CNC Machine

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Group:

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- **Introduction**
    - **Context**

The goal of this project is to design, implement and test a CNC machine. **Numerical control** is the automated control of machining tools by means of a computer. A CNC machine processes a piece of material (metal, plastic, wood, ceramic, or composite) to meet specifications by following a coded programmed instruction and without a manual operator directly controlling the machining operation.

- **Specifications**

The device will draw a certain picture given as input on a piece of paper.

- **Objectives**

Design and implement a drawing algorithm and a parsing algorithm using Java and Arduino language.

- **Bibliographic study**

Motion is controlling multiple axes, normally at least two (X and Y), and a tool spindle that moves in the Z (depth). The position of the tool is driven by direct-drive stepper motors or servo motors to provide highly accurate movements, or in older designs, motors through a series of step-down gears. Open-loop control works as long as the forces are kept small enough, and speeds are not too great. On commercial metalworking machines, closed-loop controls are standard and required to provide the accuracy, speed, and repeatability demanded.

G-code is the most widely used computer numerical control (CNC) programming language. It is used in computer-aided manufacturing to control automated machine tools and has many variants.

G-code instructions are provided to a machine controller (industrial computer) that tells the motors where to move, how fast to move, and what path to follow. The two most common situations are that, within a machine tool such as a lathe or mill, a cutting tool is moved according to these instructions through a toolpath cutting away material to leave only the finished workpiece and/or an unfinished workpiece is precisely positioned in any of up to nine axes around the three dimensions relative to a toolpath and, either or both can move relative to each other. The same concept also extends to noncutting tools such as forming or burnishing tools, photo plotting, additive methods such as 3D printing, and measuring instruments.

Boards used:

The **Arduino Uno** is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is like Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

The **Arduino 3S Motor Driver Shield** includes 4 H-Bridge drivers, allowing you to control up to 4 DC motors with independent control of speed and direction from your Arduino UNO, Diecimila, Duemilanove or Freeduino or compatible boards. Alternatively, it will drive two stepper motors, and the PWM capability makes microstepping a breeze.

A **servomotor** is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

- **Analysis**
    - **Sending data to Arduino**

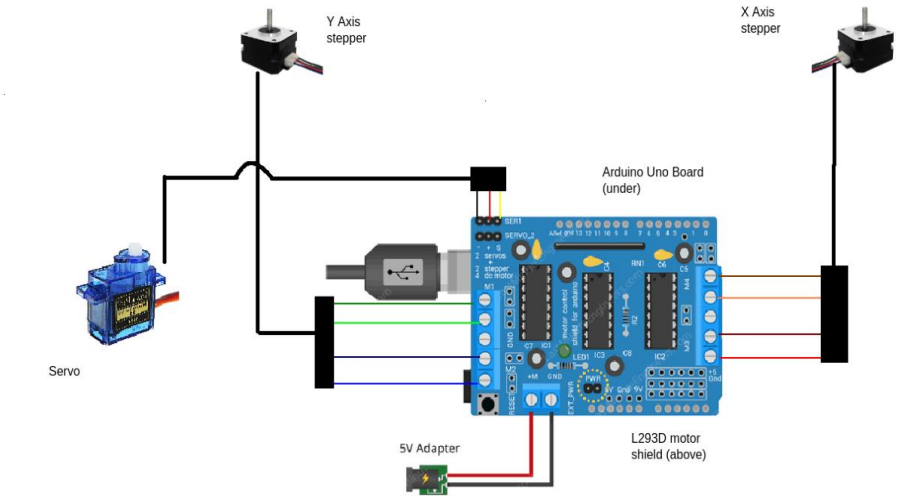
The way this machine works is simple: it receives data from the Serial input (given as a string), the Arduino will parse it and will transform it into movements of the stepper or servo motors.

- **Parsing the string**

The parsing element of the machine, the Arduino will parse the line. If the line is a comment or a semicolon, then it will discard it. Otherwise, it will parse it and create the commands. For example, the command “G1 X40 Y40” will move the pen to the position (40, 40), and “M300 S30” will put the pen down.

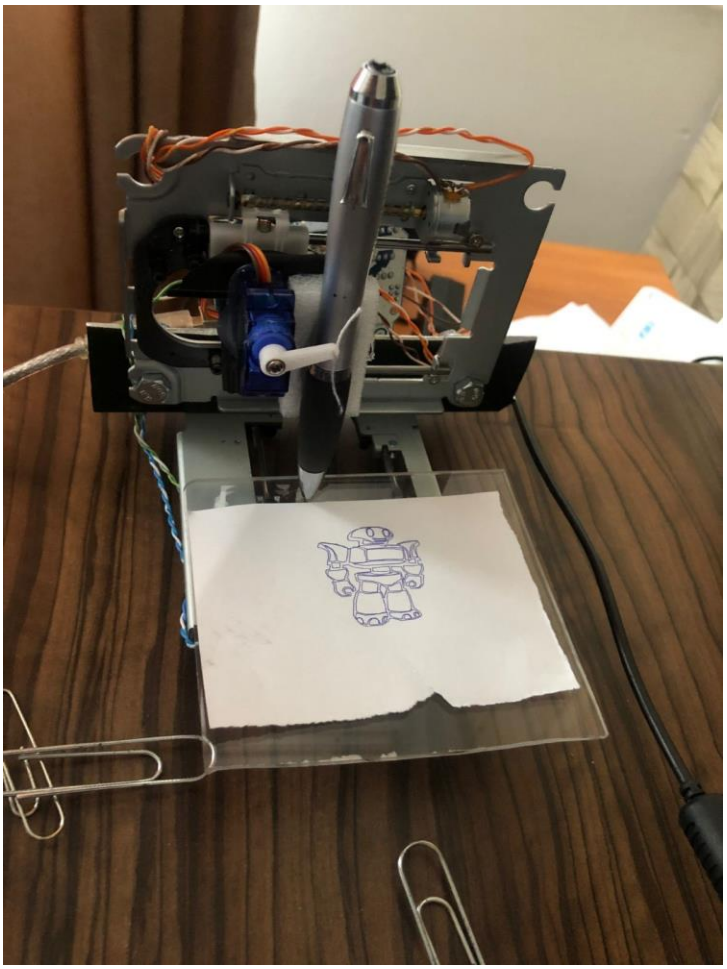
- **Design**

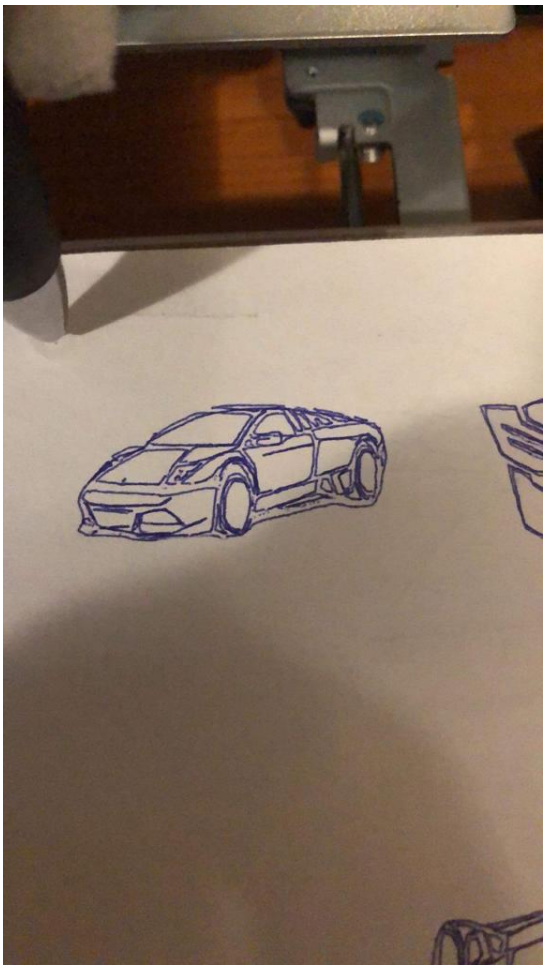
The circuit is created using 2 stepper motors, which are used for X and Y axis movements, one servo motor used for lifting the pen up or down (depending on the instruction). The board used for creating this project is the Arduino Uno board, because it pairs very well with the L923D motor shield, which can control up to 2 stepper and 2 servos. The Arduino is connected to a 7V power supply and to the computer.



The algorithm for sending data is created in Java. It uses a special library called "com.fazecast.jSerialComm.SerialPort;", which takes care of sending data through Serial Port.

- **Testing and validation**





- **Conclusions**

This project was an incredibly good starting point in my next career because it combined notions of programming and engineering, and creating a machine that can

- **Bibliography**

https://www.youtube.com/watch?v=xfQ0YosR6us

https://www.youtube.com/watch?v=vxhYIVOXXXk

https://www.youtube.com/watch?v=VQmxU7CV9bM&t=455s

https://www.youtube.com/watch?v=DCqvSVN96Lk