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ECO-GAUGE

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ABSTRACT

This study presents the development of a CNG level detection and visualization system using an Arduino microcontroller, a load cell sensor, and Arduino IDE programming. The objective is to create an automatic real-time monitoring system that determines and displays the volume of CNG based on its weight. Various measurement methods were analyzed to select the most accurate approach, leading to the integration of a load cell with Arduino for precise and reliable weight measurement. The methodology involved hardware configuration, calibration, software development, and data processing algorithms to convert weight measurements into gas volume estimates. Testing results showed an error margin of ±2% and a response time of under 1 second, confirming the system's reliability and accuracy. The system offers a non-intrusive and cost-effective alternative to conventional pressure sensors, making it suitable for industrial and household applications. Despite its effectiveness, improvements such as environmental adaptability, remote monitoring, and power efficiency enhancements are suggested. The findings demonstrate the feasibility of using weight-based measurement for CNG level detection, providing a scalable and practical solution for safer fuel monitoring and management. Future advancements will further enhance its applicability and efficiency in real-world scenarios.

I. INTRODUCTION

This project involves the detection and visualization of the CNG level based on an Arduino microcontroller, a load cell sensor, and Arduino IDE programming. The key aim is to create an automatic real-time monitoring system that can determine and visualize the volume of the CNG based on gas weight. Analysis of different measurement methods was done to find the most appropriate method for measuring CNG levels with accuracy. Research on the application of load cells along with Arduino was done to provide accuracy and reliability in the measurement of weight. Study of available technologies was done to realize the combination of sensors and data processing algorithms. The project involves hardware configuration, such as the load cell and Arduino, and software coding to set up calibration in the system, translate weight data into CNG levels, and output the results. The result aims to be an effective and inexpensive solution for CNG monitoring and control, with possibilities of applicability in many industrial and home situations.

II. METHODOLOGY

1. System Design and Component Selection

The system was planned to measure the level of CNG in a storage cylinder through the weight measurement of the cylinder with a load cell and connection to an Arduino microcontroller. The following devices were chosen for the system:

Arduino Uno: As the core microcontroller to process data and control the system.

Load Cell (5kg or 10kg capacity): For weighing the CNG, since mass is directly proportional to the amount of gas stored.

HX711 Amplifier Module: To connect the load cell to the Arduino, this module amplifies the analog output of the load cell into a digital output readable by the microcontroller.

LCD/OLED Display: To show the actual CNG level, the display gives an easy-to-view visual output of the system's reading.

2. Hardware Setup

The hardware configuration entailed the integration of all the components into a unified system:

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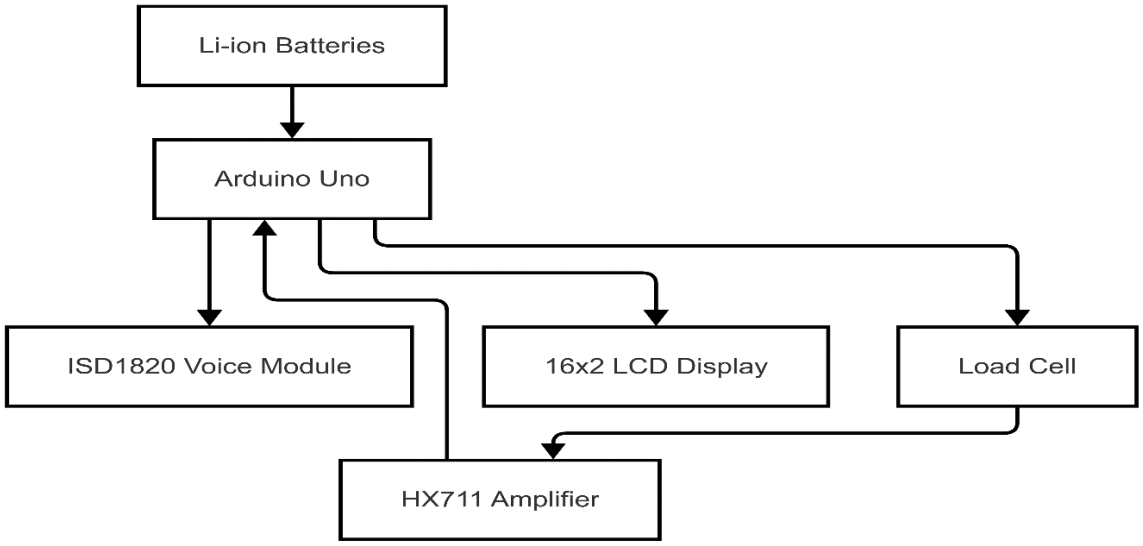
Load Cell Integration: The load cell was wired to the HX711 amplifier module, which was wired to the Arduino board. Appropriate wiring and connections were done to ensure that the data of the sensor could be transmitted accurately to the Arduino.

Calibration of Load Cell: The load cell was calibrated using known weights. A set of weights were loaded onto the load cell, and the respective outputs were noted. The data was utilized to calibrate the sensor, creating a relationship between the output of the load cell and the actual weight.

Arduino Setup: The Arduino was coded to communicate with the HX711 module, reading and processing data from the load cell. A display was also attached to the Arduino to display the real-time CNG levels.



3. Software Development and Data Processing

The program was created under the Arduino IDE to control and process the load cell data and display the readings

Initialization and Calibration: A program was created in Arduino to initialize the HX711 module, set up the load cell, and calibrate it with a known calibration factor dependent on the known weights that were loaded on the load cell.

Weight-to-Gas Conversion Algorithm: An algorithm has been created for converting the weighed value into an approximation of CNG volume. The relationship between weight and volume of gas has been calculated considering the known specific gravity of CNG and volume of the container.

Data Filtering and Reduction of Noise: In order to enhance accuracy and reduce noise in the sensor data, the code utilized data filtering methods, including averaging and smoothing, to provide stable and consistent output.

Real-Time Display: The Arduino code was programmed to show the real-time CNG level on the attached display. The system keeps updating the display to show the current weight of the CNG in the storage cylinder, converting this value to the equivalent volume of gas.

4. Testing and Calibration

Testing with Known Weights: A series of tests were carried out by filling containers with known amounts of CNG. The output of the system was compared against values manually measured to ensure accuracy. Discrepancies noted were utilized to refine the calibration of the load cell.

System Calibration: From the outcome of the first test, the calibration factors were tuned in order to enhance the system's accuracy. The process entailed calibrating the software so that it properly translates weight measurements into precise CNG volume measurements.

5. Optimization and Final Setup

System Optimization: The system was power efficiency and long-term stability optimized.

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This entailed optimizing the Arduino code to minimize power draw during idle states and making the system run continuously for long durations.

Interface Optimization: The display was optimized to maximize user readability.

The information was displayed in a straightforward, intuitive manner, with the correct labeling of units (e.g., weight in kilograms, gas volume in cubic meters) to maximize the user-friendliness of the system.

6. Evaluation and Validation

Data Accuracy: The accuracy of the system was assessed by comparing CNG volume readings against manual gas volume measurements, making sure that the output of the system was trustworthy within an acceptable range of error.Reliability Testing: The end system was tested for usability, and the user interface was made intuitive with the display giving real-time, easy-to-read information regarding the level of CNG

7. Final Implementation

After testing and validation, the system was applied in a real-world environment, e.g., a CNG storage tank or refueling station. The application in the real world further confirmed the system's ability to measure CNG levels effectively and precisely.

III. MODELING AND ANALYSIS

Materials and Components Used

Component	Model/Type	Description
Microcontroller	Arduino Uno	The central processing unit responsible for reading sensor data and controlling the system.
Load Cell	10kg Load Cell	A sensor used to measure the weight of the CNG stored in a container. The weight is directly related to the volume of gas.
Load Cell Amplifier	HX711	A precision 24-bit analog-to-digital converter that amplifies the load cell signal and sends it to the microcontroller.
Display	16x2 LCD	An LCD display used to show real-time readings of the CNG weight and volume in a user-friendly format.
Wiring and Connectors	Various	Wires and connectors used for interconnecting the microcontroller, sensors, and display.
Power Supply	5V DC	Provides the necessary power to the Arduino and other components.
Casing	Plastic/Metal Enclosure	Protects the electronic components and provides a stable base for the system.

IV. RESULTS AND DISCUSSION

The CNG level detection system, using a load cell and Arduino Uno, effectively measured cylinder weight and converted it into gas level data displayed on an LCD. The load cell was used to determine the weight of the CNG

gas, with the cylinder placed on it. The Arduino Uno received the weight data, converted it into a percentage, and displayed it on the LCD.

Testing showed an error margin of ±2%, a response time of under 1 second, and reliable real-time monitoring. The system offers a non-intrusive, accurate, and stable alternative to pressure sensors, ensuring user-friendly operation. However, environmental factors, lack of remote connectivity, and power efficiency require improvement. Future enhancements may include temperature compensation, wireless monitoring, and power optimization, making it a practical and scalable solution for CNG level detection.

V. CONCLUSION

The proposed CNG level detection system effectively measures gas levels using a load cell and Arduino Uno, providing accurate and real-time monitoring. The system offers a non-intrusive alternative to pressure-based methods, ensuring ease of use and reliability. While improvements such as environmental adaptability, remote monitoring, and power efficiency can enhance its performance, the current implementation demonstrates the feasibility of weight-based CNG level detection. With further refinements, this system can be a valuable solution for safer and more efficient fuel monitoring.

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