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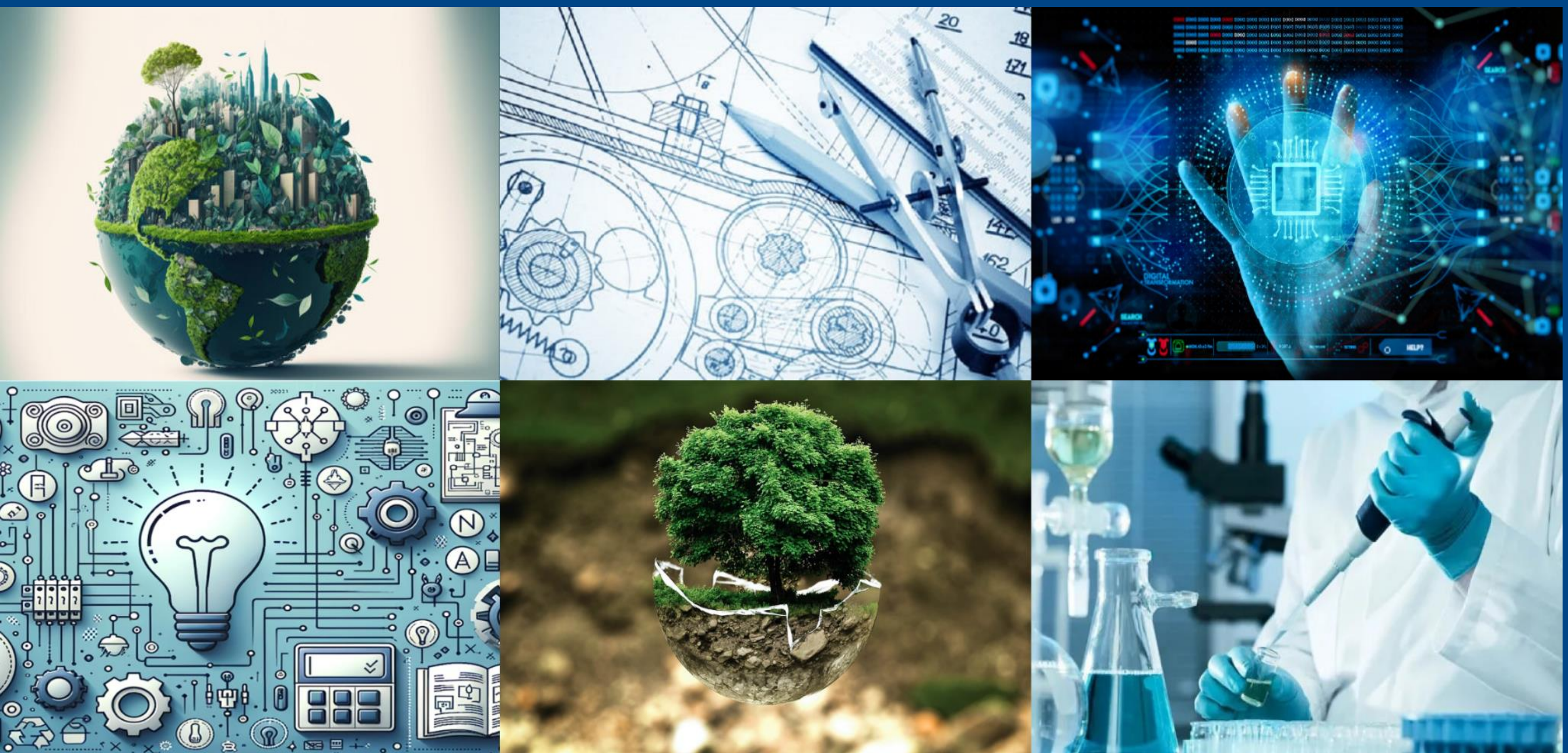

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Gauge Automation for Automatically Check Job.

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ABSTRACT: The Automated Spectacle Plate Inspection Machine is a microcontroller-based system designed to measure and classify spectacle plates based on their dimensional accuracy. The system uses two LVDT probes to precisely measure the inner and outer diameters of each spectacle plate. These probes are actuated using a 100mm stroke pneumatic cylinder, ensuring accurate contact with the measurement points. A second 150mm stroke pneumatic cylinder is used to push the inspected plate forward after classification.An Arduino Nano acts as the main controller, processing the analog signals from the LVDT probes, displaying the measurements on an LCD, and comparing them with predefined standard values. Based on the comparison, the machine classifies each plate into one of three categories: OK size, Over size, or Under size. A motorized conveyor feeder is employed to supply spectacle plates to the inspection station automatically, enhancing inspection speed and reducing manual handling.This project offers a robust and low-cost solution for automated inspection and quality control in industrial environments, especially where high accuracy and repeatability are required.

I. INTRODUCTION

In modern manufacturing industries, precision and consistency in component dimensions are critical for ensuring product quality and proper assembly. Manual inspection methods are often time-consuming, prone to human error, and unsuitable for high-volume production lines. To address this challenge, the **Automated Spectacle Plate Inspection Machine** is developed as a reliable and efficient solution for inspecting the inner and outer diameters of spectacle plates.

This machine is designed to automate the inspection process using Linear Variable Differential Transformer (LVDT) probes, pneumatic actuators, and an Arduino Nano microcontroller. The system ensures accurate measurement, real-time display, and intelligent classification of each spectacle plate as **OK size**, **Over size**, or **Under size**. The use of a motorized conveyor feeder ensures a continuous supply of plates into the system, enhancing throughput and reducing manual labor.

By integrating sensor-based measurement with automated control, the machine provides a cost-effective andscalable solution for quality control in mechanical and fabrication industries, where spectacle plates are commonly used in piping and pressure vessel applications.

II. LITEATURESURVEY

Automated inspection technologies have seen significant advancements in recent years, particularly in the context of dimensional accuracy and defect detection for metal components such as spectacle plates. Several studies have investigated various approaches, ranging from traditional image processing to AI-driven inspection systems.

Lee and Park (2018), in their study *"Automated Optical Inspection in Manufacturing"*, investigated the use of high-resolution cameras and advanced image processing algorithms to detect dimensional deviations and surface defects in industrial components. Their findings highlighted the potential of camera-based inspection for real-time quality control.

Patel and Shah (2020), through their work *"Machine Vision for Quality Control in Metal Parts"*, focused on implementing contour and edge detection techniques specifically for measuring inner and outer diameters (ID and OD) of circular parts such as spectacle plates. Their research emphasized the accuracy and repeatability of machine vision in diameter measurement.

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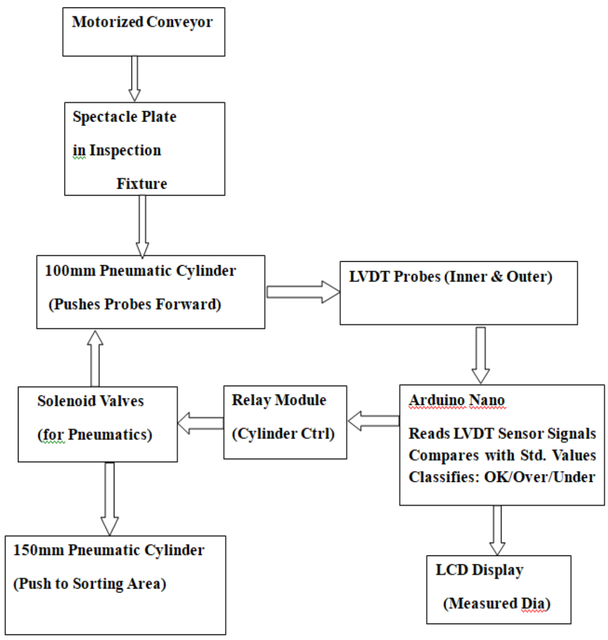
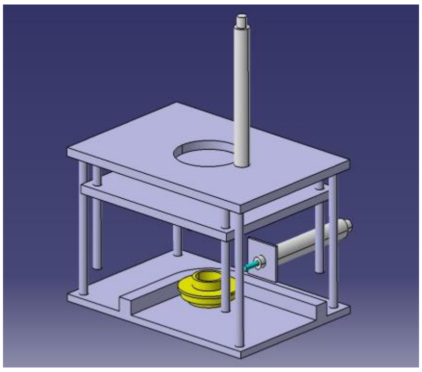
Yadav and Mehta (2019), in *"A Review on Industrial Inspection Using Image Processing"*, conducted a comprehensive survey of various image processing techniques including thresholding, blob detection, and shape analysis. These methods were identified as critical components of modern automated inspection systems.Zhang and Xu (2017), in their paper *"Use of Computer Vision for Dimensional Inspection in Fabrication"*, explored the deployment of vision-based tools in real-time fabrication environments. They demonstrated that computer vision systems could provide rapid, non-contact inspection suitable for high-throughput scenarios.Singh and Kumar (2021), in *"Smart Inspection Systems in Industry 4.0"*, examined the integration of Internet of Things (IoT) platforms and Programmable Logic Controllers (PLCs) with image processing units. They concluded that such smart systems can significantly enhance defect detection capabilities and facilitate automated quality assurance.Thomas and Fischer (2016), in their comparative study *"Laser-Based Measurement Techniques for Plate Inspection"*, evaluated the performance of traditional gauges against modern laser scanning technologies. Their findings emphasized that laser-based systems offer superior accuracy, speed, and non-contact operation.Roy and Sutar (2022), in *"Automatic Defect Detection in Metal Components Using AI"*, proposed the application of neural networks for classification of dimensional defects. Their AI-driven approach showed significant promise in automating both detection and decision-making in inspection lines.Gupta and Bhatt (2018), in *"Non-Contact Dimensional Inspection Using Vision Systems"*, analyzed high-peed camera systems designed for precise ID and OD measurement. Their study concluded that vision systems, when properly calibrated, can outperform conventional contact-based methods in speed and consistency.Das and Dey (2019), in *"Review on Automated Dimensional Inspection Methods"*, presented a comparative analysis of coordinate measuring machines (CMMs), laser scanners, and vision systems. Their review underscored the advantages of non-contact methods in modern manufacturing setups.Ramesh and Nair (2023), in *"Intelligent Manufacturing with Vision-Based Inspection"*, explored the implementation of intelligent, vision-based inspection systems within high-volume manufacturing environments. Their research highlighted the role of machine learning and adaptive control in enhancing inspection precision and flexibility.Collectively, these studies confirm the growing importance and effectiveness of automated, non-contact inspection systems in ensuring the quality and dimensional integrity of components like spectacle plates in contemporary manufacturing industries.

III. BLOCK DIAGRAM





IV. METHODOLOGY

The development of the Automated Spectacle Plate Inspection Machine follows a systematic and structured engineering approach. The entire process is divided into distinct phases, each focusing on a specific part of the system—from component selection to implementation, integration, and testing.

1. System Design and Planning

- **Requirement Analysis**: Identified key functional requirements such as measuring inner and outer diameters, automatic classification, job handling, and real-time display.

- **Component Selection**: Based on cost, accuracy, and availability:

Arduino Nano: Main controller for system logic.

- **LVDT Sensors**: For precise measurement of diameters.
- **Pneumatic Cylinders**: 100mm for LVDT probe pressing; 150mm for job ejection.
- **Motorized Conveyor**: For job feeding.
- **16x2 LCD Display**: To show diameter values and result status.

2. Mechanical Setup

- Designed a **fixture** to hold the spectacle plate during inspection.
- Installed **LVDT probes** with a movable mechanism actuated by the 100mm pneumatic cylinder to reach the measuring points.
- Mounted the **150mm pneumatic cylinder** for pushing inspected jobs to sorting zones.

3. Sensor Integration

- LVDT sensors were connected to the Arduino via signal conditioning circuits.
- Performed **calibration** to correlate voltage outputs to exact dimensional values (in mm).
- Implemented **noise filtering** using software averaging techniques to increase accuracy.

4. Control System Programming

Developed firmware using Arduino IDE to:

- Read analog values from LVDT sensors.
- Convert analog readings to physical dimensions.
- Compare measured values with preset standards and tolerances.
- Trigger pneumatic cylinders based on inspection results.
- Update the LCD with real-time measurements and status (OK, Over Size, Under Size).

5. Pneumatic Circuit Design

- Integrated **5/2 solenoid valves** controlled by Arduino through relays to actuate the cylinders.
- Designed the circuit to allow sequential operation: probe engagement → measurement → classification push.

6. Conveyor Integration

- Motorized feeder synchronized with the control system to automatically feed one spectacle plate at a time into the inspection zone.

7. Testing and Validation

- Tested the system with multiple spectacle plates of known dimensions.
- Validated the measurement accuracy by comparing Arduino readings with vernier caliper data.
- Tuned the software logic to handle minor measurement fluctuations and ensure correct classification.

8. Safety and Fail-Safe Mechanisms

- Implemented delays and limit checks in software to avoid misfiring of cylinders.
- Emergency stop mechanism added for manual override during testing.

V. RESULT

The **Automated Spectacle Plate Inspection Machine** was successfully developed and tested to inspect the **inner and outer diameters** of spectacle plates with high accuracy using LVDT sensors and Arduino Nano. The system achieved the following results:

1. **Accurate Measurement Output**
2. **Real-time Data Display**
3. **Automatic Classification**
4. **Efficient Sorting Operation**
5. **Reliable and Repeatable Operation**

VI. CONCLUSION

The Automated Spectacle Plate Inspection Machine was successfully developed using LVDT probes, pneumatic actuators, and an Arduino Nano for accurate and fast measurement of inner and outer diameters. It automatically classifies plates as OK, Oversize, or Undersize, reducing manual effort and inspection time. With real-time display, automated sorting, and easy programmability, the system is cost-effective, low-maintenance, and ideal for mass production and quality control.

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