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Development of Arduino Based Motorized Test Stand

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Abstract

This project develops an Arduino-based motorized test stand for precise force measurement and testing applications. The system is built around an Arduino microcontroller, which controls the movement of a CM Series Stepper Motor through the EM1 Series Stepper Drive. Force measurement is carried out using an S Beam Load Cell, providing real-time force feedback, while a Digital Force Gauge enhances measurement accuracy. An LCD display is used to present the collected data, ensuring easy monitoring for users. The system is programmed and integrated using the Arduino IDE, enabling precise motor control and force readings. This setup allows for automation and high repeatability in mechanical testing, making it suitable for material characterization and force analysis in both research and industrial applications. The proposed test stand offers a cost-effective and efficient solution for automated force measurement.

Keywords: Arduino microcontroller, sensors, speed, torque, displacement, force, test protocols, automate test cycles, and monitor real-time data, small-scale product development, and prototyping.

1.Introduction

The Arduino-Based Motorized Test Stand project is designed to provide a cost-effective, flexible, and automated solution for testing mechanical components like motors, actuators, and materials. Mechanical testing is essential in fields such as research, engineering, and quality control to understand how materials perform under different conditions. However, traditional test stands are often expensive and hard to customize. This project leverages the power of Arduino, an open-source microcontroller, to create an affordable and scalable testing platform that is user-friendly and adaptable to various testing needs. Known for its simplicity and extensive support community, Arduino is ideal for developing a customizable test stand that's both low-cost and accessible. The test stand integrates motors, sensors, and actuators to apply controlled motion or forces to the specimen. Real-time data, including speed, torque, force, and displacement, are captured through sensors such as rotary encoders, load cells, and strain gauges. This enables users to monitor and analyze the performance of components under realistic testing conditions. By automating the test process, the system minimizes human error, ensures repeatability, and increases efficiency, leading to consistent and accurate results. In conclusion, this Arduino-based solution offers a powerful, low-cost alternative to traditional test stands, providing an accessible, scalable platform for students, engineers, and researchers to conduct precise mechanical tests.

2.Methodology

The methodology involves designing, assembling, programming, and calibrating components to create an automated, customizable mechanical testing platform.

2.1 System Design and Conceptualization

The project identifies key parameters (speed, torque, force, displacement), creates a modular design for component integration, ensuring stability, performance, and future upgradability for customization.

2.2 Hardware Selection and Integration

The Arduino microcontroller, stepper/DC motors, sensors (encoders, load cells, displacement), and a stable frame ensure precise, reliable testing with minimal vibration.

2.3 Software Development

Custom Arduino code controls motors, collects sensor data, automates test cycles, and provides a user interface to display real-time parameters for repeatable testing.

2.4 System Assembly and Integration

The system is assembled, sensors calibrated, and electrical connections made to ensure accurate data collection before testing.

3. Hardware Implementation

The hardware implementation involves selecting and integrating an Arduino microcontroller, stepper/DC motors, sensors (rotary encoders, load cells, displacement), and a mechanical frame. These components work together to enable precise motor control and accurate data measurement.

3.1 Arduino Microcontroller

The Arduino microcontroller is an open-source, affordable platform widely used for prototyping. It offers ease of programming, compatibility with various sensors, and is ideal for controlling motors and automating systems.

3.2 Stepper Motor

A stepper motor is a type of motor that moves in discrete steps, providing precise control of rotation. It's commonly used in applications requiring accurate positioning, such as automation systems.

3.3 Rotary Encoders

Rotary encoders are sensors that detect rotational position and speed. They convert mechanical motion into electrical signals, providing feedback for precise control in motors and automation systems.

3.4 Load Cell

A load cell is a sensor that measures force or weight. It converts mechanical load into an electrical signal, commonly used for force, weight, and pressure measurements.

4.Advantages of Arduino Based Motorized Test Stand

The Arduino-based motorized test stand offers affordability, flexibility, and ease of use. It provides precise control over testing parameters, enables automation for repeatability, is highly customizable, supports real-time data collection, and is ideal for educational and research applications.

5. Challenges and Solutions

5.1 Component Integration

Ensuring seamless integration of various components.

Solution: Use standardized components and thorough documentation to design the system architecture.

5.2 Sensor Accuracy

Achieving precise measurements of force, torque, speed, and displacement.

Solution: Calibrate sensors thoroughly and use high-quality, well-calibrated sensors.

5.3 Test Protocol Customization

Allowing users to program and customize test protocols can introduce complexity in both hardware and software.

Solution: Develop a simple programming interface for users to input parameters. Offer pre-configured testing templates for common tests to reduce complexity.

6. Applications

Arduino based motorized test stand are widely used in aerospace, automotive, and R&D sectors.

6.1 Manufacturing and Production

In manufacturing, the test stand ensures quality control, material testing, and evaluates mechanical components like motors, actuators, gears, and structural parts before production.

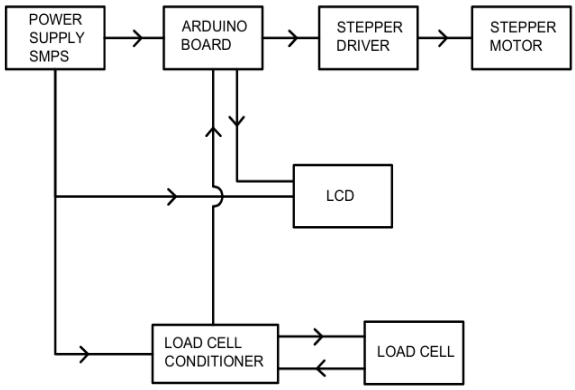
6.2 Automotive

Automotive manufacturers use the test stand to evaluate suspension systems, shock absorbers, gears, and motors for strength, durability, and performance.

6.3 Aerospace

In aerospace, the test stand conducts material, fatigue, and performance testing of components to ensure safety and reliability.

7. Block diagram



8. Conclusion

The Arduino-Based Motorized Test Stand project successfully created an affordable, customizable, and automated mechanical testing system for educational institutions, research labs, and small businesses. By leveraging the Arduino platform, the test stand provides a reliable solution for various tests like tension, compression, and material fatigue. The integration of motors, sensors, and real-time data collection ensures accurate measurements and repeatability. The system's adaptability allows users to modify test parameters, and the simple interface makes it accessible to users with minimal expertise.

Appendix

A. Stepper Motor Specifications

- Flange Size – 57mm
- Length – 65mm
- Holding Torque – 1.3 N/m
- Rated Current – 4A

B. Stepper Drive Specifications

- Dimension (L*W*H) - 86*55.5*20.5
- Input Voltage - 20~36Vdc
- Current Output - 2.2A
- Pulse Voltage Input - 5~24Vdc

C. Weight indicator Specifications

- Power Output - 4 V
- Measuring Range - -4 to +4 mV/V
- D/A Convertor - 24 bit
- Display - 5 digit, 7 segment, LED
- Linearity - < 0.01% of full scale

D. S-Beam Load Cell Specifications

- Rated capacity – 25Kg to 1 Tonne
- Rated output – 3.0 mV/V
- Input impedance - 343–450 Ω
- Output impedance - 349–355 Ω

E. Power Supply Specifications

- Stepper Motor Driver - 24V DC
- CM Series Stepper Motor - 24V DC
- Arduino Uno - 5V DC
- Load Cell + HX711 - 5V DC

- LCD Display

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REFERENCES

1. Afrin, S. Roksana and R. Akram, "AI-Enhanced Robotic Process Automation: A Review of Intelligent Automation Innovations," in IEEE Access, vol. 13, pp. 173-197, 2025
2. Chang, "Design and Applications of Novel Enhanced-Performance Force Sensor," in IEEE Sensors Journal, vol. 16, no. 12, pp. 4665-4666, June15, 2016
3. Cherkasova, "Modeling and Development of a Load Cell Control System with Electromagnetic Force Compensation," 2019 III International Conference on Control in Technical Systems (CTS), Russia, 2019, pp. 121-125.
4. Chimehi and B. Wallace, "Load Cell Force and Direction Sensor System for Push Bars," 2022 IEEE Sensors Applications Symposium (SAS), Sundsvall, Sweden, 2022, pp. 1-6.
5. Choi, "A Highly Power-Efficient LED Back-Light Power Supply for LCD Display," in Journal of Display Technology, vol. 9, no. 5, pp. 382-387.