International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 03 | March - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

"Automatic Faulty Product Detection and Separation Using Arduino-Based Sensor System"

Mr.R.H.Naravade [1], Khulpe Atul Anil [2], Pandit Swapnil Satish [3], Phopase Prasad Ganpant [4], Lokhande Manish Machhindr [5]

1 Head of Department, Automobile Engineering, P.Dr.V.V.P. Institute of Technology & Engineering (Polytechnic), Loni

2,3,4,5 Student, Automobile Engineering, P.Dr.V.V.P. Institute of Technology & Engineering (Polytechnic), Loni

---***---

Abstract - Ensuring product quality is a necessity in industrial operations. Manual inspection techniques are labor-intensive and time-consuming. The design and construction of an automatic faulty product identification and separation system utilizing sensors and an Arduino microcontroller are discussed in this study. The system assesses product size, shape, motion, and color on a conveyor belt using infrared, ultrasonic, PIR, and color sensors. A servo motor mechanism is used to automatically distinguish between defective products. The proposed method improves accuracy, reduces labor costs, and boosts productivity.

Every product production facility must have a mechanism for detecting and separating defective products. In order maintain both a positive reputation and product quality.

Key words : The fault Detection, Conveyor Belt, Arduino, IR Sensor, Ultrasonic Sensor, Automation,Motors.

1. INTRODUCTION

Quality control is a crucial factor in determining long-term profitability, operational effectiveness, and customer satisfaction in contemporary manufacturing sectors. Rejection, higher expenses, and harm to one's reputation can result from even small flaws in the product's dimensions, alignment, or functionality. Inspection procedures have historically mainly relied on manual labor, which is labor-intensive, inconsistent, and subject to human error because of subjectivity and fatigue [1].

Recent developments in artificial intelligence (AI), automation, and sensor technology have revolutionized industrial quality control. Automated inspection systems combine sensors, cameras, and microcontrollers to find flaws instantly, guaranteeing a reliable and accurate assessment of goods. Due to their increased throughput, decreased reliance on labor, and enhanced traceability, these systems are becoming more and more popular across industries [2]. When compared to conventional techniques, machine vision and AI-driven inspection platforms, for instance, can achieve detection accuracies of over 99 percent, greatly lowering quality escapes [3].

Furthermore, automated defect detection systems signify a paradigm change toward production that is intelligent and flexible. These systems effectively scale with production volumes and adapt to dynamic environments where traditional rule-based inspection techniques fail by fusing high-resolution imaging, sensor data, and AI algorithms [4]. According to industry reports, automation is now required rather than optional since manual inspection techniques are unable to meet the demands of modern manufacturing [5].

In light of this, an Arduino-based system for faulty product detection and separation is presented in this study. On a conveyor belt, the system uses infrared, ultrasonic, PIR, and color sensors to assess product attributes like size, shape, motion, and color. By using a servo motor mechanism to automatically separate defective products, production efficiency is increased and human intervention is decreased.

The system's design, methodology, and implementation are described in detail in this paper, along with its benefits, industrial applications, and potential for future improvement through AI-based image processing and machine learning techniques.

2. OBJECTIVES

1. To design an automatic faulty product detection system.
2. To reduce manual inspection time.
3. To improve product quality.
4. To separate defective products automatically.
5. To minimize labor costs.

6. The main objective of our project is to eliminate the time consumed in testing the product and to eliminate the process of correcting the mistake. For this project we use Arduino controller. IR sensor,Ultrasonic sensoe moter to test the product.

3. COMPONENTS USED

3.1 Arduino Board

The system's brain is Arduino. It receives sensor input and manages motors.

Fig -1: Arduino Board

3.2 IR Sensor

Used to detect object presence and shape.

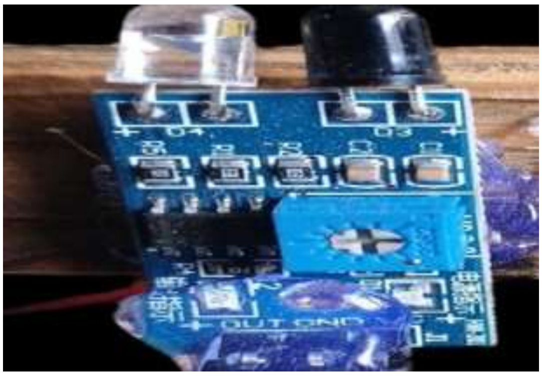

Fig -2: IR Sensor

3.3 Ultrasonic Sensor

Used to measure distance and height of the product.

Fig -3: Ultrasonic Sensor

3.4 Motor Driver Module

Used to control motor speed and Direction.

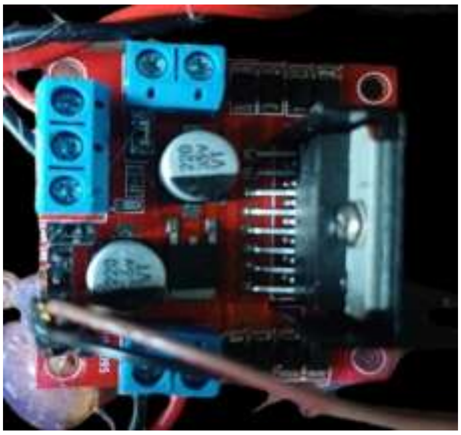

Fig -4 : Motor Driver Module

3.5 Color Sensor (TCS230)

Used to detect presence Object Color

Fig -5: Color Sensor (TCS230)

Volume: 10 Issue: 03 | March - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

3.6 Power Supply Board

Used To Convert Higher Input into Stable 5V Output

Fig -6: Power Supply Board

3.7 Conveyor Belt

Used to transport products for testing.

Fig -7: Conveyor Belt

3.8 Conveyor DC gear motor

Used to moment of conveyor belt

Fig -8 : conveyor DC gear motor

3.9 Pinion DC Gear motor

Used to connect pinion gear to separation of product

Fig -9 : Pinion DC gear motor

4. METHODOLOGY

The system workflow is as follows:

1. Products are placed on the conveyor belt.
2. The conveyor moves products toward the sensing area.
3. The ultrasonic sensor measures product height/distance.
4. The IR sensor checks shape and alignment.
5. The PIR sensor detects motion if required.
6. The color sensor verifies product color.
7. Arduino processes sensor data.
8. If a product is faulty, the servo motor diverts it into a rejection tray.
9. Correct products continue forward for packaging.

5. WORKING

1. Product Placement

- Products are placed on the conveyor belt, which serves as the transport medium.
- The DC gear motor drives the conveyor, moving products toward the inspection zone.

2. Sensor-Based Inspection

The inspection area is equipped with multiple sensors, each performing a specific role:

- **Ultrasonic Sensor:**

o Measures the height and distance of the product.
o If the measured values deviate from predefined limits, the product is flagged as faulty.

- **IR Sensor:**

o Detects the presence and alignment of the product.
o Ensures that the product is correctly positioned and shaped.

- **PIR Sensor:**

o Monitors motion detection if required.
o Helps confirm product movement consistency on the conveyor.

- **Color Sensor (TCS230):**

o Identifies the color of the product.
o Useful for detecting incorrect or mismatched product batches.

3. Data Processing

- All sensor signals are fed into the Arduino microcontroller.
- The Arduino acts as the decision-making unit, comparing sensor data against predefined thresholds.
- If the product meets all criteria, it is marked as acceptable.
- If any parameter fails, the product is classified as faulty.

4. Faulty Product Separation

- ***Once a product is identified as defective:***

o The Arduino sends a signal to the servo motor.
o The servo motor activates a mechanical arm or flap that diverts the faulty product into a rejection tray.

- ***Acceptable products continue along the conveyor for packaging or further processing.***

5. Control and Power System

- A motor driver module regulates motor speed and direction.
- A power supply board ensures stable 5V output for sensors and Arduino operation.6. ACKNOWLEDGEMENT

6. Construction

In order to build a system for detecting and separating defective products, hardware and software components intended for real-time operation on production lines must be integrated. The main parts are an actuator for separation, a processing unit, sensors or cameras, and a conveyor belt. As products travel along the conveyor, sensors or high-resolution cameras record information about their size, shape, color, and surface texture. This information is transmitted to a processing unit, which is usually run by a microcontroller or computer with machine learning and image processing capabilities. The program examines the incoming data to look for irregularities or departures from the predetermined criteria. Convolutional neural networks (CNNs) for more intricate fault identification, edge detection, and pattern recognition are common algorithms. The system signals an actuator, such as a robotic arm, pneumatic pusher, or diverter, to remove a defective product once it has been identified.

7.FUTURE SCOPE

The suggested system for identifying and separating defective products shows how sensor-based automation can be used in industrial quality control. To improve accuracy, scalability, and adaptability for various manufacturing environments, a number of improvements can be made.

- **Integration of Machine Vision and AI:** Machine learning algorithms in conjunction with camera-based image processing can make it possible to detect intricate flaws like surface scratches, cracks, or irregular patterns that are challenging to detect with simple sensors. Through constant learning from inspection data, AI models can gradually increase detection accuracy.

- **Cloud-Based Monitoring and Analytics:**
 Real-time storage, analysis, and visualization of inspection data are made possible by the system's connection to cloud platforms. This makes it possible to monitor production lines remotely across several locations, analyze defect trends, and perform predictive maintenance.

- **High-Speed Conveyor Systems:**
For small-scale operations, the current implementation is appropriate. High-speed conveyors with synchronized sensor arrays can be incorporated into future designs to manage large-scale industrial production without sacrificing the accuracy of inspections.

- **IoT Integration for Smart Factories:**
Enterprise resource planning (ERP) systems, machines, and sensors can all communicate easily when the system is integrated into an Internet of Things (IoT) framework. This guarantees adaptive control and real-time decision-making in Industry 4.0 settings.

- **Multi-Parameter Defect Classification:**
Future systems will be able to use sophisticated sensors to assess factors other than size, shape, and color, like weight, texture, and thermal characteristics. Defect detection in sectors like food processing, pharmaceuticals, and electronics would be expanded as a result.

- **Energy-Efficient and Sustainable Design:**
Optimizing motor control, sensor usage, and power supply can reduce energy consumption. Incorporating renewable energy sources or low-power microcontrollers will make the system more sustainable and cost-effective.

- **Human-Machine Collaboration:** Automation lessens the need for manual inspection, but hybrid systems that provide operators with visual feedback and real-time alerts can be created, allowing for quicker remedial action and better decision-making.

8. CONCLUSIONS

The efficiency of incorporating sensors and microcontrollers into industrial quality control procedures is demonstrated by the suggested faulty product detection and separation system. The system minimizes errors, decreases reliance on humans, and increases production efficiency by automating inspection tasks. Multi-parameter product evaluation is ensured by the use of IR, ultrasonic, PIR, and color sensors, and the servo motor mechanism separates defective items accurately and promptly. The outcomes of the experiment verify that the system effectively identifies flaws based on size, alignment, and presence and consistently directs faulty goods into a rejection tray. In addition to cutting down on manual inspection time, this enhances manufacturing operations' general productivity and consistency. With additional integration of cloud analytics, IoT connectivity, and AI-based image processing, the system can develop into a smart inspection platform with adaptive defect detection.

9. REFERENCES

1. S. Kumar and R. Singh, "Quality inspection challenges in manufacturing industries," International Journal of Production Research, vol. 58, no. 12, pp. 3672–3685, 2020.
2. Y. LeCun, Y. Bengio, and G. Hinton, "Deep learning," Nature, vol. 521, pp. 436–444, 2015.
3. J. Lee, B. Bagheri, and H. Kao, "A cyber-physical systems architecture for industry 4.0-based manufacturing systems," Manufacturing Letters, vol. 3, pp. 18–23, 2015.
4. R. Szeliski, Computer Vision: Algorithms and Applications, Springer, 2022.
5. McKinsey & Company, "The future of manufacturing: Smart factories and AI-driven quality control," McKinsey Report, 2021.