ELECTRIC TENSILE MACHINE RESEARCH REPORT

https://github.com/CNCKitchen/Open-Pull

This document was prepared by Egor Shabalkin.

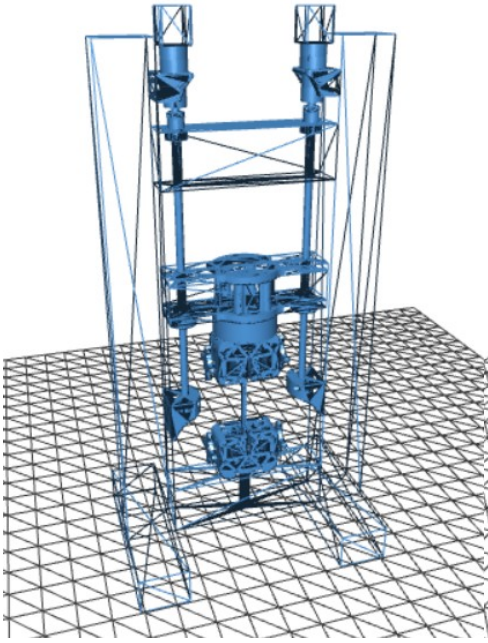

Fig. 1 Wireframe

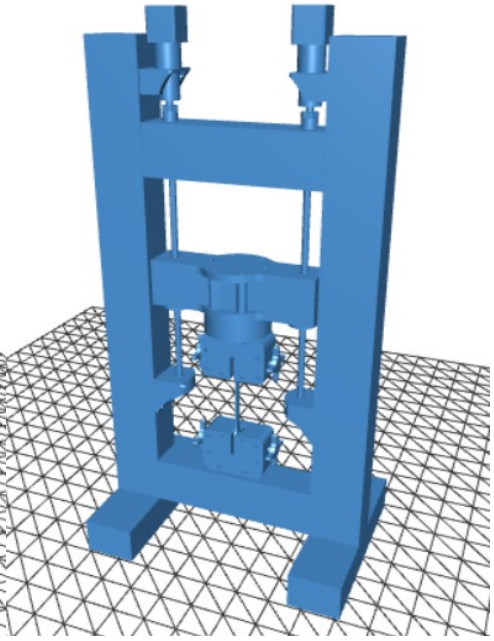

Fig. 2 Solid

This is merely an example of a possible assembly configuration for the machine. Dimensions, components, and the layout can be modified or rearranged as needed.

Executive Summary

The Open-Pull DIY Universal Test Machine offers a cost-effective solution for basic material testing. While not professional grade, this machine allows for rudimentary strain and stress testing of materials with data evaluation through analysis.

Technical Summary

The machine is designed to be built from readily available components, controlled by Arduino code, and capable of performing a variety of tests such as stretching and modulus tests. Data captured from these tests can be analysed using custom software or Excel and extensometer.

In more details: https://www.youtube.com/watch?v=uvn-J8CbtzM

Materials and Cost*

The following is an estimate based on current market prices (USD) for some components:

- 2x **NEMA 17 Stepper Motor 1.68A Geared 14:1**: $42.00 - $52.55 per motor .
- 2x **Trapezoidal Lead Screw 10x2 500mm:** $20 - 35$ each.
- 2x **Arduino Nano**: €21.60 (approx.) $24.00 - $26.00 each .
- 2x **A4988 Stepper Motor Driver**: $5.99 - $10.19 each .
- **SparkFun Load Cell Amplifier – HX771**: $10.95.
- **Coupling 8 to 10mm.**
- 2x **Trapezoidal Nut 10x2, Steel.**
- 2x **Trapezoidal Thread Flange Nut Brass.**
- 2x **Angular Contact Bearing, 3200 2RS.**
- 2x **Ball Bearing 6202.**
- 4x **Ball Bearing 608.**
- **Load Cell - AEP TC4 - 5kN or Digital Crane Scale:** from $30.

Links

https://www.phidgets.com/?prodid=345#:~:text=NEMA17%20,Compatibility%20Specifications%20Other%20Steppers

https://store-usa.arduino.cc/products/arduino-nano?selectedStore=us

https://www.amazon.com/a4988-stepper-motor-driver/s?k=a4988+stepper+motor+driver

https://www.amazon.com/s?k=Digital+Crane+Scale&crid=8RF6YFF0CA66&sprefix=digital+crane+scale%2Caps%2C96&ref=nb_sb_noss_1

https://www.sparkfun.com/products/13879

*These are estimated prices; actual costs will depend on many factors such as the specific types of materials used, the measurement method, the test type and more.

Timeline

Component Acquisition: 1 - 2 weeks for ordering and delivery of components.

Assembly: 1 weeks for mechanical assembly, wiring, and initial testing.

Software Setup: 1 - 2 weeks for installing and configuring the Arduino, which may not include the time required for calibration and optimization.

Electronics and Wiring

1. **Motor Drivers:**

- Insert selected for the project stepper motor drivers into their respective headers on the electronic board.
- Make sure to add heat sinks to the drivers if they're not pre-attached.

2. **Microcontroller Setup:**

- Place the Arduino Nano on a breadboard or mount it onto the frame if a permanent setup is preferred.
- Connect the motor drivers to the Arduino following Fig. 3.

3. **Power Supply:**

- Wire the power supply to the motor drivers and the Arduino Nano, ensuring correct voltage and polarity.
- Add any additional components like the fan or load cell amplifier as per the schematics.

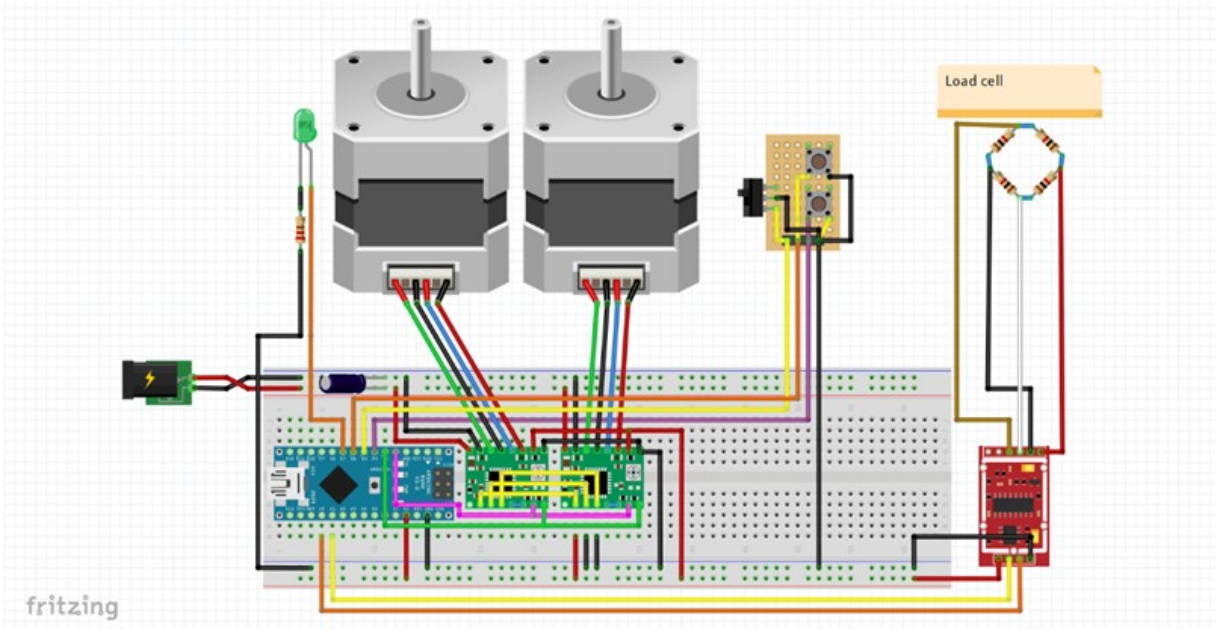

Fig. 3 schematics

Software Installation

Arduino Code:

- Connect the Arduino Nano to a computer via USB.
- Open the Arduino IDE and load the provided code for the Open-Pull machine.
- Upload the code to the Arduino Nano, making sure the correct board and port are selected.

Testing and Calibration

4. **Initial Testing:**

- Power up the machine and send basic commands via the serial monitor in the Arduino IDE to test movement.
- Check for smooth operation of the lead screws and ensure the frame is stable during motion.

5. **Calibration:**

- Use the tare command (M12) to reset any sensors before starting a test.
- Perform a slow test (M10) to ensure the machine moves at the correct speed and distance.

Final Setup

6. **Optical Extensometer Setup:**

- Set up a standard camera to capture the strain data during tests.
- Install any software or scripts required for tracking markers on the test material

7. **Data Analysis:**
- Execute the testing procedures while systematically recording the data for subsequent analysis in Excel, other analytical software suites, or through manual methods.

Safety Check

Before conducting any tests, make sure to perform a safety check:

- Inspect all connections and components for proper installation.
- Ensure there is no risk of short circuits in the electronics.
- Keep hands clear of moving parts when the machine is in operation.

Please note that this assembly tutorial is a simplified guide. Always refer to the assembly instructions and safety guidelines provided by CNCKitchen

Risk Assessment

Potential risks include delays in parts delivery and the need for troubleshooting during assembly and software setup, optimization, and calibration.

Conclusion

The Open-Pull machine will enhance testing capabilities at a relatively low cost and with manageable risks. With a total cost for materials potentially under $500 (excluding shipping and any additional small components), and a projected completion timeline of 4-5 weeks, this investment suggests a swift enhancement to our operations. Furthermore, it is anticipated to yield substantial returns, not only by augmenting our material testing capabilities but also by bolstering our social media presence with engaging content.