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Mini CNC Plotter Project

What is a CNC Plotter?

- A **CNC Plotter** is a computer-controlled drawing machine that moves a pen or tool across a flat surface to draw images, text, or patterns with precision. The term **CNC** stands for *Computer Numerical Control*, meaning the machine follows programmed instructions (G-code) to move in the X, Y (and sometimes Z) directions. Mini CNC plotters are often built using recycled parts from old CD/DVD drives or 3D printers and are widely used in educational, prototyping, and artistic applications.

Components Required

To build a Mini CNC plotter, you need both hardware and software components:

Hardware:

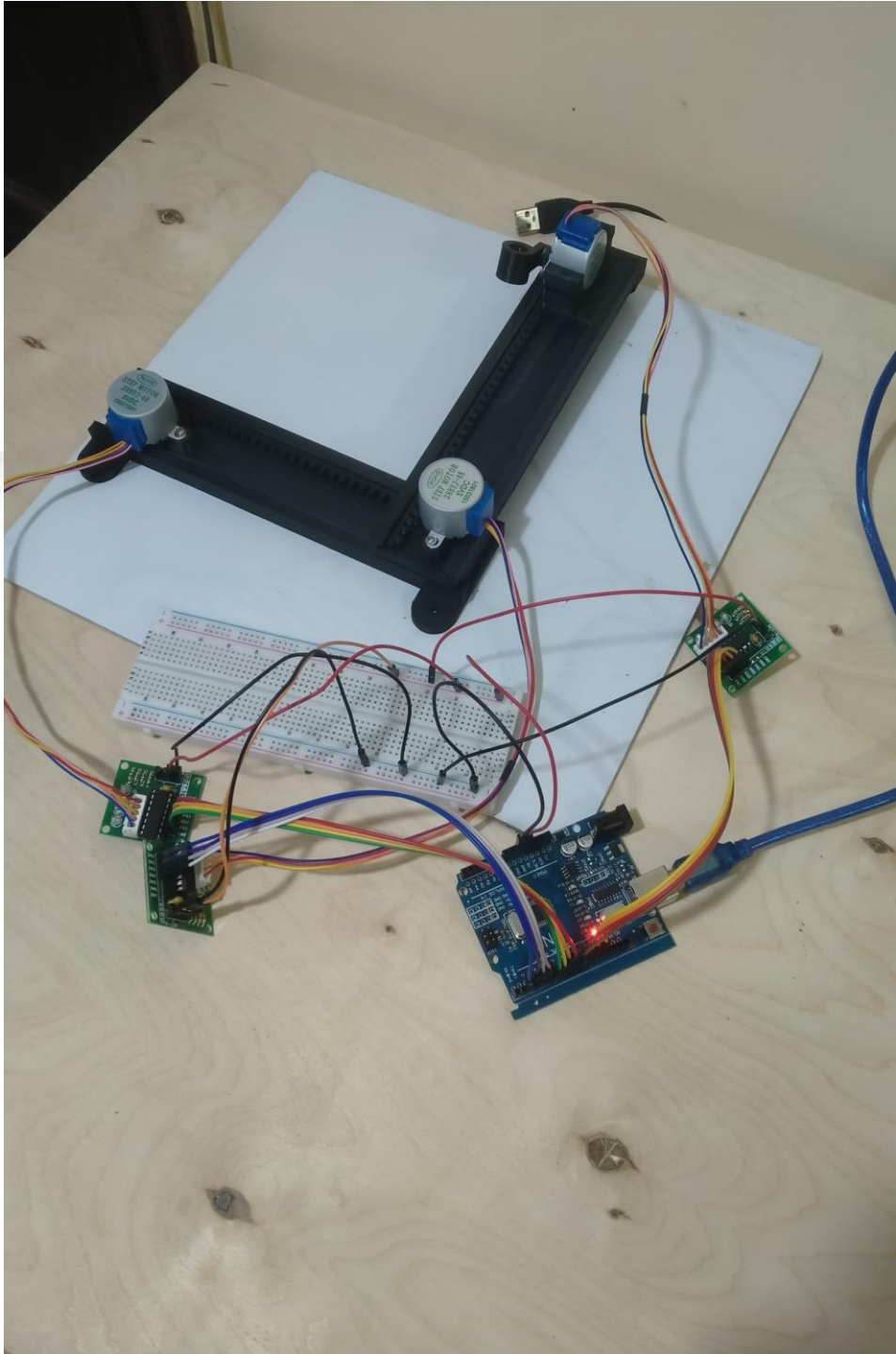
- **Arduino Uno:** Main controller that sends signals to the motors based on the code received from the computer.
- **Stepper Motors (28BYJ-48)**
  - Used to move the X and Y axes accurately in small steps.
- **ULN2003 Driver Boards**
  - These control the stepper motors by receiving signals from the Arduino.
- **Breadboard**

Used to connect wires and distribute power without soldering.

- **Jumper Wires**
  - Connect all the components together to send signals and power.
- **USB Cable**
  - Connects the Arduino to the computer for power and data transfer.
- **Mechanical Frame**
  - Holds all parts in place and provides a base for movement.
- **Pen Holder**
  - Holds a pen to draw based on the CNC movements.

Software:

- **GRBL Firmware**: Loaded onto the Arduino to interpret G-code.
- **Arduino IDE**: Used to upload the GRBL firmware.
- **G-code Sender Software (like Universal G-code Sender)**: Sends drawing instructions to the machine.
- **Inkscape with G-code plugin**: Used to design or convert images into G-code.



Working Principle

The CNC plotter works on the basis of coordinate-based motion control:

A design is converted into **G-code** — a series of commands that represent movements.

The G-code is sent to the **Arduino Uno** running **GRBL firmware**.

The firmware translates these commands into electrical signals.

The **CNC Shield** and **motor drivers** translate the signals into stepper motor movements.

As the motors rotate, the pen moves across X and Y axes to draw the pattern.

The Z-axis (if implemented) lifts or drops the pen between drawing segments.

Mechanical Assembly

- **Assembly Steps:**
  - **Fix the Motors:**
    Attach the stepper motors firmly to the base/frame.
  - **Add Linear Rails or Sliders:**
    Install the sliding mechanism that allows movement in X and Y directions.
  - **Connect Motion System:**
    Use belts, gears, or threaded rods to move the platform.
  - **Install the Pen Holder:**
    Place the pen mount in the middle so it can reach the drawing area.

- Key Features of the Structure:
- **Stable & Precise:**

The frame should be light but strong enough to keep the movements accurate.

- **Smooth Motion:**

Use linear rails or sliders so the pen moves without shaking or friction.

- **Recycled Components:**

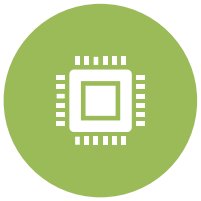
You can reuse parts from old CD/DVD drives (like motors and rails) to save cost.

- **Tool Mount (Pen Holder):**

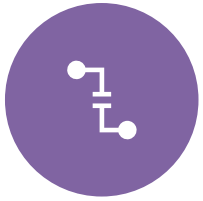
A simple holder for a pen, marker, or even a laser. You can lift it manually or use a servo motor.

Electronics Setup

Connect Stepper Motors:
Plug each motor into the correct slot on the **CNC Shield** using the motor drivers.



Mount CNC Shield:
Place the **CNC Shield** directly on top of the **Arduino Uno**.

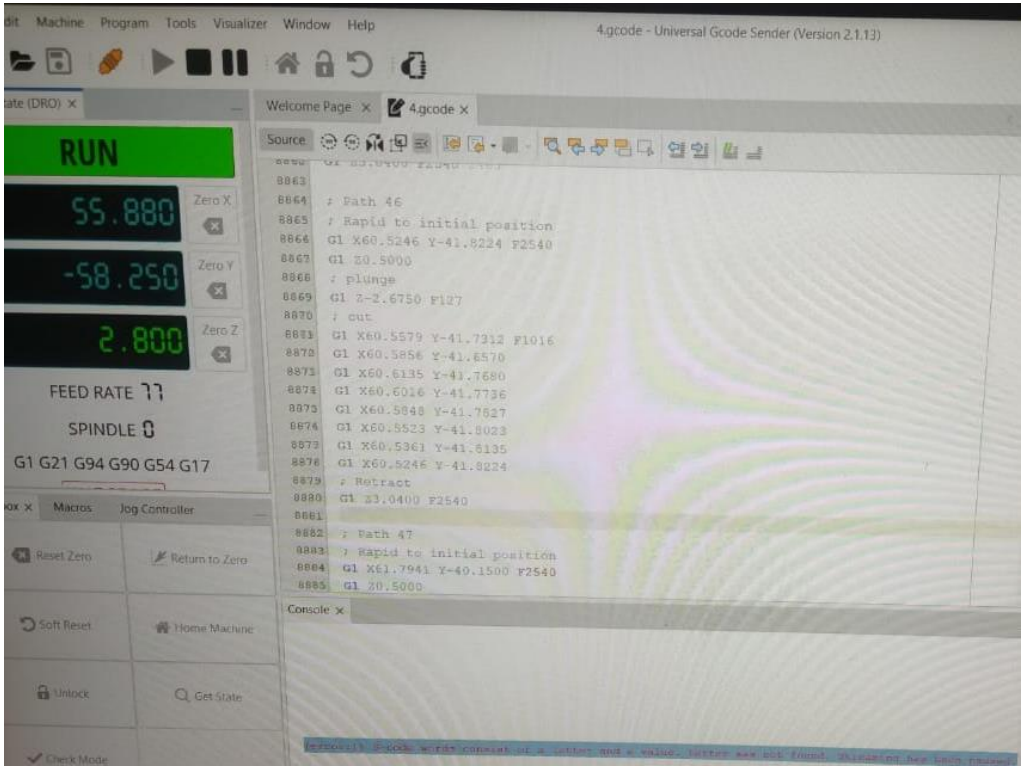


Upload GRBL Firmware:
Use the **Arduino IDE** to upload GRBL to the Arduino — this allows it to read G-code commands.

Set Jumpers:
Adjust the small jumper pins on the CNC Shield to control **microstepping** and **motor current**.

Connect Power Supply:
Give the CNC Shield power (usually 12V) to run the motors.

Software Used



GRBL (on Arduino): Lightweight firmware that interprets G-code.

Arduino IDE: For firmware upload.

Universal G-code Sender (UGS): GUI-based tool to load and send G-code to the machine.

Inkscape: A vector graphics editor used to design shapes.

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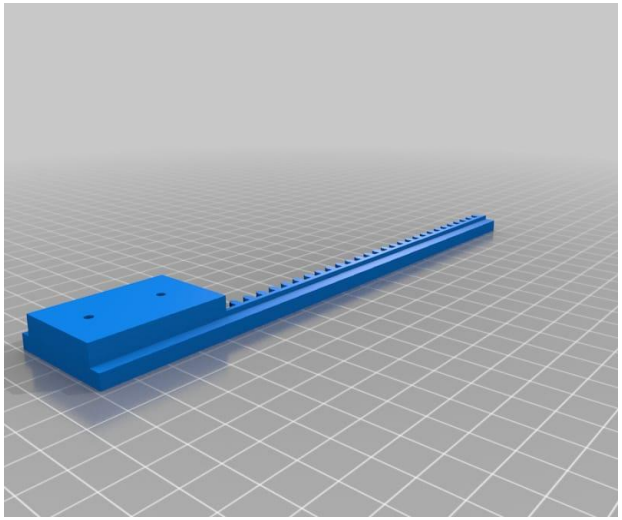
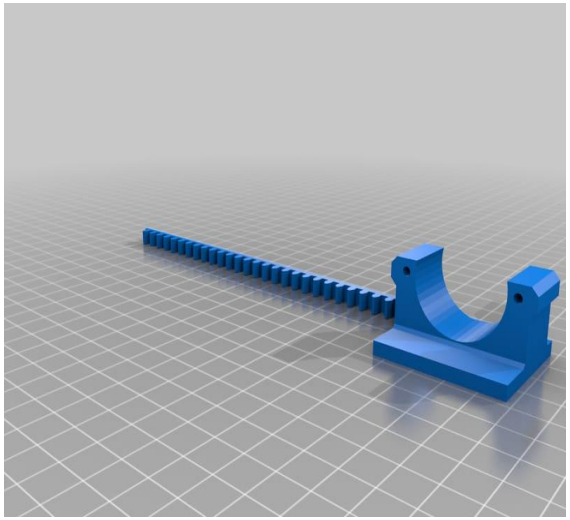
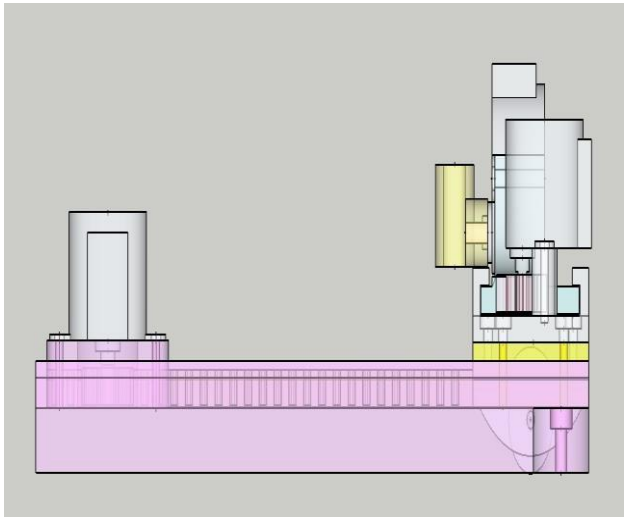
Calibration & Testing

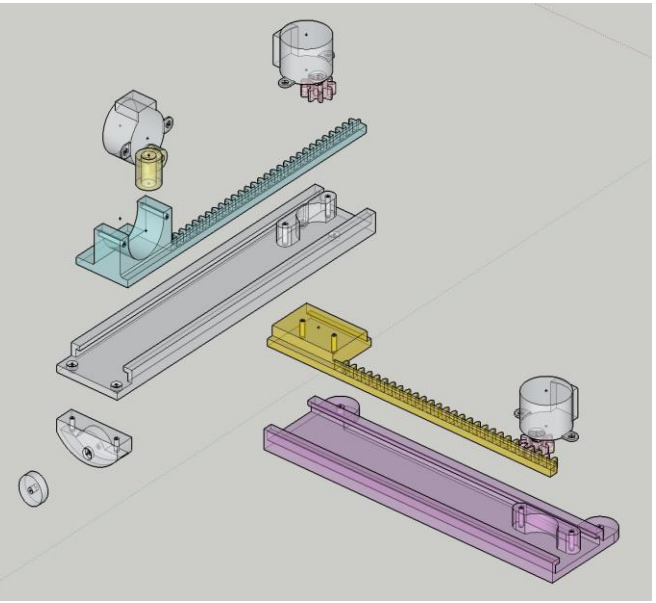
- Test each motor for correct direction and steps.
- Calibrate **steps per millimeter** in GRBL settings.
- Ensure pen pressure and lift are optimized.
- Adjust the speed/feed rate to avoid skipping or distortion.
- Print test shapes (square, circle, text) to check accuracy.

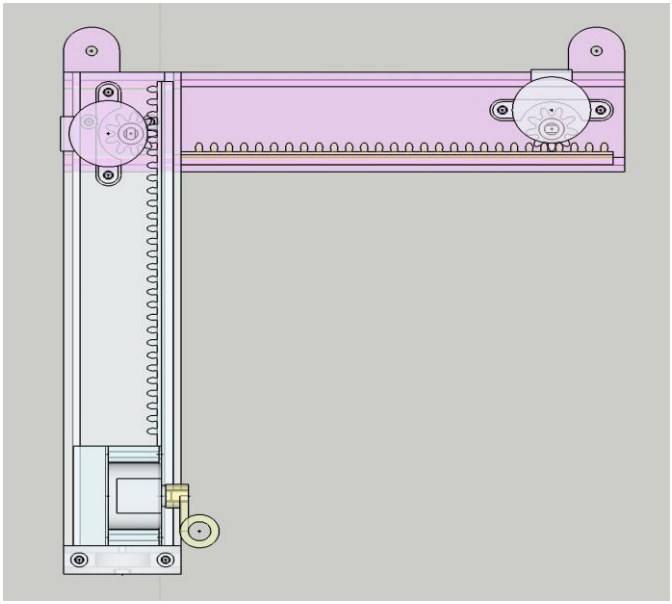
Some pictures of the project :

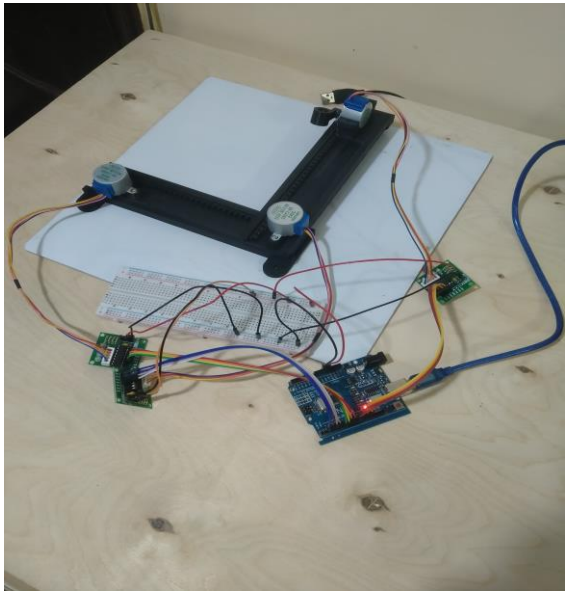




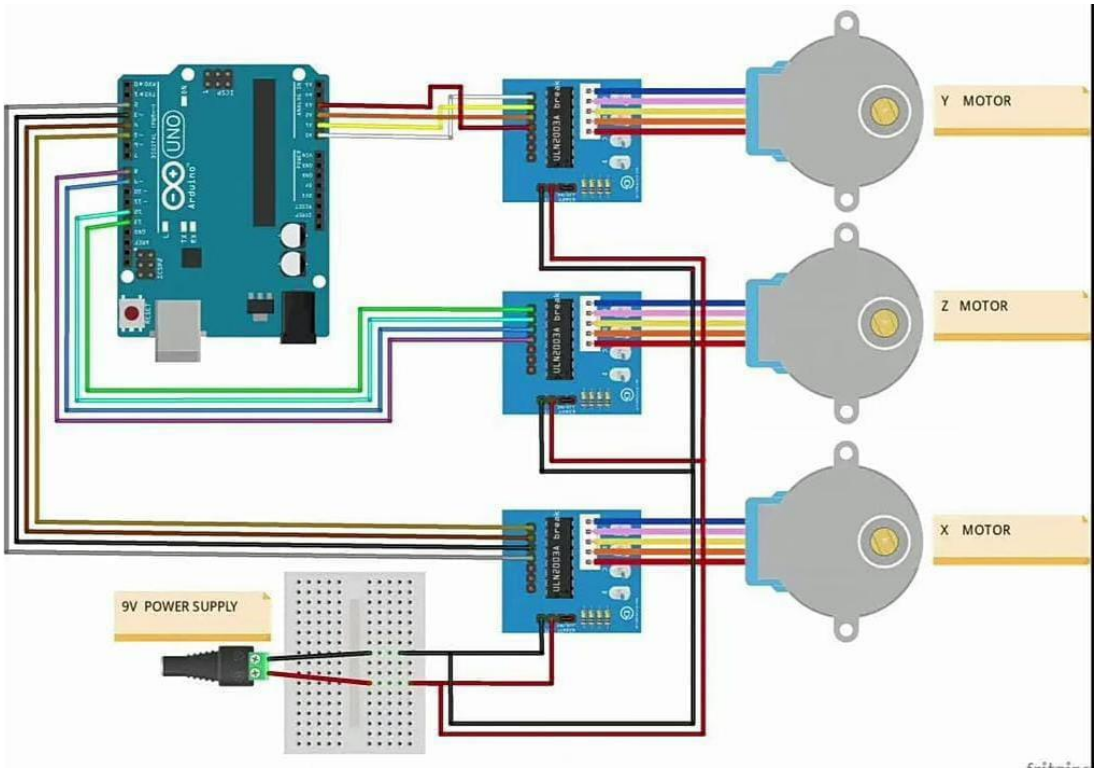








Simulation



Applications:

- **Educational Projects**: Teach robotics, electronics, and automation.
- **PCB Prototyping**: Plot circuit layouts (with conductive ink).
- **Art and Design**: Automated sketching and signature machines.
- **Laser Engraving (advanced mods)**: Replace pen with a low-power laser.
- **Small-scale manufacturing**: Personalized labels, logos, or cards.

Conclusion

- The Mini CNC Plotter is a perfect example of how multiple disciplines — electronics, mechanics, and programming — come together in one project. It’s low-cost, educational, and flexible. Ideal for beginners and hobbyists looking to explore automation, control systems, and creative tech solutions.

Thanks