

PROJECT ABSTRACT

Mini CNC Plotter using Arduino

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01 Title

Mini CNC Plotter using Arduino

02 Introduction / Background

CNC (Computer Numerical Control) machines are the backbone of modern manufacturing, yet most mechanical students graduate having never built one. A mini pen plotter is the perfect entry point: it uses the same G-code language, the same stepper motion control and the same calibration discipline as industrial machines — at a fraction of the cost — and it produces visible, precise output that makes the engineering tangible.

03 Problem Statement

CNC theory in textbooks stays abstract: students learn G-code syntax without ever watching a machine execute it. This project closes that gap with a complete, working 2-axis CNC plotter — Arduino + GRBL motion control, stepper-driven gantry, servo pen lift — that draws vector art and text from real G-code, with measured accuracy the student can defend.

04 Objectives

- Build a rigid 2-axis gantry plotter with stepper drive and pen lift.
- Run GRBL firmware on Arduino for true G-code motion control.
- Convert vector artwork to G-code with an Inkscape workflow.
- Calibrate steps/mm for sub-millimetre positioning accuracy.
- Implement homing, feed-rate tuning and safe travel limits.
- Measure and report drawing accuracy (drawn vs designed dimensions).

05 Proposed System / Working

A smooth-rod gantry with GT2 belt drive carries the pen carriage on X and Y; NEMA 17 steppers driven by A4988/DRV8825 drivers on a CNC Shield V3 provide motion, and an SG90 servo acts as the pen-lift Z-axis. An Arduino UNO runs GRBL 1.1, receiving G-code over USB serial from Universal G-code Sender/Candle at 115200 baud and generating acceleration-planned stepper pulses. Artwork flows from Inkscape through a G-code export extension. Calibration sets GRBL's steps/mm (\$100/\$101) per axis using measured travel; feed rates (\$110/\$111) and accelerations (\$120/\$121) are tuned for the frame's rigidity. Limit switches enable homing (\$22). Accuracy is verified by

drawing test patterns and measuring them against the design.

After calibration the plotter draws text, logos and vector patterns with sub-millimetre positioning accuracy, verified against design dimensions in the report. The live demo is mesmerizing: send a G-code file and watch precise artwork emerge line by line. Homing, pen-lift operation and speed tuning are all demonstrable during the review.

06 Technologies / Components Used

Arduino UNO + CNC shield · 2 stepper motors · gantry frame · servo pen lift · GRBL firmware · power supply

07 Key Features

- GRBL 1.1 motion control on Arduino UNO + CNC Shield.
- 2-axis belt-driven gantry with NEMA 17 steppers.
- Servo pen lift for clean stroke separation.
- Inkscape-to-G-code artwork workflow.
- Homing, calibrated steps/mm, tuned feed rates.
- Interchangeable pen holders and sample G-code files.
- Measured accuracy test in the report.

08 Applications / Use Cases

- CNC training and education
- PCB layout plotting
- sign and poster art
- calligraphy automation
- sticker/vinyl cutting (with blade extension)
- as a stepping stone to 3D printers
- laser engravers

10 Conclusion

This mini CNC plotter delivers real manufacturing technology at student scale — G-code, GRBL, stepper control and calibration — producing precise, demonstrable output with the measurement data examiners expect from a mechatronics final-year project.