Indian Institute Of Technology, Guwahati

Department of Electronics & Electrical Engineering

EE304 – Design Lab

Lab Group -20

Project Title: Rangoli Laying Robot(HN4)

Project Report

Date: 22/04/2018

Name	**Roll no**
Gaddabathini Rahul	150102019
Revanth Parsa	150102047
Sai Krupal Reddy Poreddy	150102049

Abstract:

Gerber is a standard electronics industry file format used to communicate design information for manufacturing many types of printed circuit boards. In many ways, Gerber is the electronics worlds' equivalent of PDF. This odd little format, a hybrid machine control language and image, is a core component of the electronics manufacturing supply chain.we used this format to analyse the image and get 3 point data based on the path to be taken by the bot. 2-D points of the images from this gerber format.Third point whether to drop sand or not on its path to next point.

We used Serial Communication Method for real time transmission of this data. We used Python to make changes in the document generated in the gerber file format to the format which can be used to process the data in Arduino and transmit the data. We tried to process the data by using SD Card module but when our part of the project combined with the part 1 of the project it didn't worked.We used Servo motor to control the flow of the sand.

Summary of work done:

- ➢ Drawn the figure using Eagle Software and generated a gerber format file for the figure
- ➢ Python script is made to analyse available gerber file and made the changes in the gerber file to the required format.
- ➢ Real time transmission of the data is done using Serial Communication. This is done by using PYSERIAL module in the python
- ➢ We also tried using SD Card Module but it didn't gave fruitful result.
- ➢ Designed and made the sand dropping mechanism
- ➢ Used servo motor to control flow of sand

Contents

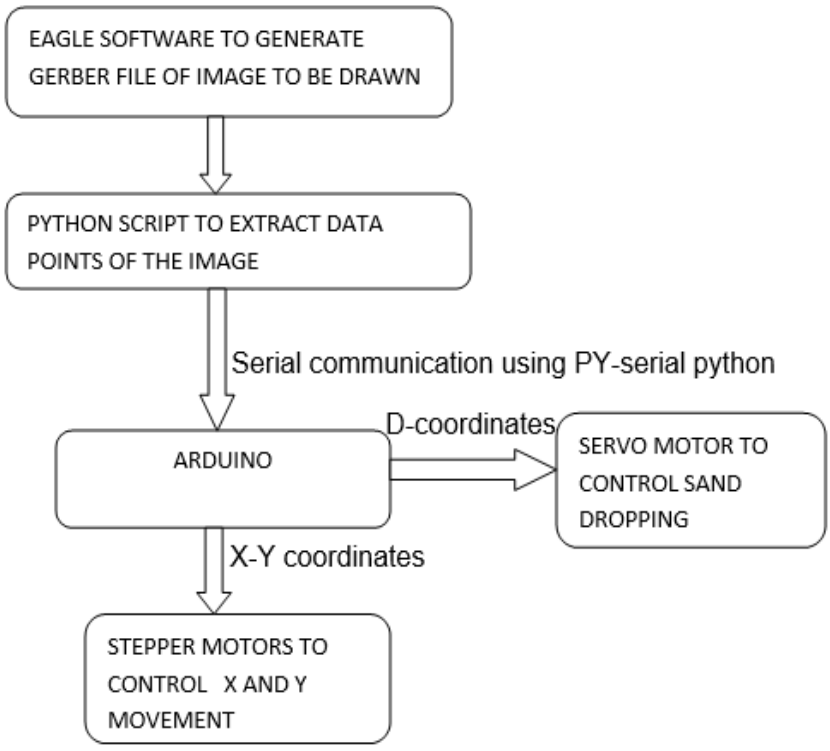
1. **Objective:**

A. Design and Make Sand Dropping Mechanism(Hardware)

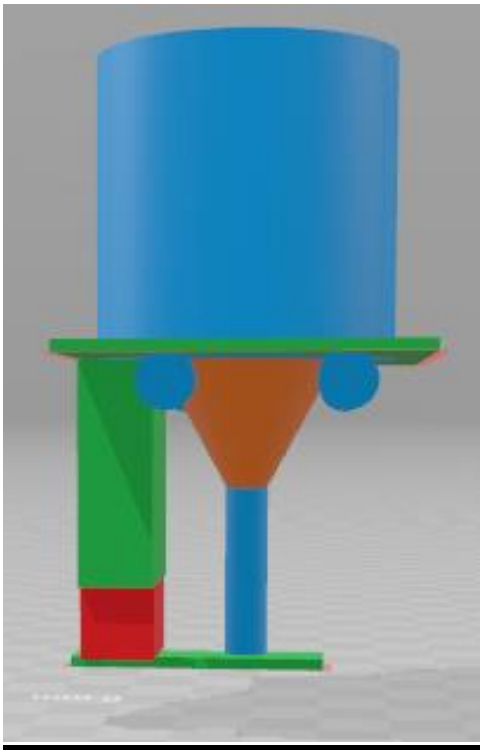
B. Draw the figure(in the Eagle Software) and create a gerber file for the figure.

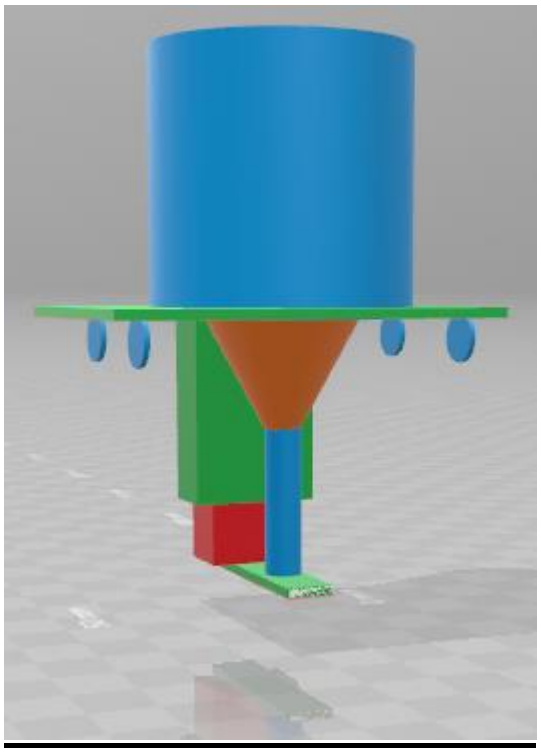
C. Provide the Coordinates for the Robot to draw the figure generated using Serial Communication or SD Card Module.

2. **Block diagram:**



3. **3D Design of Sand Dropping Mechanism:**





The bot has to support the x and y coordinate movement while moving the bot has to drop sand to form an image.The sand dropping mechanism is shown in the above figure.The blue cylinder stores sand in it.

The sand dropping mechanism moves along with the belt to which it is attached. The caster wheels(blue circles under the green board)provide the sliding movement on the bot board.

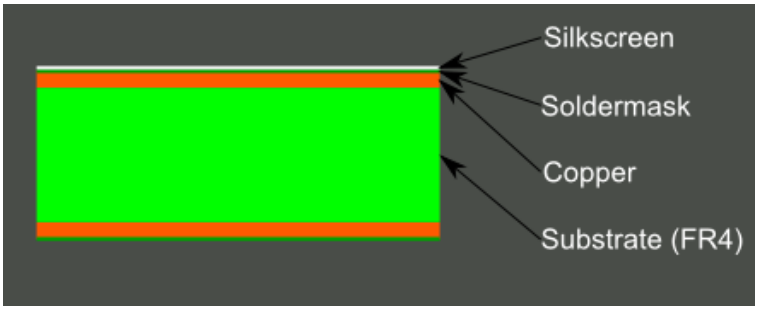
The axle rods prevent the the dropping mechanism from tripping down and provides straight movement of the bot

Servo motor(red part) attached under the board operates under the instructions of Arduino which opens and closes the hole to facilitate the dropping of sand whenever required.

4. **Sand Dropping Mechanism bot:**

5. **Literature Review:**

The content of a Gerber file is ASCII text (i.e. English letters, digits and a few special characters) and looks like a human could almost read and understand. A Gerber file contains the complete description of a PCB layer image without requiring any external files.



General PCB circuit design has these layers as in the above figure .

The base material, or substrate, is usually fiberglass.The next layer is a thin copper foil, which is laminated to the board with heat and adhesive.Similarly, some other layers are also used on top of that for PCB design.so when a gerber file is created it gives complete description of all these layers.For getting coordinate points of the figure, we used the copper layer information provided by the gerber file of the figure.

Arduino serial communication is used for communication between the Arduino board and a computer or other devices. All Arduino boards have at least one serial port (also known as a UART or USART).Through this we can communicate by sending and receiving data and this can be viewed with the help of serial monitor.

Pyserial provides a way to communicate through serial port the data can be sent and read through serial monitor using this library.

The gerber format contains the x-y coordinates of the image which makes bulk of gerber file.Gerber uses several techniques to minimize the number of bytes required to represent the data.

- Suppress the decimal point in the x,y data.so to avoid this problem while creating the gerber file we can specifying maximum number of decimal places.
- Suppress either the leading or the trailing zeros can be avoided by specifying maximum number of places in the integer value of coordinates.
- Only outputs changes in coordinate data.

and also three type of D-code for each point

D-codes are can be used as instructions to bot that perform the following functions under different situations

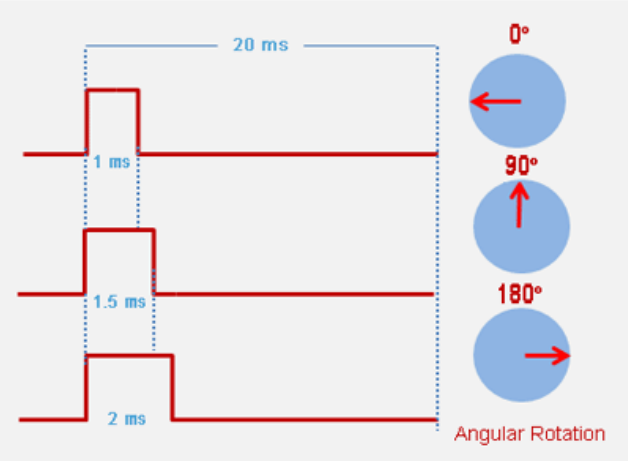
- D01(D1): move to the x-y location specified with servo leaving the hole open.
- D02(D2): move to the x-y location specified with servo leaving the hole closed.
- D03(D3): move to the x-y location specified with servo leaving the hole closed.

M02* marks the end of the gerber file.

6. **Components used:**

Components	Specification/Usage	Quantity
Servo motor	SG90 Micro Servo	1
Acrylic sheets	5mm thickness	1
Axle rods	To move caster wheels without deviation	2
Caster wheels	Used for the moment of the sand carrying bottle	4
Bottle	Used to carry Sand	1
Jumper Wires	To connect the components with Arduino	5-10

Servo motor:



Servo implies an error sensing feedback control which is utilized to correct the performance of a system. Servo motors are DC motors that allows for precise control of angular position The servo motor is actually an assembly of four things: a normal DC motor, a gear reduction unit, a position-sensing device and a control circuit.

The DC motor is connected with a gear mechanism which provides feedback to a position sensor which is mostly a potentiometer. From the gearbox, the output of the motor is delivered via servo spline to the servo arm.

Servo motor is controlled by PWM (Pulse width Modulation) which is provided by the control wires. There is a minimum pulse, a maximum pulse and a repetition rate.
Servo motor can turn 90 degree from either direction form its neutral position. The servo motor expects to see a pulse every 20 milliseconds (ms) and the length of the pulse will determine how far the motor turns.
For example, a 1.5ms pulse will make the motor turn to the 90° position, such as if pulse is shorter than 1.5ms shaft moves to 0° and if it is longer than 1.5ms than it will turn the servo to 180°.

SD card module:

The SD Card Module is a simple solution for transferring data to and from a standard SD card. The pinout is directly compatible with Arduino, but can also be used with other microcontrollers.
This module has SPI interface which is compatible with any sd card and it use 5V or 3.3V power supply which is compatible with Arduino UNO/Mega.SD module has various applications such as data logger, audio, video, graphics.

7. **Implementation:**

- Firstly we used Eagle software to create a figure.In Eagle we just drawn the figure and then using cam processor tool generated gerber file for the drawn figure.Eagle software is generally used for PCB design.
- In the gerber file it generates the coordinates which have maximum of three integers and four decimal digits.
- Secondly we have written python script for making the changes in the generated gerber file.
- The algorithm is to open a text document and copy the whole content in the gerber file to that text document and remove the lines until we get a letter X at the start of the line.
- Now we read the line and replace X with space ,replace Y with two spaces, replace D01 with 1 and replace D02 with 2.
- After that we read the text file as csv file in python and all the first column is stored in the array X ,second column is stored in the array Y and third column is stored in the array Z.
- Now we divide the whole data with 1000 and normalize in such a way to make the output in the limits that a bot can draw.
- Now opens a empty text document and appends the document with the first column as Z followed by X and Y simultaneously.
- We use the array Z to control the sand dropping.
- We gave this data to Arduino to process by using pyserial
- The algorithm to process the data using pyserial is to open the text document and send through serial port of the arduino.
- By using pyserial library these gerber coordinates can be sent to the Arduino in real time through serial communication through usb port and arduino can take these through usb serial port.
- These values can be in turn sent to the motors to draw the image.

8. **Results:**

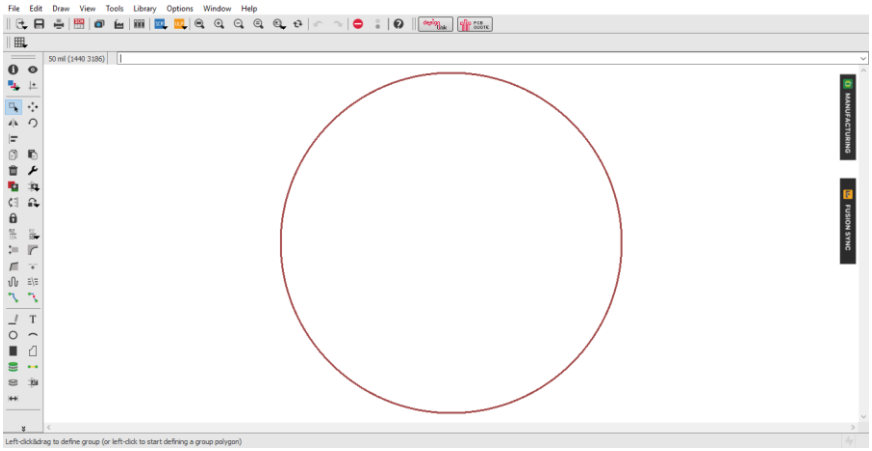


Figure drawn using Eagle

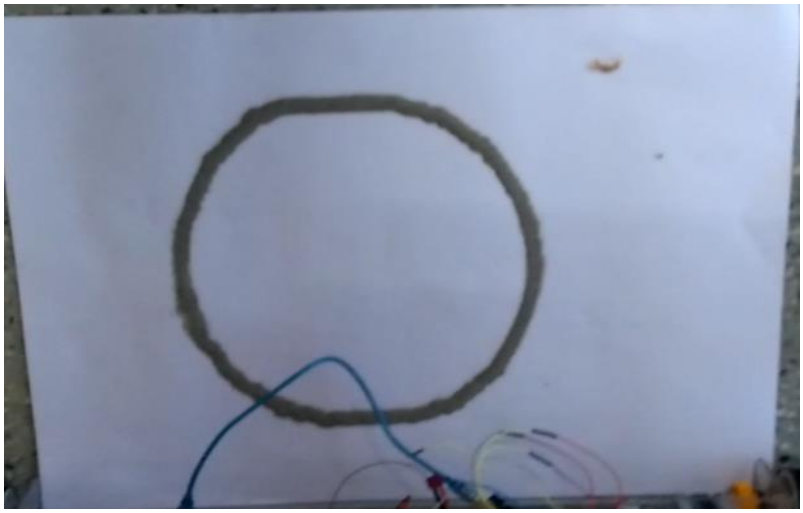


Image drawn using Robot

- The above two images clearly shows that the image which we drawn on eagle and image drawn by Robot are same.
- We tried SD Module to transmit the data but after connecting it with other part of the Robot. It is taking maximum power from arduino and allowing less power for the stepper motors.
- So, we used an alternative for transmitting data that is real time transmission of Data using **Pyserial** library in Python.

9. **Conclusions:**

- ➢ The Robot drew the Image similar to the input with the minimal error.
- ➢ SD Card Module extracts too much power from the arduino which leaves the other parts of the Robot incapacitated.
- ➢ Real time transmission is done using Pyserial library in python.

10. **References:**

1. The gerber file format specification http://www.apcircuits.com/Portals/0/Assets/Downloads/the_gerber_file_format_specification.pdf?ver=2015-06-13-175030-363
2. PCB layers https://learn.sparkfun.com/tutorials/pcb-basics
3. Pyserial https://media.readthedocs.org/pdf/pyserial/latest/pyserial.pdf