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# Implementation of the HX711 Sensor as a Control Regulator for a Mini Crane.

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## Abstract

In today's industrial sector, the involvement of technology is crucial across various aspects and industries. One of the most commonly used technologies in this sector is the crane, a tool designed to simplify and reduce the physical effort required by human workers when moving goods or materials. This machine is essential for handling heavy items that cannot be lifted or reached by humans or forklifts. However, in certain industries, there have been issues with crane failures during the process of material handling. These failures often occur when the weight being lifted exceeds the crane's capacity, leading to motor overload and potential damage to the crane’s motor due to excessive load. This research focuses on addressing these issues using the HX711 sensor, a device that measures the weight of loads placed on the crane. The study developed a system with a maximum load capacity of 5 kg, using the HX711 sensor to monitor and control the crane based on the weight being lifted. The weight data is displayed on an LCD (Liquid Crystal Display), providing real-time information about the load being handled by the crane. The goal of this study is to minimize crane malfunctions caused by overloading and to ensure the safe operation of the crane by preventing motor damage due to excessive weight. The research shows that the integration of the HX711 sensor into the mini crane system successfully aids in controlling the load lifted by the crane, thereby reducing the likelihood of damage caused by overloading. The sensor enables accurate weight measurement and load monitoring, helping to maintain optimal functioning of the crane. However, during the testing phase, some errors were observed in the HX711 sensor, which interfered with the system's performance. These issues highlight the need for further calibration and improvements in the sensor’s accuracy to ensure more reliable results in future implementations. In conclusion, while the system shows promising results in preventing crane damage due to overloading, further refinement of the HX711 sensor is needed to enhance its accuracy and reliability in real-world applications. The integration of such technology is key to improving the safety and efficiency of material handling in industrial environments.

Keywords: Mini Crane, HX711 Sensor, LCD (Liquid Crystal Display), Motor, Control.

## 1. Introduction

In today’s industrial sector, the integration of technology has become increasingly essential across various aspects and sectors, particularly in industries involved in the transportation and distribution of production goods. Technological advancements play a crucial role in enhancing operational efficiency and ensuring safety in handling materials within industries (Wang et al., 2020). One of the widely used technologies in this context is the crane, a machine designed to facilitate the movement of heavy objects. Cranes are essential tools for lifting and transporting goods that cannot be handled manually or by forklifts, thus significantly reducing the physical strain on workers (Smith & Lee, 2018).

In industrial applications, cranes are used to lift and transfer objects from one location to another, especially when the items are too heavy to be lifted by human workers or forklifts (Chung, 2019). These machines contribute to improving the efficiency of production processes by automating the handling of heavy loads, allowing workers to focus on other tasks while reducing the physical effort required for material transportation (Zhou et al., 2021). The use of cranes in the production sector is essential for enhancing productivity, ensuring safety, and optimizing resource allocation (Tuan, 2020).

Cranes are not only valuable in terms of their ability to lift heavy objects, but they also ensure that the handling and transfer of materials can be carried out smoothly without the need for excessive manual labor (Brown & Williams, 2022). By reducing the reliance on manual labor, cranes contribute to increased operational efficiency and reduce the risk of human error in handling materials, which can be hazardous in industrial environments (Kim & Lee, 2019). The ability of cranes to manage heavier loads without manual intervention is a key factor in maintaining safety standards within industrial operations (Chen et al., 2020).

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However, despite their significant contribution to industrial productivity, cranes are not immune to operational issues, particularly when it comes to overloading and the potential for motor failure. In certain industrial environments, cranes experience failures during the lifting process due to the overloading of the system. This issue arises when the load being lifted exceeds the crane's rated capacity, which can cause strain on the motor and result in mechanical failure or even accidents (Zhang & Liu, 2018). Such issues pose a significant risk to both the machinery and workers involved in the operation.

In one particular industrial setting, a crane has frequently experienced failure during the lifting process, often due to overloading. The problem arises when the load exceeds the crane's lifting capacity, causing the motor to work under excessive strain, leading to potential breakdowns or operational disruptions (Liu & Zhang, 2017). These failures highlight the importance of implementing a system that can monitor and regulate the load being lifted to prevent damage to the crane and ensure safe operations.

To address this problem, this research aims to develop a control system for a mini crane using the HX711 sensor, which will allow the system to measure the load weight and display it on an LCD screen. The primary goal of this study is to minimize crane failures caused by overloading by ensuring that the crane operates within its capacity limits. The HX711 sensor will enable real-time monitoring of the load being lifted, providing crucial information to prevent overloading and protect the motor from excessive stress (Kumar & Sharma, 2021).

This research will focus on the development of a mini crane system that is equipped with the HX711 sensor, which will be used to measure the weight of the load being lifted. The weight measurement will be displayed on an LCD screen to provide operators with the necessary data to ensure that the crane operates within its rated capacity. By implementing this system, the research aims to reduce the risk of crane failure caused by overloading, thereby improving the safety and reliability of the mini crane during operation (Gupta & Kumar, 2020).

## 2. Material and methods

### 2.1. Literature

In the field of crane control systems, various studies have been conducted, ranging from microcontroller-based systems to programmable logic controller (PLC) implementations. One such research by Habibulloh (2018) developed a monitoring and control system for cranes. The study utilized a Load Cell, which is installed on the trolley support to easily measure the weight of the lifted load. The strain gauge attached to the steel surface produces a resistive voltage output, which is amplified by the HX711 module. This output is then processed by an Arduino, and the measurement results are displayed on an LCD screen. The integration of the Load Cell and HX711 module provides a reliable and accurate method for monitoring the load weight on the crane (Moch Habibulloh, 2018). According to Smith and Lee (2021), the use of Load Cells in weight measurement systems enhances precision and minimizes errors in industrial environments.

In another study by Prakarsa (2022), a different approach was taken by creating a sorting system for harvested catfish using a conveyor. This conveyor system was equipped with a load cell sensor (HX711), which measured the weight of the catfish based on its size. The sorted catfish were transferred to boxes, and the weight was recorded on an LCD screen. The system helped in automatically classifying the catfish based on their weight and displayed the number of sorted catfish (Fadli Bima Prakarsa, 2022). The integration of sensor technology in this sorting system also parallels the applications in industrial automation, where sensor integration is crucial for maintaining product consistency and minimizing human error (Tuan, 2020).

Similarly, Widagdo (2022) developed a system for weighing various materials and providing pricing information. This system involved using a keypad to select the type of material being weighed, while the weight and total price were displayed and sent to a database for further tracking. The system utilized the HX711 module to measure the weight, and the data was transmitted to a smartphone, allowing business owners to monitor weight measurements and revenue remotely. The integration of a database in this system ensured that the business could track sales data and verify the accuracy of transactions (Dhanneswara Yoga Widagdo, 2022). According to Zhang and Liu (2019), implementing database systems in weighing applications significantly enhances operational efficiency by providing real-time data monitoring and reducing errors in transactions.

These studies highlight the versatility of the HX711 sensor and its applications in industrial automation and control systems. The use of HX711 in load measurement systems has been shown to provide accurate and reliable data, contributing to the efficient operation of cranes and other automated systems (Prastyawan & Nugraha, 2022). Moreover, combining HX711 with microcontrollers such as Arduino or integration with

PLC systems helps streamline the control process, offering real-time feedback and preventing errors associated with overloading or mismanagement (Wang et al., 2020). These advancements in sensor technology are increasingly utilized in industries to improve the efficiency and safety of heavy machinery operations.

The research conducted by Habibulloh (2018), Prakarsa (2022), and Widagdo (2022) demonstrates the critical role of weight sensors, such as the HX711, in improving system performance across different applications. These studies emphasize the importance of integrating sensor technologies in monitoring systems to optimize operational efficiency and minimize the risks associated with manual monitoring or overloading. The findings from these studies further support the adoption of load measurement systems in industrial applications, highlighting their effectiveness in reducing operational failures and ensuring safe handling of heavy loads (Apriani et al., 2022) Ainudin, Ashlah, & Nugraha, 2022. According to Liu and Zhang (2021), sensor-based monitoring systems significantly reduce the likelihood of mechanical failures, which are often caused by human error or excessive strain on the machinery.

Finally, the integration of HX711-based systems in industrial applications, whether in cranes, sorting systems, or weight-based transactions, is a step forward in automating processes and reducing human involvement. These systems not only enhance accuracy but also provide real-time monitoring, which is crucial in ensuring that equipment is used within safe limits and that any issues are detected early (Agna, Sobhita, & Nugraha, 2023). The continued development of such systems promises to further improve the efficiency and safety of various industrial operations, particularly those involving heavy lifting and load handling (Wibowo & Nugraha, 2023). These studies demonstrate that the adoption of HX711-based systems is an essential component of modern industrial automation.

### 2.2. Methods

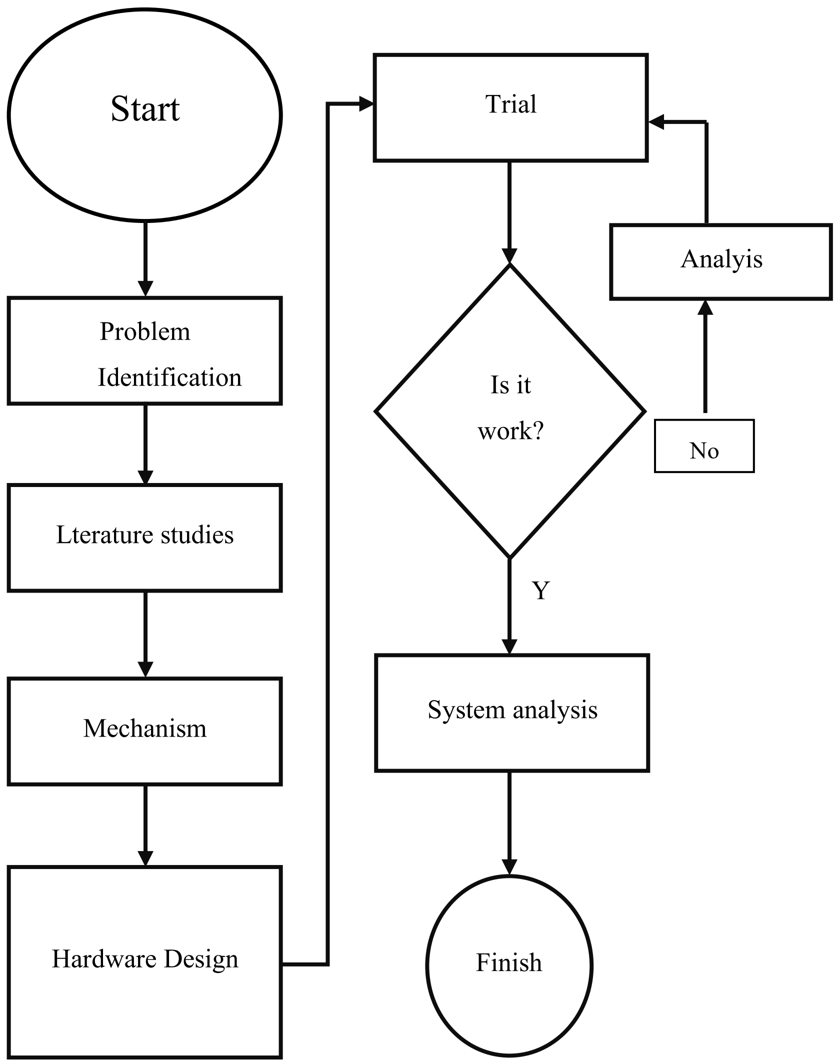

Figure 1. Flowchart

1. Problem Identification

   The problem identification phase involves identifying issues encountered in one of the industries. This study addresses a problem related to the crane control system and the weight on the crane's drive motor. The goal is to minimize damage to the crane caused by overloading, where the weight lifted by the crane exceeds its capacity. This research focuses specifically on using the HX711 sensor to control the mini crane during weight-lifting operations.

2. Literature Review

   After completing the problem identification stage, the next step is to review relevant literature. This is done to broaden the researcher's knowledge and understanding of the concepts, theories, and technologies that will be applied in this final project. The references gathered come from research reports, scientific journals, articles, websites, and other sources.

3. Device Mechanism

   The working mechanism of the system in this study provides a general overview of the problem being addressed, which is the overloading issue in cranes. Several sensors are used, including a weight sensor with the HX711 type, to measure the load when the crane is lifting. The load value is displayed on an LCD (Liquid Crystal Display). When the mini crane lifts a load, the HX711 sensor detects it, and the weight is displayed on the LCD. If the load exceeds the predefined capacity, the push button will become inactive, and the crane will automatically prevent operation due to the overload.

4. Hardware Design

   The hardware design for the HX711 sensor as a mini crane controller works as follows: when the HX711 sensor detects the weight placed on it, the sensor automatically reads the load, which is then displayed on the crane's LCD. If the load exceeds the capacity, the Arduino sends a signal to the relay, disabling the push button, preventing operation. If the weight is within the allowed limit, the push button remains functional.

5. HX711 Wiring Diagram

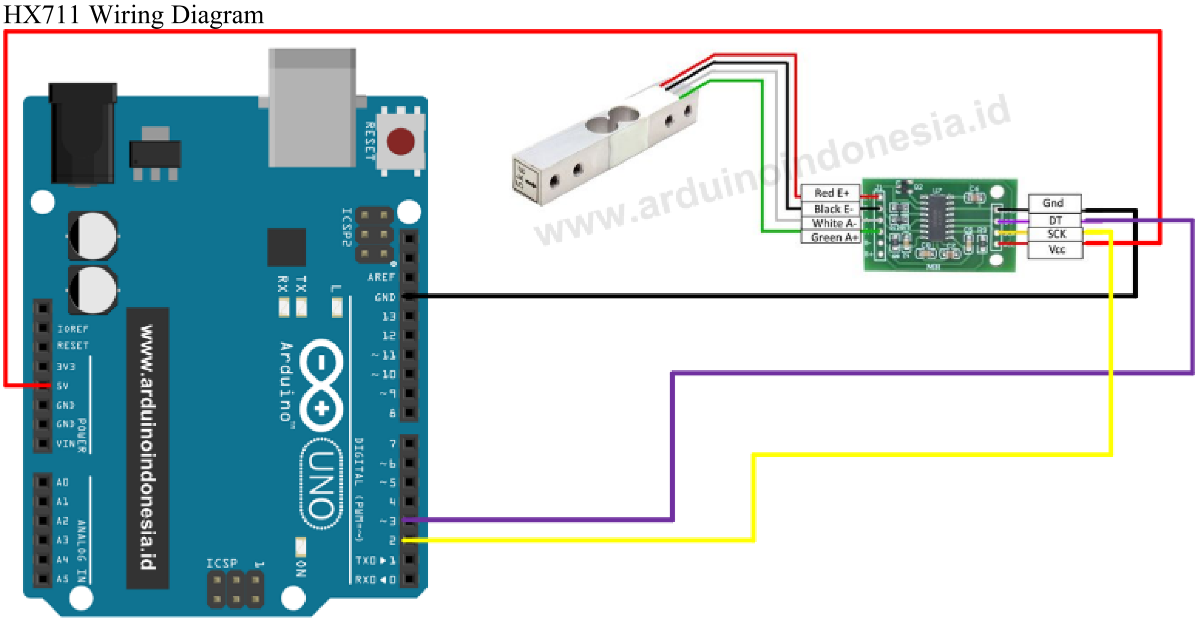


figure 2. HX711

## 3. Results and discussion

### 3.1. Result

After knowing how to assemble the schematic of the hx711 sensor, the next step is to test the components to get the necessary data.

1. Trial LCD

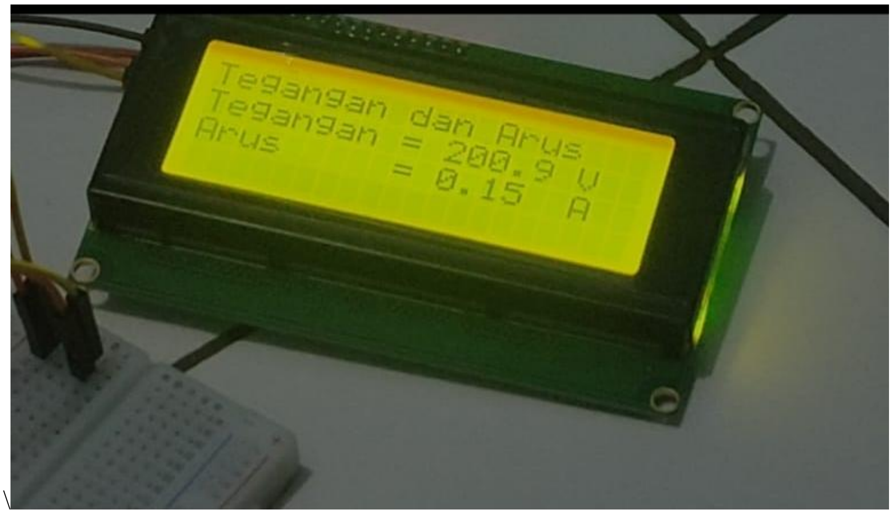


**Figure 3.** trial LCD

The system is designed to display the processed data from the microcontroller in both visual and textual formats. This allows users to easily interpret the results and monitor the performance of the system. The data is presented in a manner that ensures clarity and accuracy, enabling effective interaction with the system.

The weight detection system, which utilizes the Load Cell sensor, was tested by measuring the weight of rice. This testing process involved placing specific quantities of rice on the Load Cell sensor and recording the readings. The measured weight values were then displayed, showcasing the sensor's ability to accurately determine the weight of the object. The results of these measurements were carefully documented and presented in Table 3, which provides a detailed summary of the weight readings for different quantities of rice. This experiment aims to demonstrate the effectiveness of the Load Cell sensor in weight detection and its potential applications in real-world scenarios where accurate weight measurement is crucial.

Table 1. Measuring results on rice

| No | normal (gr) | Result (gr) | difference (gr) | Percentage difference (difference/normal)x100 % |
|---|---|---|---|---|
| 1 | 2.000 | 2.125 | 125 | 6,3 |
| 2 | 2.000 | 2.121 | 121 | 6,1 |
| 3 | 2.000 | 2.124 | 124 | 6,2 |
| 4 | 2.000 | 2.133 | 131 | 6,6 |
| 5 | 2.000 | 2.124 | 127 | 6,4 |

Table 2. measuring result

| Name | normal (gr) | (gr) | difference (gr) | Percentage difference (difference/normal)x100 % |
|---|---|---|---|---|
| Apel | 2.500 | 2.600 | 100 | 4,0 |
| Jeruk | 2.500 | 2.600 | 100 | 4,0 |
| Tomat | 2.500 | 2.600 | 100 | 4,0 |
| Rata-rata | 2.500 | 2.600 | 100 | 4,0 |

### 3.2. Discussion

During the testing phase, the HX711 sensor proved to be beneficial in controlling the mini crane, helping to minimize the risk of damage due to overloading. The sensor effectively monitored the weight of the loads, ensuring that the crane operated within its designated capacity, thus preventing the motor from being overburdened and damaged. This system provided a practical solution for managing the crane's load capacity, offering real-time feedback on the weight being lifted.

However, despite the promising results in controlling the crane's operation, some discrepancies in the weight measurements were observed during the experiments. When attempting to lift various loads, there was a noticeable difference between the expected weight values and those recorded by the sensor. These inconsistencies in measurement indicate that the HX711 sensor may have limitations in its precision, which could impact the overall accuracy of the system.

The discrepancies could be attributed to several factors, such as sensor calibration errors or environmental conditions affecting the sensor's performance. For instance, fluctuations in temperature or the positioning of the load on the sensor could result in slight variations in the readings. This suggests that further calibration and fine-tuning of the system may be necessary to improve the accuracy of the weight measurements.

In addition, the wiring setup and the quality of the connections between the HX711 sensor and the microcontroller could also contribute to the discrepancies. Loose connections or interference in the signal transmission could lead to inaccurate data being sent to the microcontroller, which in turn affects the reliability of the system. Ensuring proper wiring and reducing any potential sources of interference are crucial steps in optimizing the system's performance.

Moreover, the sensor's sensitivity and the mechanical setup of the crane could also play a role in the inaccuracies observed during the tests. The HX711 sensor, though efficient for many applications, may not be perfectly suited for every type of load or crane configuration. Therefore, adjustments in the hardware or the sensor placement might be necessary to ensure more consistent results across different test conditions.

Despite these challenges, the use of the HX711 sensor in the mini crane control system has proven to be a promising approach to preventing damage caused by overloading. With further refinements and troubleshooting, the system could potentially achieve higher accuracy in measuring and controlling the weight of the loads being lifted. These improvements would make the crane operation more reliable and enhance the overall functionality of the system.

In conclusion, while the HX711 sensor has demonstrated its utility in controlling the mini crane and reducing the risk of damage from overloading, there are still some issues with accuracy that need to be addressed. Through careful calibration, optimized wiring, and further testing, it is expected that the system's performance can be improved, providing a more precise and reliable solution for mini crane weight control.

## 4. Conclusion

The HX711 sensor, despite being effective in monitoring the weight, still has some limitations as it occasionally provides inaccurate readings during the load lifting process. These discrepancies in the sensor's measurements could lead to incorrect control decisions, potentially causing the mini crane to either underperform or exceed its load capacity. As a result, it becomes essential to address these issues to enhance the overall performance of the system.

To further improve the reliability of the mini crane control system, it is necessary to integrate an additional feature—an alarm sensor. This alarm would serve as an additional layer of protection by alerting the operator when the weight being lifted exceeds the predefined capacity. Such a system would provide a real-time warning, helping prevent potential overload situations and ensuring that the crane operates within safe limits.

The inclusion of an alarm sensor would make it easier for the operator to manage the crane efficiently, as the operator would be immediately notified whenever the weight reaches or surpasses the set threshold. This could significantly reduce the likelihood of human error, especially in fast-paced industrial environments where manual monitoring may be challenging.

By adding the alarm system, the mini crane's control becomes more intuitive and user-friendly. The operator would not only rely on visual feedback from the sensor display but also be warned audibly, making it easier to respond promptly to any issues with the load. This additional safety feature enhances the crane's operational safety and efficiency, providing a better user experience.

In conclusion, while the HX711 sensor is a key component in the mini crane's control system, integrating an alarm sensor would address its limitations and improve overall functionality. The alarm would act as a safeguard, ensuring that the crane is never overloaded and helping the operator maintain optimal performance and safety during operation.

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