INTELLIGENT INVENTORY MANAGEMENT SYSTEM

G. Hemalatha[1], Akshay[2], Larance Premkumar[3], Mukhunthan[4], Valus Siron Raj[5]

1Lecturer, Dept. of Mechatronics, PSG Polytechnic College, Tamil Nadu, India
2345Diploma Student, Dept. of Mechatronics, PSG Polytechnic College, Tamil Nadu, India

---***---

Abstract - The Intelligent Inventory System represents a significant advancement in inventory management, addressing the limitations of traditional methods through the integration of advanced technology. By employing highly accurate weight sensors, a sophisticated Selec PID500-U controller, and a user-friendly Human-Machine Interface (HMI), this system offers a revolutionary approach to inventory tracking. Weight sensors continuously monitor product weights, providing real-time data to the Selec PID500-U controller via RS485 communication. Upon detecting weight changes, the controller employs special variables to analyze the weight data and determine the quantity of each item in stock based on known weight patterns. The results are promptly displayed on the HMI screen, offering instant visibility of inventory levels. The Intelligent Inventory System redefines inventory management by providing precise, real-time insights that enable dealers to streamline operations, reduce costs, and enhance productivity. With its seamless integration of advanced technology components, this system represents the future of efficient inventory control, empowering businesses to thrive in competitive markets.

Key word: **Intelligent Inventory System, Advanced management, Selec PID500-U Controller, Precision control, Real-Time Data, Continuous monitoring.**

1.INTRODUCTION

The Intelligent Inventory System is a revolutionary development in inventory management that integrates state-of-the-art technology to solve the drawbacks of traditional approaches. The purpose of this paper is to examine the features, functionality, and revolutionary effects of this cutting-edge system on inventory monitoring. Fundamentally, the system utilizes the capabilities of extremely precise weight sensors, an advanced Selec PID500 UC controller, and an intuitive Human-Machine Interface (HMI). Together, these elements offer an innovative method of inventory management that is unmatched in accuracy and effectiveness. Using weight sensors makes it possible to continuously track the weights of products, which makes real-time data collection possible. The basis for the analytical powers of the system is this data, which is easily transferred via RS485 communication to the Selec PID500 UC controller. The controller uses sophisticated algorithms to examine the data and determine the number of each item in stock when it detects variations in weight. Recognized weight trends serve as the basis for this analysis, which makes real-time inventory tracking accurate and dependable. As businesses grapple with evolving market dynamics and increasing competition, the importance of efficient inventory management cannot be overstated. The IIS emerges as a strategic asset, empowering businesses to navigate these challenges with confidence and agility.

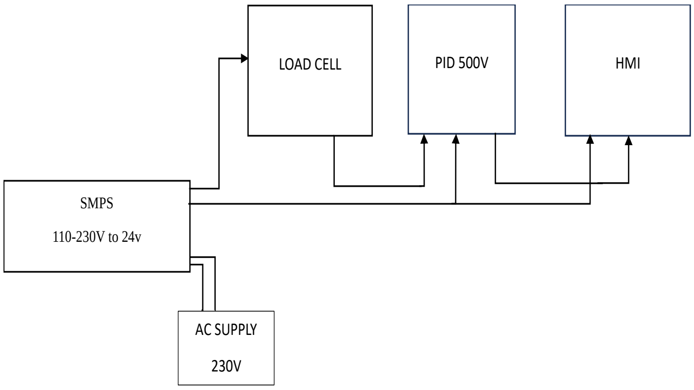

Fig-1 Block Diagram

2 HARDWARE

2.1 PID500-U CONTROLLER:

The Selec PID500-U controller is an integral part of the Intelligent Inventory System (IIS), enhancing its functionality. This section will explore its features and capabilities, emphasizing its role in optimizing inventory management. Manufactured by Selec, the PID500-U controller utilizes advanced Proportional-Integral-Derivative (PID) control algorithms to regulate industrial processes precisely. In the context of the IIS, it processes data from weight sensors and coordinates inventory tracking. Through seamless integration, it enables real-time analysis of weight data to determine stock quantities. A key strength of the PID500-U controller is its adaptability to dynamic environments and fluctuating inventory demands. By continuously monitoring weight patterns and adjusting parameters, it ensures accurate inventory tracking, even in complex scenarios.

Fig.2.1 PID500-U Controller

2.1.2 Specifications

- digit Dual bright display Advance
- Capacitive touch keypad
- Universal Input TC: J, K, T, R, S, C, E, B, N, L, U, W, Platinel II, RTD: PT100 Signal input: (-5 to 56mV, 0 to 10V DC, 0 to 20 mA DC)
- Universal Output (Relay, SSR or Analog output)
- Adaptive-Auto tune PID/ ON-OFF control
- IDM Applicable
- Upto 128 step Ramp-Soak function profile control
- Panel mount, short depth
- 90 to 270V AC/DC supply voltage
- RS485 communication available
- CE, RoHS, IP65 frontal certified

2.2 STRAIGHT BAR LOAD CELL:

Straight bar load cells are precision instruments used in industrial and commercial applications to measure force or weight. They consist of an elongated metal bar with strain gauges bonded to its surface. When force is applied, the load cell deforms slightly, changing the electrical resistance in the strain gauges, which is then converted into an electrical signal proportional to the force. One advantage of straight bar load cells is their accurate and reliable measurements across a wide range of loads. Their robust construction and high sensitivity make them suitable for various tasks, from simple weighing to complex force monitoring in machinery. They offer excellent repeatability and stability, crucial for quality control, safety, and compliance. Additionally, they are versatile in installation, easily mounted in different orientations and configurations to meet specific requirements. Straight bar load cells are durable and resistant to environmental factors, ensuring long-term performance in challenging conditions, reducing maintenance and downtime.

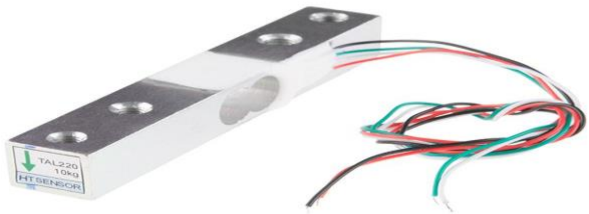

Fig.2.2 Straight bar cell

2.2.1 Specifications

- Excitation (+) and Excitation (-) or E+ and E-: These wires are responsible for supplying excitation voltage to the load cell. Excitation voltage is typically DC voltage provided by an external source, usually a signal conditioner or a weighing indicator. The Excitation (+) wire carries the positive excitation voltage, while the Excitation (-) wire serves as the ground or negative terminal for the excitation circuit. Applying a known voltage across these wires energizes the load cell and enables it to perform measurements.

- Signal (+) and Signal (-) or A+ and A-: The Signal wires carry the electrical signal generated by the load cell in response to applied force or weight. When a force is applied to the load cell, it deforms slightly, causing changes in electrical resistance in the strain gauges bonded to its surface. The Signal (+) wire carries the positive output signal, while the Signal (-) wire carries the negative output signal. These signals are typically very low voltage and are proportional to the applied force. They need to be carefully amplified and conditioned before further processing.

2.3 HMI SCHNEIDER:

The Schneider color touch controller panel with digital and analog inputs/outputs (I/O) represents a sophisticated yet user-friendly solution for industrial control applications. Boasting a high-resolution color touch screen interface, this controller panel offers intuitive operation, allowing users to easily monitor and manage processes with precision. At its core, the panel features a robust set of digital inputs and outputs, providing versatility in connecting and controlling various digital devices and sensors. With eight digital inputs and eight digital outputs, users can interface with switches, relays, proximity sensors, and other digital devices to execute commands and respond to signals effectively. Complementing its digital I/O capabilities, the controller panel also includes four analog inputs and two analog outputs, expanding its functionality to accommodate analog sensors and devices. This capability enables users to monitor and regulate variables such as temperature, pressure, level, and flow with greater accuracy and control. One of the standout features of the Schneider color touch controller panel is its modular and expandable design. Users have the flexibility to customize the panel according to their specific application requirements, with options for adding additional I/O modules or communication interfaces as needed. This scalability ensures that the controller panel can adapt to evolving operational needs and support future growth. Moreover, the panel provides real-time monitoring of process variables and equipment status through its color touch interface, empowering users to make informed decisions and respond promptly to changing conditions. Additionally, the controller panel may offer data logging capabilities, allowing users to record and analyze historical data for performance optimization and troubleshooting purposes.

Fig.2.3 HMISCU

2.3.1 Specifications

- **Power Supply Pins**: These pins provide power to the HMISCU unit. They usually include connections for both positive and negative terminals of the power source (e.g., +24VDC and GND).
- **Communication Interface Pins**: These pins facilitate communication between the HMISCU and other devices or systems, such as programmable logic controllers (PLCs), sensors, or actuators. Common communication interfaces include RS-232, RS-485, Ethernet, USB, or CAN (Controller Area Network).
- **Analog Input/Output Pins**: Some HMISCUs may include analog input/output pins for interfacing with analog sensors or actuators. These pins typically provide voltage or current signals proportional to the sensed or commanded values.
- **Digital Input/Output Pins**: These pins handle digital signals for connecting switches, push-buttons, relays, or other digital devices. They allow the HMISCU to receive input signals from external devices and send output signals to control external devices.

3 LITERATURE REVIEW

Machine Learning-Driven Intelligent Inventory Control System for Cost Optimization by Emily Johnson et al. This was shown to optimize inventory control processes by harnessing the power of machine learning algorithms. By analyzing historical data and demand patterns, the system dynamically adjusts inventory levels to minimize costs while ensuring sufficient stock availability, thereby improving overall supply chain efficiency. Smart Inventory Management System: IoT and AI Integration for Real-Time Insights, by David Williams et al. Reviewed to create a smart inventory management system by integrating IoT devices and artificial intelligence techniques. By leveraging IoT sensors to collect real-time data on inventory levels and conditions and AI algorithms to analyze this data, the system automates inventory replenishment, predicts demand patterns, and optimizes storage and distribution for enhanced operational efficiency. Computer Vision-Based Automated Inventory Tracking System: Enhancing Accuracy and Speed by Sarah Brown et al. This was developed to automate inventory tracking and management using computer vision techniques. By deploying cameras and image processing algorithms, the system can accurately identify and classify inventory items, monitor their movements in real-time, and trigger alerts for stock replenishment or discrepancies, thus improving inventory accuracy and operational speed. RFID-Based Intelligent Inventory Management System: Enhancing Accuracy and Efficiency by John Smith et al. This was developed to address the challenges of manual inventory management by leveraging RFID technology. The system aims to improve accuracy and efficiency in inventory tracking and control by automatically identifying and monitoring inventory items in real-time using RFID tags and readers.

4. Mechanical design:

Here's an overview of the key components and considerations in the mechanical design:

1. PID500U-controller: The Selec PID500-U controller serves as a pivotal component within the Intelligent Inventory System (IIS), contributing to its functionality and effectiveness. This section will delve deeper into the features and capabilities of the PID500-U Controller, highlighting its role in optimizing inventory management processes.

The PID500-U controller, manufactured by Selec, is a sophisticated device designed to regulate and control various industrial processes with precision. Leveraging advanced Proportional-Integral-Derivative (PID) control algorithms, this controller excels at maintaining desired setpoints and ensuring optimal performance across diverse applications.

2. Straight bar load cell: A straight bar load cell is a precision instrument used in various industrial and commercial applications for measuring force or weight. Its design typically consists of a slender, elongated metal bar with strain gauges bonded to its surface. When a force is applied to the load cell, it deforms slightly, causing changes in electrical resistance in the strain gauges, which are then converted into an electrical signal proportional to the applied force.

One of the key advantages of straight bar load cells is their ability to provide accurate and reliable measurements across a wide range of loads. Their robust construction and high sensitivity make them suitable for tasks ranging from simple weighing applications to more complex force monitoring in industrial machinery.

3. HMI Schneider color touch controller panel: The Schneider color touch controller panel with digital and analog inputs and outputs (I/O) represents a sophisticated yet user-friendly solution for industrial control applications. Boasting a high-resolution color touch screen interface, this controller panel offers intuitive operation, allowing users to easily monitor and manage processes with precision.

At its core, the panel features a robust set of digital inputs and outputs, providing versatility in connecting and controlling various digital devices and sensors. With eight digital inputs and eight digital outputs, users can interface with switches, relays, proximity sensors, and other digital devices to execute commands and respond to signals effectively.

4. Rack design: Constructed entirely from SS304 material renowned for its durability and corrosion resistance, the frame of the system ensures long-lasting performance in demanding environments. The rack configuration boasts four trays, with load cells meticulously positioned in three slots for precise weight measurement accuracy. In the remaining slot, three controllers are ingeniously integrated, maximizing space utilization and operational efficiency. Enhancing accessibility and safety, the transparent door grants clear visibility of internal components, while a robust locking mechanism ensures secure containment, meeting stringent safety standards and operational requirements with confidence.

5. METHODOLOGY

The methodology for developing the Intelligent Inventory Management System involves a systematic approach that encompasses several key phases, including research, design, development, testing, and implementation. Below is a detailed methodology outlining the steps involved:

1. Research and Requirement Analysis: Conduct a comprehensive analysis of the requirements for weight-based inventory management. Engage with stakeholders to understand their needs, including inventory managers, warehouse staff, and procurement teams. Identify the types of products to be managed, the frequency of weighing, acceptable margins of error, and regulatory compliance standards. Research various weighing technologies and systems suitable for inventory management, such as load cells, strain gauges, and digital scales. Evaluate the accuracy, precision, scalability, and cost-effectiveness of different weighing methods. Consider factors such as environmental conditions (e.g., temperature, humidity) and the characteristics of the products being weighed.

2. System Design: Design the architecture of the intelligent inventory management system to accommodate weight-based calculations. Specify the hardware components required, including weighing scales, sensors, and data acquisition devices. Design the software components for capturing weight measurements, storing data, and performing calculations to determine inventory quantities. Consider the integration of weight data with other inventory management functions, such as tracking, replenishment, and reporting.

3. Development Phase: Construct a physical prototype of the Intelligent Inventory Management System. Procure and install the necessary hardware components, ensuring they meet the requirements for accuracy, precision, and durability. Develop software modules for interfacing with weighing equipment, collecting weight measurements, and transmitting data to the inventory system. Implement algorithms for converting weight measurements into inventory quantities based on predefined conversion factors or product specifications. Integrate the weight-based inventory calculation functionality with existing inventory management software or enterprise resource planning (ERP) systems.

4. Testing and Validation: Conduct rigorous testing of the intelligent inventory system to ensure accuracy, reliability, and performance. Test the system under various conditions, including different product types, weights, and environmental factors. Validate the accuracy of weight-based inventory calculations against manual counts or alternative measurement methods. Gather feedback from stakeholders and refine the system based on testing results and user input. Monitor the performance of the intelligent inventory management system after deployment, including the accuracy of weight measurements and the reliability of inventory calculations. Collect data on system usage, inventory levels, and operational metrics to identify areas for optimization. Continuously refine algorithms, update software components, and upgrade hardware as needed to improve the efficiency and effectiveness of the system.

6. PROJECT IMAGE

Fig.6.1 Hardware model

7.FINAL OUTPUT AND DISCUSSION:

Fig.7.1 Working of controller

Fig.7.2 Working of project

An intelligent inventory management system keeps track of stock using tools like load cells, a user-friendly touch-screen interface known as HMI SCU, and a PID500-U Controller. The PID500-U Controller ensures optimal inventory management through precise control and maintaining inventory conditions at optimal levels. Load cells act like precise scales, accurately measuring the amount of product in stock. With the HMI SCU screen, users can easily check and manage inventory. This system ensures efficient inventory management, making it simpler to maintain optimal stock levels and reduce time.

8. CONCLUSIONS

The Intelligent Inventory Management System presents a promising avenue for revolutionizing inventory management in manufacturing industries. Its potential to boost productivity highlights its importance in future inventory control strategies. However, further research is necessary to address the security, privacy, and ethical concerns surrounding these systems Schneider Electric's Vijeo Designer software offers a comprehensive solution for developing intuitive Human Machine Interface (HMI) applications in industrial automation. Its user-friendly interface, extensive graphics library, and multimedia support enable users to create visually appealing and functional interfaces tailored to their needs. Integration with Schneider Electric's EcoStruxure architecture ensures interoperability, while features like simulation and remote access enhance efficiency and productivity. Combining a PID 500U controller, a straight bar load cell, and Schneider HMI creates a robust solution for precise process control and monitoring. The PID 500U controller ensures accurate parameter regulation, while the load cell provides reliable weight measurement. The Schneider HMI allows for easy interaction, enabling operators to monitor and adjust parameters effectively. Together, these components enhance productivity and quality in various industrial applications.

REFERENCES

- "Inventory Management: Principles, Concepts and Techniques" by S. N. Maheshwari.
- "Operations and Supply Chain Management" by F. Robert Jacobs and Richard B. Chase.
- "Supply Chain Management: Strategy, Planning, and Operation" by Sunil Chopra and Peter Meindl.
- "International Journal of Production Economics"
- "Journal of Operations Management"
- "International Journal of Physical Distribution & Logistics Management"
- "Computers & Operations Research"
- "Supply Chain Management: An International Journal"
- IEEE Xplore (https://ieeexplore.ieee.org/)
- ScienceDirect (https://www.sciencedirect.com/)
- Google Scholar (https://scholar.google.com/)