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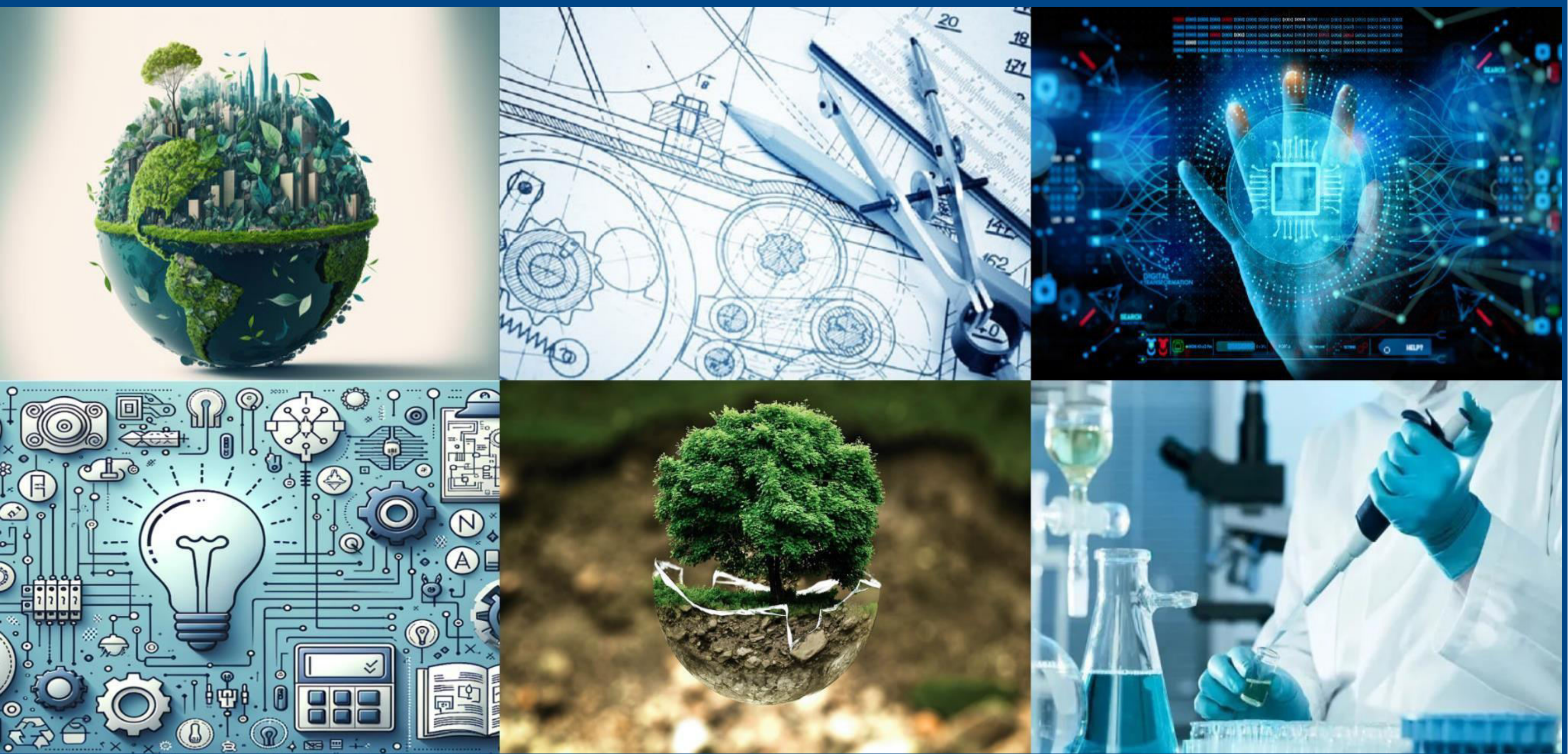

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Gear Testing Machine

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ABSTRACT: Gear testing is an essential process in assessing the accuracy and reliability of gears used in mechanical systems. This project presents the design and development of a semi-automatic Parkinson gear testing machine that streamlines the measurement of critical gear parameters, including pitch circle diameter, concentricity, gear tooth finish, and the number of teeth.

The system is built around a NEMA 17 stepper motor, which rotates a standard gear to drive the testing gear. A 1-micron dial gauge is employed to measure concentricity and tooth finish with high precision. Two rotary encoders are integrated—one connected to the standard driving gear and the other to the gear under test—to calculate essential parameters such as the pitch circle diameter and number of teeth.

The machine's operation is controlled by an Arduino Nano microcontroller, which processes input data from sensors and encoders. Results are displayed on a 16x4 LCD screen, providing clear and immediate feedback to the user. An MG995 servo
motor facilitates the engagement and disengagement of the gear under test, ensuring seamless operation. The system also includes two user-friendly buttons for start/stop and pause functions.

This semi-automatic setup reduces manual intervention, minimizes human error, and offers precise, repeatable measurements, making it an efficient solution for industrial gear testing and academic research applications. The project demonstrates the successful integration of mechanical systems, sensors, and microcontroller-based automation to achieve accurate and reliable gear testing.

I. INTRODUCTION

Gear testing plays a crucial role in ensuring the quality, precision, and reliability of gears used in various mechanical systems. Among the many techniques available, Parkinson gear testing is a widely accepted method to evaluate gear parameters such as pitch circle diameter, concentricity, gear tooth finish, and the number of teeth. Traditional gear testing methods are often manual, time-consuming, and prone to human error. To address these challenges, this project aims to develop a semi-automatic Parkinson gear testing machine that combines precision measurement tools with automation to enhance efficiency and accuracy.

The machine employs a NEMA 17 stepper motor to rotate a standard gear, which drives the gear under test. A 1-micron dial gauge is used to measure critical parameters like concentricity and gear tooth finish. Two rotary encoders are integrated into the system— one connected to the standard driving gear and the other to the testing gear—to calculate parameters such as pitch circle diameter and the number of teeth with high accuracy.

At the heart of the system lies an Arduino Nano microcontroller, which processes input data from sensors and encoders and displays the results on a 16x4 LCD screen. An MG995 servo motor is utilized for engaging and disengaging the gears during operation, ensuring smooth transitions. Additionally, user interaction is streamlined through the provision of two buttons, enabling start/stop and pause functionality.

This semi-automatic machine not only simplifies the gear testing process but also offers precise measurements, making it an ideal tool for industrial applications and academic research. The project highlights the integration of mechanical, electrical, and software components to create an efficient and reliable gear testing solution.

II. METHODOLOGY

The development of the semi-automatic Parkinson gear testing machine involves a systematic approach, integrating mechanical components, precision instruments, and microcontroller based automation. The methodology is outlined as follows:

1. System Design and Components Integration

- Mechanical Framework: Design a robust mechanical setup to securely hold the standard gear and the gear under test. Ensure precise alignment to minimize mechanical errors.
- Drive Mechanism: Use a NEMA 17 stepper motor to rotate the standard gear, which drives the testing gear. The stepper motor provides precise rotational control, essential for accurate measurements.
- Measurement Tools: o A 1-micron dial gauge is incorporated to measure concentricity and gear tooth finish. o Two rotary encoders are connected to the standard driving gear and the testing gear to measure pitch circle diameter and the number of teeth.

2. Control System Development

- Microcontroller: Use an Arduino Nano to control and process data from the dial gauge and rotary encoders. The Arduino Nano also manages user inputs and servo motor operation.
- Actuation: An MG995 servo motor is employed for engaging and disengaging the testing gear with the standard gear.
- User Interface: A 16x4 LCD display is used to present the measured parameters, while two buttons provide start/stop and pause functionalities.

3. Software Implementation

- Motor Control: Develop code for the Arduino Nano to control the NEMA 17 stepper motor and MG995 servo motor.
- Data Processing: Write algorithms to process inputs from rotary encoders and the dial gauge for calculating pitch circle diameter, concentricity, and number of teeth.
- User Interaction: Implement code to handle button inputs and display results on the LCD screen in a user friendly format.

4. Calibration and Testing

- Calibrate the rotary encoders and dial gauge to ensure accurate readings.
- Perform initial tests using gears with known specifications to validate the accuracy and reliability of the machine.

5. Optimization and Final Assembly

- Optimize the system for smooth operation, reducing vibrations and ensuring consistent measurements.
- Assemble the components into a compact, durable design for ease of use and transport.

6. Documentation and Analysis

- Document the design, assembly, and testing processes for inclusion in the final report. • Analyze the system's performance and compare it with conventional gear testing methods to evaluate improvements in efficiency and accuracy.

III. DESIGN PROCEDURE

The design of the Gear Testing Machine follows a structured approach to ensure precision, reliability, and efficiency.
The procedure is divided into key steps:

1. Requirement Analysis

- Define the parameters to be measured: o Concentricity o Pitch circle diameter (PCD) o Number of teeth o Gear eccentricity o Backlash
- Determine the accuracy required for the measurements.
- Choose a cost-effective solution with high precision and automation.

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2. Mechanical Design

- Gear Holding Mechanism:
  - o Design a rigid frame to hold both the standard gear and testing gear securely.
  - o Ensure alignment between the gears to avoid measurement errors.

- Stepper Motor Mounting: o Securely position the NEMA 17 stepper motor to drive the standard gear. o Provide sufficient torque for smooth rotation.

- Digital Dial Gauge Placement:
  - o Design an adjustable mount to position the digital dial gauge accurately.
  - o Ensure that it makes precise contact with the gear surface.

- Rotary Encoder Integration:

o Place two incremental rotary encoders to track the rotation of both the standard and testing gears. o Ensure a non-slip connection to gears. • LCD Display and Control Panel:

- Mount the LCD screen and control buttons in an accessible location.

IV. PHOTOGRAPH

V. CONCLUSION

The development of the semi-automatic Parkinson gear testing machine represents a significant advancement in precision gear testing. By integrating mechanical, electronic, and software components, the machine delivers accurate, efficient, and reliable measurement of critical gear parameters such as pitch circle diameter, concentricity, gear tooth finish, and the number of teeth. The use of a NEMA 17 stepper motor, rotary encoders, a 1-micron dial gauge, and an MG995 servo motor ensures precise operation and measurement accuracy. The Arduino Nano serves as the central controller, effectively processing data and displaying results on a user-friendly 16x4 LCD screen. The inclusion of start/stop and pause buttons adds operational convenience, making the system intuitive and easy to use. This machine addresses the limitations of traditional manual gear testing methods by reducing human error, enhancing repeatability, and saving time. Its compact and cost-effective design makes it a versatile tool for small-scale industries, workshops, and academic research. Additionally, its modular structure allows for future upgrades and scalability, ensuring adaptability to evolving requirements. In conclusion, the semi-automatic Parkinson gear testing machine successfully bridges the gap between manual testing and high-cost automated solutions, offering a practical and efficient alternative for gear quality assurance. This project underscores the potential of combining mechanical engineering principles with modern automation to create innovative and impactful solutions.

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