IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁒ Peer-reviewed & Refereed journal ⁒ Vol. 14, Issue 1, January 2025

DOI: 10.17148/IJARCCE.2025.14136

LabVIEW based sorting system using conveyor line used in manufacturing industries

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Abstract: The proposed project presents a LabVIEW-based automated sorting system designed for conveyor lines in manufacturing industries, aimed at improving efficiency and accuracy in product sorting. The system utilizes two sensors: one to measure the size of objects and another to detect their position on the conveyor. Based on predefined size criteria, logical operations trigger an actuator to sort objects into designated categories. A graphical user interface (GUI) on the LabVIEW front panel provides real-time monitoring and control, including indicators for size, position, and system activity. This system significantly reduces manual effort, enhances sorting precision, and ensures seamless integration into industrial workflows. Potential applications include quality control, material handling, and packaging, making it a cost-effective solution for automated production lines.

Keywords: automated sorting system, LabVIEW, pneumatic actuators, sensor integration, workflow automation.

I. INTRODUCTION

In modern manufacturing, efficient production and accurate inventory management are essential, but traditional manual sorting methods are often prone to errors, time-consuming, and costly. These processes require labour to categorize products by their features, which can lead to inefficiencies and increased operational costs. As production volumes grow, the need for faster, more accurate sorting mechanisms becomes critical to avoid delays and financial losses. The proposed project addresses these challenges by introducing an automated sorting system that uses sensors, pneumatic actuators, and LabVIEW for control and monitoring. This system categorizes products based on their height, improving speed, accuracy, and reducing reliance on manual labour

The automation of sorting processes offers several benefits, including increased productivity, reduced labour costs, and enhanced operational efficiency. With minimal human intervention, the system ensures precise categorization, while real-time monitoring through LabVIEW enables manufacturers to track performance and make data-driven decisions. This scalable solution not only reduces dependency on skilled labour but also allows workers to focus on more strategic tasks like quality control. Ultimately, this automated system represents a significant leap forward in manufacturing, enhancing workflows, fostering innovation, and improving competitiveness in industries handling large volumes of products.

II. OBJECTIVES

A. Develop a conveyor sorting system that detects and categorizes objects accurately by size to improve sorting precision and reliability

The primary objectgive of this project is to design and implement an automated conveyor sorting system capable of detecting and categorizing objects accurately based on their size. This system aims to replace manual sorting methods, which are often prone to errors and inefficiencies. By leveraging sensors and advanced detection technologies, the project seeks to ensure that objects are classified with high precision, thereby improving the reliability of sorting processes. This objective addresses the industry's need for a dependable solution that minimizes human intervention while enhancing operational efficiency [1].

B. ***Optimize the sorting mechanism to handle objects of similar sizes by enhancing Detection precision and ensuring consistent sorting accuracy***

Sorting objects with similar dimensions is a critical challenge that this project aims to overcome. The objective is to refine the detection mechanism to differentiate objects with minimal size variations accurately. This involves employing high-resolution sensors and optimizing the calibration process to maintain consistent accuracy. By

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addressing this challenge, the project ensures that the sorting mechanism is robust and adaptable to various manufacturing requirements [2].

C. Making the system time efficient

Time efficiency is a crucial factor in modern manufacturing processes. The project aims to design a conveyor system that operates at optimal speeds while maintaining accuracy. This involves integrating advanced control systems and algorithms to synchronize sensor readings with actuator responses, ensuring seamless and rapid sorting. By minimizing processing time without compromising quality, the system contributes to increased productivity and reduced downtime. This objective emphasizes the importance of delivering a solution that not only meets accuracy standards but also aligns with the fast-paced demands of industrial environments [3].

III. PROPOSED METHODOLOGY

For a LabVIEW-based sorting system using a conveyor line in manufacturing industries, the methodology should cover various stages from design to implementation and testing. This will ensure the sorting process is automated, efficient, and reliable. Below is a proposed methodology:

A. Define System Requirements

The project identifies functional needs like sorting objects based on criteria such as size or color using sensors and actuators, ensuring efficient real-time operation. Non-functional requirements focus on reliability, scalability, and robustness for seamless integration into industrial environments.

B. System Design

Hardware includes a motorized conveyor, sensors (proximity, vision, and optional weight), and actuators for sorting. The LabVIEW VIs manage tasks like sensor data processing, motor control, and error handling. This ensures a modular and scalable design.

C. Hardware and Software Integration

LabVIEW interfaces with hardware using NI-DAQmx and calibrates sensors for precise operation. Motors are controlled to regulate conveyor speed, and sorting logic activates actuators to segregate items based on real-time data from sensors.

D. Programming the Control Logic

The control logic implements loops for continuous sensor monitoring, conveyor adjustments, and sorting criteria using LabVIEW. Error handling and safety features like emergency stops enhance system reliability and operational safety.

E. User Interface Design

The LabVIEW front panel offers a user-friendly interface for monitoring and control. Operators can view real-time sensor data, object counts, and system status while managing conveyor speed and troubleshooting issues.

F. Testing and Calibration

Individual components are tested before integration. Calibration ensures accurate sorting, and performance tests evaluate throughput under different conditions. Simulated errors verify the system's ability to recover from faults.

G. Optimization and Maintenance

The system is optimized for throughput and equipped with automated diagnostics for maintenance. User training ensures effective use of the LabVIEW interface and addresses common troubleshooting scenarios.

H. Documentation

Comprehensive documentation includes LabVIEW code explanations, a system manual, and a user guide for the interface. This ensures easy maintenance and understanding of the sorting system's operations.

IV. CORE LOGIC

The block diagram is the core logic of the LabVIEW program, defining how inputs from sensors are processed and how actuators are controlled.

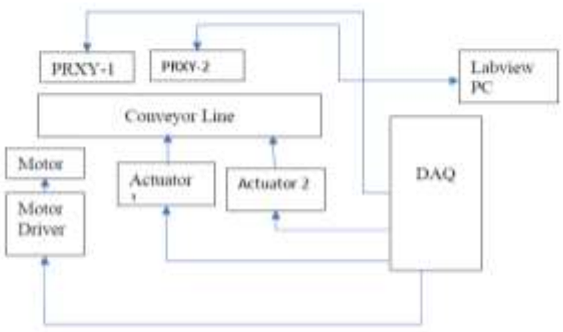

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Fig. 1 Block Diagram (LabVIEW)

Fig. 2 Front Panel

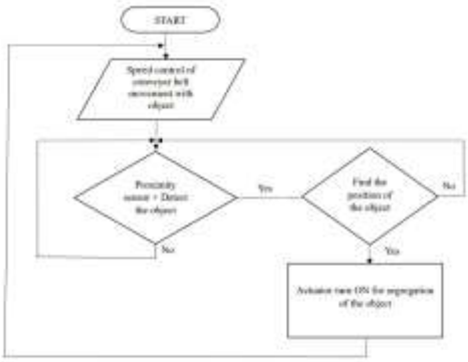

Fig. 3 Flow chart

A. ***Functions used***

1). Task in Function:

Fig. 4 Task in function

Task in specifies the task to which to add the virtual channels this VI creates. If you do not specify a task, NI-DAQmx creates a task for you and adds the virtual channels this VI creates to that task.

2). DAQmx Start Task.vi:

Fig. 5 DAQmx Start Task

Transitions the task to the running state to begin the measurement or generation. Using this VI is required for some applications and is optional for others.

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3). Data (Boolean):

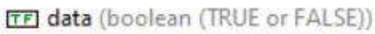

Fig. 6 Data (Boolean)

Data contains a Boolean sample to write to the task.

4). DAQmx Read:

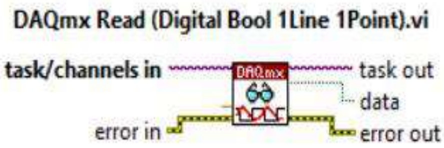

Fig. 7 DAQmx Read

Reads a single Boolean sample from a task that contains a digital input channel composed of a single line.

5). DAQmx Write:

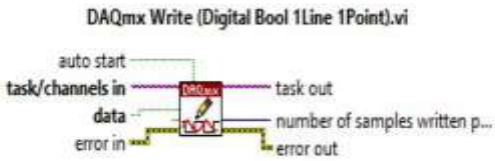

Fig. 8 Flow chart DAQmx Write

Writes a single Boolean sample to a task that contains a digital output channel composed of a single line.

6). DAQmx Stop Task:

Fig. 9 DAQmx Stop Task

Stops the task and returns it to the state the task was in before the DAQmx Start Task VI ran or the DAQmx Write VI ran with the auto start input set to TRUE.

7). DAQmx Clear Task:

Fig. 10 DAQmx Clear Task

Clears the task. Before clearing, this VI aborts the task, if necessary, and releases any resources the task reserved. You cannot use a task after you clear it unless you recreate the task.

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8). Case Structure:

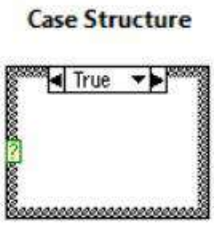

Fig. 11 Case Structure

Contains one or more sub diagrams, or cases, exactly one of which executes when the structure executes. The value wired to the case selector determines which case to execute.

9). While Loop:

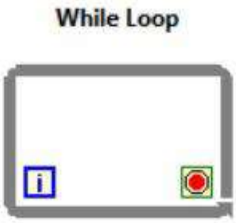

Fig. 12 While Loop

Repeats the code within its sub diagram until a specific condition occurs. A While Loop always executes at least one time.

V. RESULTS AND DISCUSSIONS

Object sensed by proximity sensor 1 (pnp) as object is of the height which is in detectable range by sensor1. (NOTE: If the object is not detected by sesnosr1 , the object will move undisturbed till the end of the conveyor line) as shown in **Fig. 13** below

Fig. 13

The object which was sensed by the sensor 1 is sensed by sensor2 (npn) which stops the rotation of conveyor belt by cutting off the power supply to the motor and triggers the actuator which pushes the object away from the conveyor line

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and the conveyor belt starts rotating again with power being supplied to the mototr . (NOTE: The actuator is triggered only when the object is sensed by both sensor1 and sensor2) as shown in **Fig. 14** below

Fig. 14

Actuator in untriggered state (as shown in **Fig.15** below)

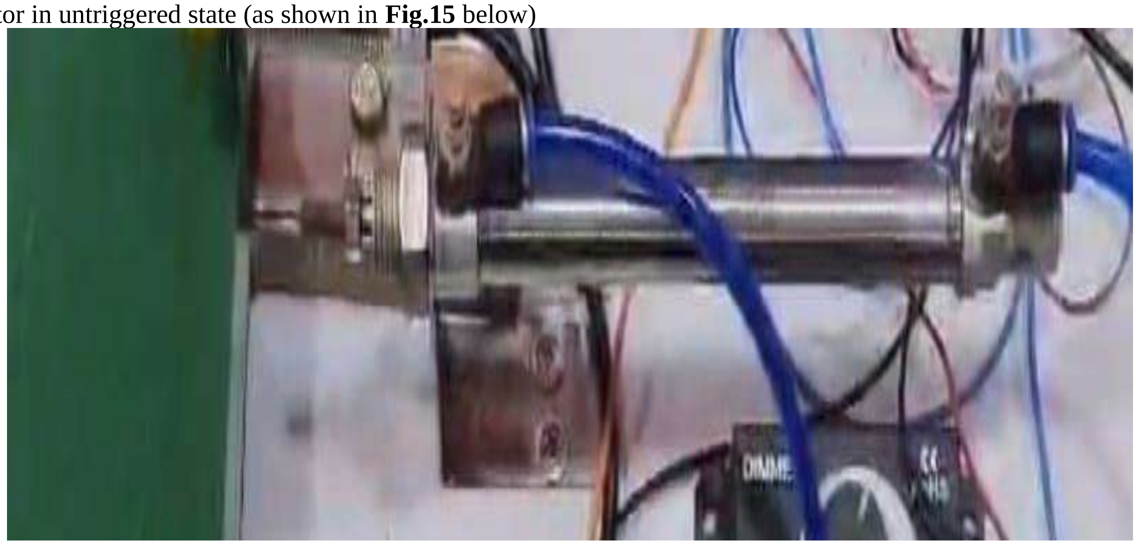

Fig. 15

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Actuator in triggered state (as shown in **Fig.16** below)

Fig. 16

VI. OPTIMIZATION

A. *SORTING ACCURACY AND THROUGHPUT ANALYSIS AT DIFFERENT SPEEDS.*

TABLE I

Speed (RPM)	Sorting Accuracy (%)	Number of Items Sorted
55	98.5	10
65	98.2	12
75	97.8	14
85	97.5	16
95	97.0	18
105	96.8	20
115	96.5	22
125	96.0	24
140	95.8	26
155	95.5	28
170	95.2	30
190	94.8	33
210	94.5	36
230	94.2	39
250	94.0	42

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A. GRAPHICAL RESPRESENTATION.

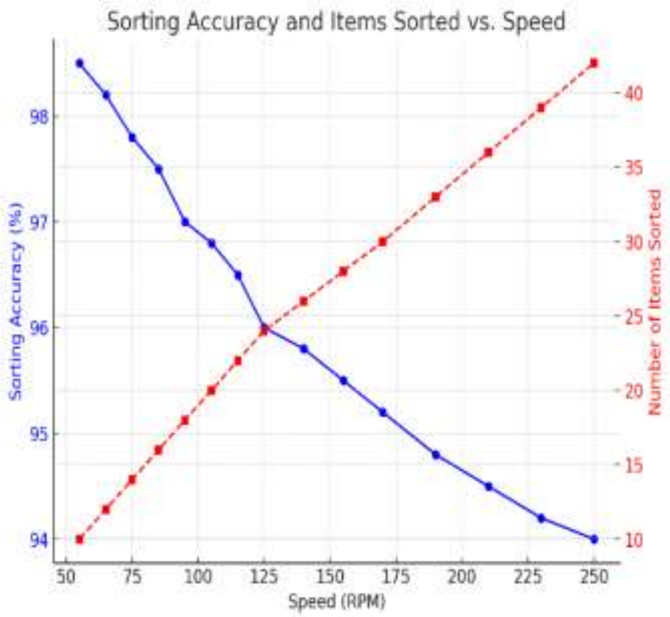

Fig. 17

Optimization in the LabVIEW-based sorting system involves balancing speed, accuracy, and efficiency to achieve the best performance. The table and graph demonstrate that increasing the motor speed results in a higher number of items sorted but reduces sorting accuracy. This trade-off is crucial in selecting the optimal speed where efficiency is maximized without significantly compromising accuracy. Fine-tuning sensor response time and actuator control can help mitigate errors at higher speeds. By analyzing these parameters, the system can be adjusted to meet specific industrial requirements, ensuring both precision and productivity in automated sorting applications.

VII. CONCLUSION

The LabVIEW-based automatic sorting machine significantly improved time efficiency by automating the sorting process and reducing reliance on manual labor. The system's real-time processing capabilities enabled quick identification and classification of objects, ensuring seamless workflow and minimal delays. This enhancement in speed contributed to a higher production rate, making the system suitable for large-scale industrial applications.

Beyond time efficiency, the system demonstrated high accuracy and reliability in sorting objects based on predefined parameters. The integration of sensors and actuators ensured precise detection and movement control, minimizing errors in the sorting process. This accuracy reduced the need for manual inspections, leading to a more consistent and error-free operation.

The project also contributed to cost reduction by lowering labor costs and minimizing sorting errors. Automation reduced human intervention, decreasing the likelihood of misclassification and rework expenses. Additionally, the efficient use of energy and resources further optimized operational costs, making the system a viable solution for industries looking to improve productivity while maintaining cost control.

Overall, this LabVIEW-based sorting system demonstrated a robust and scalable solution for automated manufacturing processes. Its adaptability allows for future upgrades, such as incorporating AI-based decision-making or integrating IoT for remote monitoring. This project highlights the potential of automation in modern industries, paving the way for more intelligent and efficient manufacturing solutions.

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