Build-A-Bot

PaintBot

Team members:

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Introduction

THE IDEA:

While brainstorming an idea for Build-a-Bot we thought, enough of the line followers and obstacle avoiding bots, we wanted to make something which we can build in real life and would be of actual use. Hence the concept of the PaintBot.

THE CONCEPT:

PaintBot is not an ordinary printer. While most printers print on sheets or tiles lying horizontally, PaintBot prints directly onto vertical walls. It can be mounted in front of any vertical(or even slanting) wall and it will print whatever image you want onto that wall in a beautiful dot pattern.

As we know Painting is time taking art and needs perfection, even more so when it comes to painting on walls. PaintBot aims to easily paint onto walls with considerable precision and complexity.

It uses some UGS systems to interpret the image and make it able to print.

Bill of materials

S.No.	Part Name	Frequency
1.	Arduino UNO Board	1
2.	Stepper Motors	2
3.	Servo Motor	1
4.	DC power source	1
5.	Connecting cables	As required
6.	Stepper Driver	3
7.	Capacitors (10uf and 100uf)	2
8.	Resistor (470 ohm)	1
9.	Voltage Regulator (7805)	1
10.	LED	1

Working

What our project aims to do is, convert an image into a set of coordinates with colours attached to them. Then a spray-printer unit is to be carried around using a set of motors onto those specified coordinates and print the desired image.

The given project uses the power of Arduino UNO board as its main electronic unit.

Electronics

***Arduino Uno** is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started..Thus being the most used and documented board of the whole Arduino family we have used this as the main unit for our bot A simple schematic for the same is shown below.*

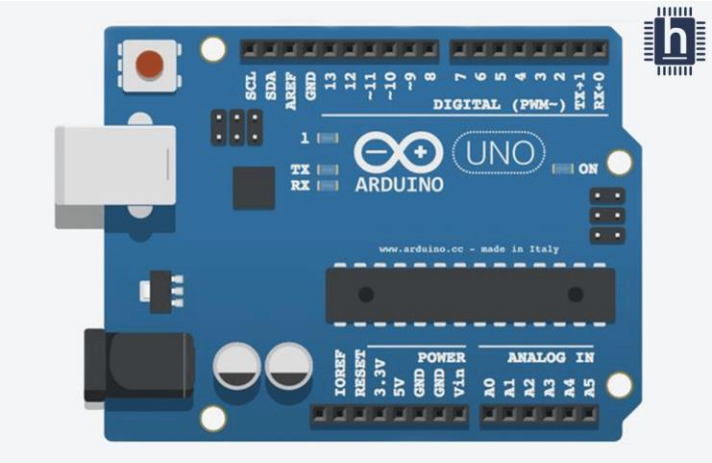

Fig.1: An Arduino UNO Board

For controlling the x-axis and y-axis movement of our PaintBot to draw the required sketch we are using 3 steppers motors here. Two of them are responsible for vertical motion of the bot against gravity while the third one controls the horizontal movement. A schematic of a simple stepper can be seen below.

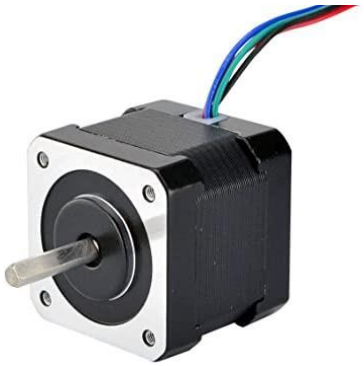

Fig.2: A simple stepper motor

For the binary on/off of our spray machine we are using a servo motor here. All of these components will be placed on a steel frame specially designed keeping in mind the desired requirements of the bot's motion. The frame structure is made using SolidWorks and a pictorial representation for the same is shown below.

Fig.3: The main body frame

All of this would be controlled using a PC connected to Arduino UNO board having a CNC shield installed with stepper motor driver thus enabling it to control the motion of spray via controlling the three stepper motors and servo motor simultaneously.

*For the demonstration purpose we have used **Proteus software**. The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. We will use it here to control and code various components to be used in building our precious "PaintBot".*

The circuit diagram made using proteus is given below.

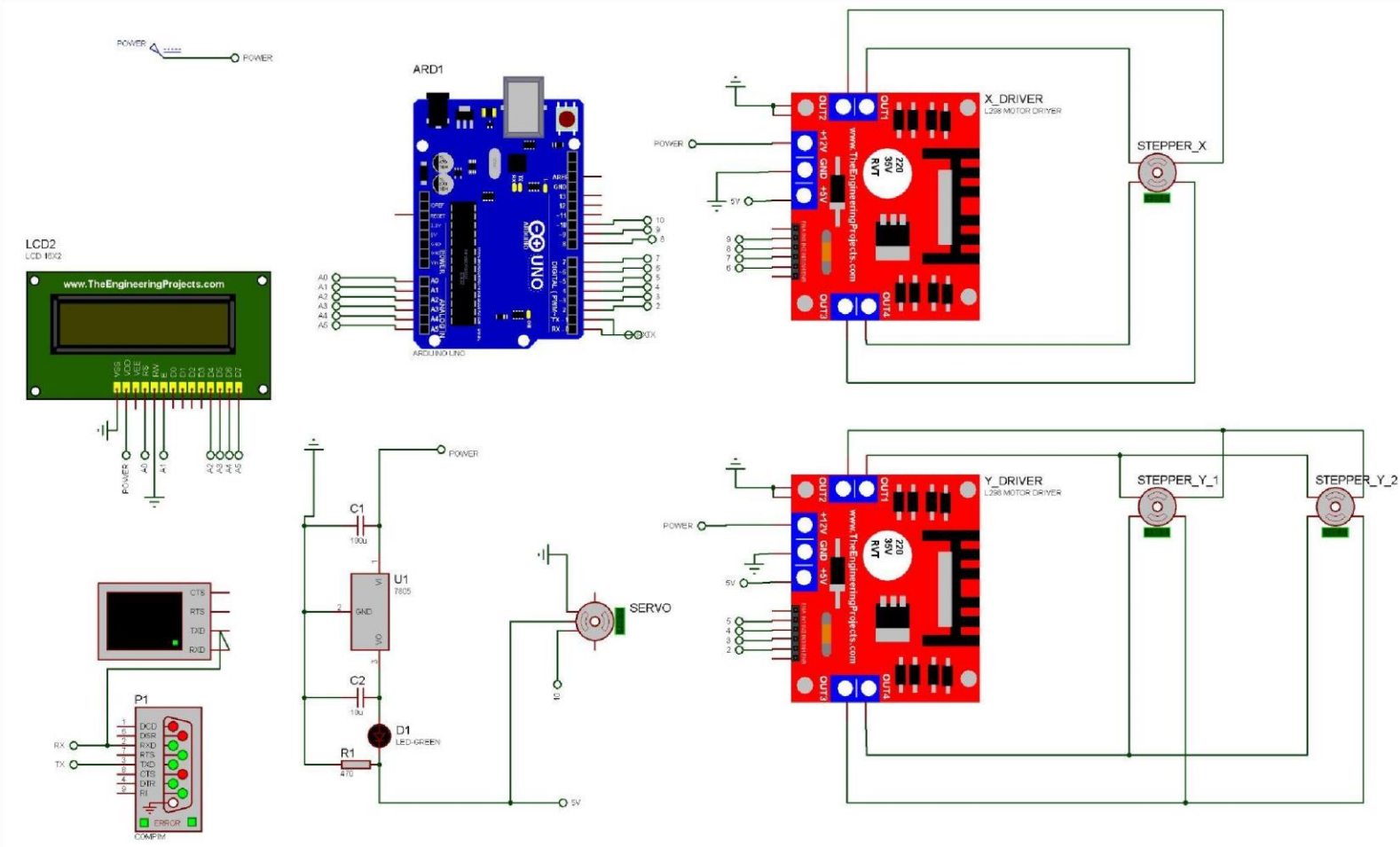

Fig.4: The Circuit Diagram

Our PaintBot uses 3 stepper motors and a servo motor for basic functioning. These components are essentially controlled by the Arduino Uno along with the L298 drivers which control the stepper motors. These are powered by a 12 V D.C. power supply while the servo motor uses 5V power for its functioning. This is done via the use of a voltage regulator(7805) which in turn has filter capacitors of 100uF and 10uF in its i/p and o/p respectively. The servo motor is used to control the trigger of the sprayer of the paintbot. We've used a stepper motor along with an L298 motor driver to control the motion along the x-direction while two stepper motors are used to facilitate the motion along the y-direction. Some components were only included for the sake of simulation and can be left while implementing the project in real life. These components include a 2x16 LCD panel which is used here to show the coordinates of the sprayer at any instant and a COMPIM which essentially serves as a virtual port.

For simulation purposes, we first use Virtual Serial port Emulator (VSPE) to generate a virtual port. Then we upload the hex file of our arduino IDE code to the arduino uno present in the proteus simulation. Then we set the physical port in COMPIM as the port that we generated in the VSPE and then start simulation in proteus. Instructions to the motors are provided by a g-code file. A g-code file is a file that is nothing but a picture converted in a set of instructions used by the motors. We can convert our image to be painted into a g-code file using softwares like inkscape(with extension) etc. A g-ctrl file enables this g-code to be read by the Arduino and this drives the various motors in our bot by the required amounts so as to reach correct spots and spray at the correct instants.

Mechanics

Movement in the Y direction:

For movement in the Y direction, the PaintBot uses a ball screw mechanism. The pitch of the thread is 1cm, hence one full rotation in the motor corresponds to 1cm in linear movement. The PaintBot aims to make an image with dots which will be 1cm apart from each other in both X and Y directions. One stepper motor will be attached to each of the vertical threaded poles placed on either end of the structure, both the motors will work in sync causing the X-direction rod to move up and down.

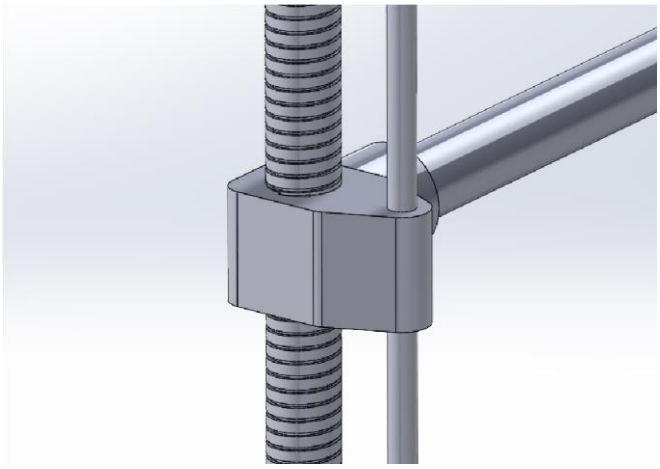

Fig.5: The Ball-Screw Mechanism

Movement in the X direction:

For movement in the X direction, the PaintBot uses a cogwheel mechanism. We will tune the stepper motor responsible for movement in the X direction to cause movements of precise 1 cm. One stepper motor will be responsible for the movement, as there is not much load which has to be undertaken by the motor in horizontal movement.

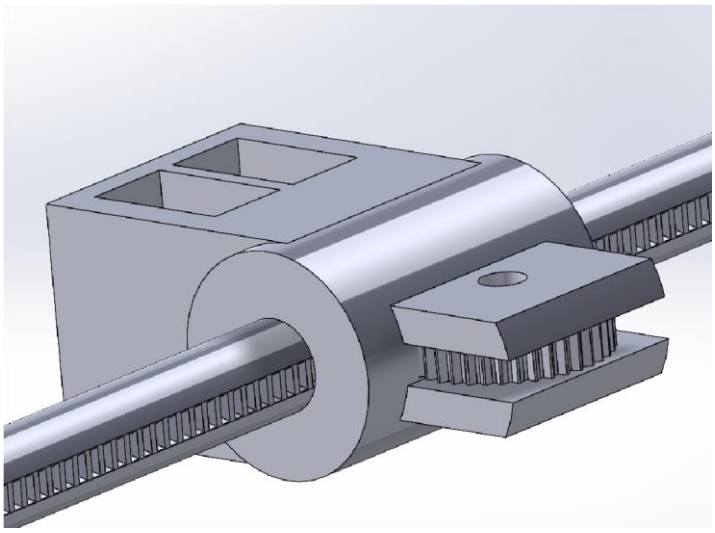

Fig.6: Cogwheel Mechanism

General Mechanical Details:

1) The vertical rods will be made up of aluminium as there is not a concern of weight as such but we need to keep the overall weight of the structure low while maintaining strength and rigidity.
2) The horizontal rod will be made of High-Density Polyethylene Plastic, because of its low density. Meanwhile the groove will be made of steel and placed into the plastic as we can't afford wear and tear in the grooves.

Sprayer Casing:

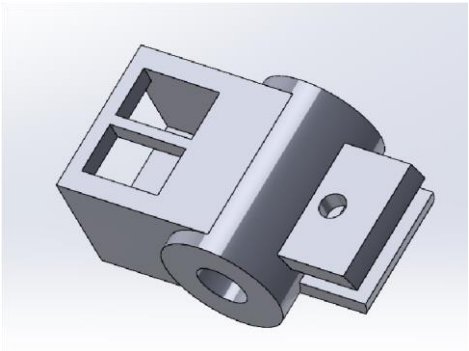

Fig.7: Sprayer Casing

The details of the sprayer casing will be finalised based on the wiring and sprayer size requirements.

Stand:

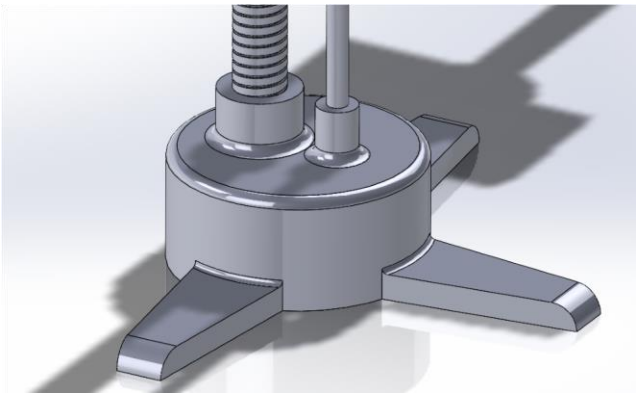

Fig.8: The Stand

The stand is provided with room to fit the stepper motors and the wiring required.

Practicality

The idea of our paintbot is quite feasible both ideally as well as practically. The idea here is of having any kind of design/paint on our walls in an automated fashion.

We have designed the structure in such a way that it can be put apart and stored, and then can be easily reassembled when needed.

The use of this bot is not for typical consumers, but rather for companies or firms responsible for beautifying walls, making wall art in places like museums, or even for making advertisements.

The aim of the bot was to achieve considerable complexity and accuracy at a low cost of production.

Cost

Name of the part	Nos.	Price (Rs.)
Arduino uno board	1	550
Stepper Motor	3	1800 * 2 + 550
Stepper driver	2	535*2
Capacitors (10uf and 100uf)	2	1.45 + 2.45
Resistors	1	2
Voltage Regulator (7805)	1	15
Servo motor	1	105
Plastic for rod	-	70 per Kg(granules)
Aluminium for rods	-	210 per Kg

Important Links

- ☐ Link to Simulation file.