform these tasks efficiently and reliably, contributing to the overall functionality and effectiveness of the project.

VI. FUTURE SCOPES

The project described in the code snippet lays a solid foundation for various applications within the realm of transportation safety and monitoring. However, there are several avenues for future development and expansion:

1. Enhanced Data Analysis and Predictive Maintenance: Implementing advanced data analytics techniques can help extract insights from the collected data.

2. Integration with Autonomous Vehicles: As autonomous vehicle technology continues to evolve, integrating this system with autonomous vehicles can enhance safety and efficiency further.

3. Scalability for Fleet Management: Extending the project to manage entire fleets of vehicles can provide comprehensive insights into fleet operations.

4. Environmental Monitoring and Sustainability: Incorporating environmental sensors into the system can enable monitoring of air quality, temperature, and other environmental parameters during transportation.

5. Integration with Blockchain Technology: Implementing blockchain technology can enhance the security and transparency of data transactions within the transportation network.

6. Global Positioning System (GPS) Augmentation: Integrating additional GPS technologies, such as differential GPS (DGPS) or real-time kinematic (RTK) positioning, can improve the accuracy of location tracking, particularly in challenging environments such as urban canyons or dense forests.

7. Remote Monitoring and Control: Developing mobile applications or web-based interfaces for remote monitoring and control can provide stakeholders with access to real-time data and the ability to intervene or adjust parameters as needed, regardless of their location.

8. Regulatory Compliance and Reporting: Implementing features to automatically track and report compliance with regulatory requirements, such as weight limits, driving hours regulations, and emissions standards, can help streamline regulatory compliance processes and reduce the risk of fines or penalties.

Overall, the future scope of this project extends beyond its current capabilities, offering opportunities for innovation and advancement in the fields of transportation, IoT technology, and data analytics

VII. CONCLUSION

In conclusion, the IoT-Powered Transportation Safety and Load Monitoring System represent a transformative solution in the realm of transportation operations. By harnessing the capabilities of IoT technology, this system revolutionizes the way safety and efficiency are managed in the transportation industry.

Through accurate load tracking, advanced accident detection mechanisms, and a user-friendly interface, the system empowers logistics operators to optimize load distribution, prevent overloading, and ensure compliance with safety regulations. Moreover, its integration with GPS technology enables real-time monitoring of cargo status and location, enhancing overall visibility and control over transportation activities.

As the project evolves, there are exciting opportunities for further development and expansion, including enhanced data analytics, integration with autonomous vehicles, and scalability for fleet management. By embracing emerging technologies and addressing evolving industry needs, the project continues to pave the way for safer, smarter, and more sustainable transportation networks.

In essence, the IoT-Powered Transportation Safety and Load Monitoring System represents a significant advancement in leveraging technology to enhance safety, efficiency, and user experience within transportation operations. It sets a new standard for industry practices and underscores the transformative potential of IoT solutions in shaping the future of transportation.

.

REFERENCE

[1] The model of transport monitoring application based on Internet of Things | May 2018 | Conference: International Scientific Conference on Science and Traffic Development (ZIRP) | At: Opatija, Croatia

[2] Monitoring and Protection of Electrical Load using 'IOT' Shubham U. Bodalkar, Nikhil G. Umare, Rohit M. Pardhi, Pawan J. Zore, Swapnil S. Nikure, Prof. D.D. Dhawale

[3] Intelligent transportation system using IOT: A Review | April 2022| Renula Bhokarkar Vaidya |Dr. Babasaheb Ambedkar Marathwada University

[4] A.Cichockiand R.Unbehaven, *Neural Networks for Optimization and Signa lProcessing*, 1sted.Chichester, U.K.:Wiley, 1993, ch.2, pp.45-47.

[5] W.K.Chen, *Linear Networks and Systems* ,Belmont, CA:Wadsworth, 1993, pp. 123-135.

[6] Development of an IoT based real-time traffic monitoring system for city governance | Author links open overlay panel Mohammed Sarrab [a], Supriya Pulparambil [a], Medhat Awadalla [b]

[7] A REVIEW ON IOT IN TRANSPORTATION SECTOR | IRJET journel

[8] Exploring IoT-Enabled Smart Transportation System | 2019 | Sushmita Mishra

[9] International Scientific Conference on Science and Traffic Development (ZIRP) | The model of transport monitoring application based on Internet of Things | 2018 | Alem Čolaković

[10] 2014 IEEE International Conference on Vehicular Electronics and Safety | An internet of things based intelligent transportation system | 2014 | Viswanathan Bojan