Automated Marker and Nesting Software

Pranav Bhatane

***Abstract*—In the 21st century, we make extensive use of plywood, steel sheets and aluminum sheets in our day to day life for various purpose but most of the times we need these materials in rectangular shapes, and we have to cut out them from rectangular-shaped sheets.**

We have developed a robot that can automatically optimize rectangular shapes and fit them into the minimum area so that the area wastage is minimum consequently the material wastage is minimized.

I. Introduction

The main intention of this project is to reduce the wastage of the sheet materials used for various purposes.
Generally, when we have to cut out some shape from any type of sheet we cut them randomly due to which a lot of material is wasted.
At the same time while marking the dimensions of shapes on the sheet error arises this is not desirable.
Generally, for this purpose industrial nesting software and CNC machines are used, but they are costly to use and have their limitations.
By the use of an automated marker, we can reduce the material wastage at the same time mark the shapes accurately.

II. Traditional Background

Traditionally for cutting, we have been simply randomly marking the shapes and then cutting them with the use of various cutting tools.
For efficient cutting, we use ‘nesting software’ along with CNC machines.
But these methods have their disadvantages and limitations.
Using CNC machines along with nesting software is not handy and CNC machines are costly.
In CNC machines, one can cut out on a fixed size of sheet

III. Proposed Solution

By use of an automated marker, one can draw shapes on sheets of any dimensions.
Compared of CNC machines it is easier to use.
It can be used on any type of material other than CNC machine where it is material dependent.
But the output is comparable to the output of the CNC machines
once the shapes are drawn on the sheet we can cut them out using a suitable cutting tool according to the material used.

IV. Implementation

For the Automated Marker we have used a Tricycle Design (inverted). Two wheels in front and a castor wheel in rear. The motors used are stepper motors with a step angle of 1.8° with a wheel of 3.5 cm radius.
Specifications of stepper motor: NEMA 17, step angle 1.8°.
For driving the motors we used A4988 Driver IC.
All the processing is done on SRA board with a ATMEGA 16 microprocessor.
Robot motion programming is done in embedded C.
Programming of shape optimization (Nesting Software) is done in Python.

V. Working

As our project needed high accuracy, we had two options to set our robot into motion:
1. By using DC Motor + Encoder
2. By using Stepper Motor
As the encoder disk of desirable ticks were not available in market, we tried 3D printing the encoder disks. We printed disks with 50 & 100 ticks, but there were irregularities in the prints which may cause huge error in the Motion and thus effect on accuracy of robot significantly.
As a result we had to use stepper motor. It was relatively costly but the efficiency and accuracy overshadowed the extra cost.
A stepper motor works very differently then a normal DC motor. It moves when HIGH-LOW pulse is given to it. Each pulse will make it move by one step angle so by applying mathematics($s = r\Theta$) we can determine the angle/steps to traverse specific length.

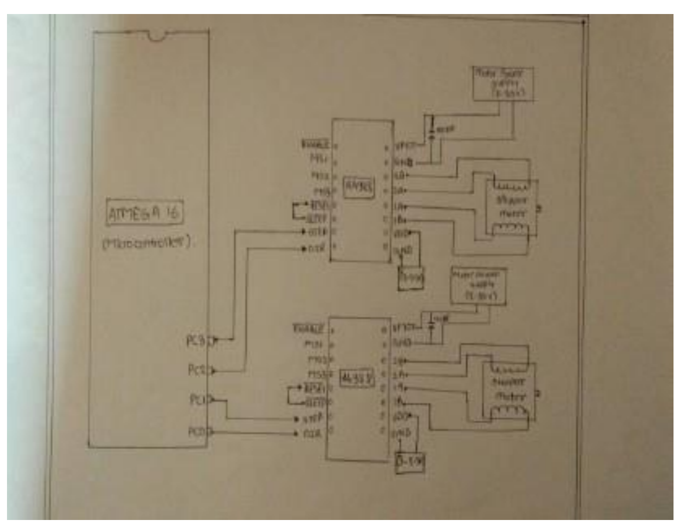


Fig. 1. Minimal Wiring Diagram

PranavBhatane (e-mail: pranavbhatane33@gmail.com)

Fig. 2. Automated Marker Bot

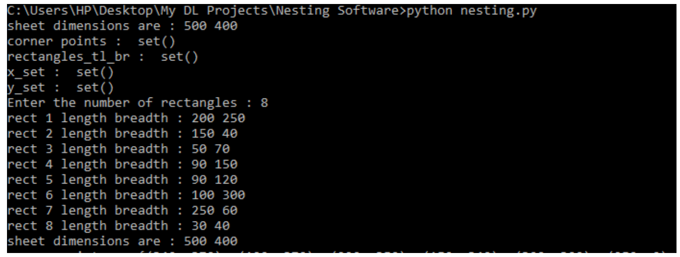
The Body of the robot is made out of Aluminum. As the clamps of steeper motors were not available we made the clamps manually using aluminum.
The pen is mounted in between the wheels on the axis of the motors and on the midpoint(approx).
The processor board is mounted on the robot itself, but it is powered externally with a 12V battery.
The robot is programmed to move from one co-ordinate to another. It can also be programmed to make some specific shapes by applying geometry.
The optimized shape co-ordinates are fed into robot and the shape is drawn.

Fig. 3. Result of drawing same rectangle over another.

As you can see the turns are not perfect at the moment. You can see small circles at the edges of rectangles. That is cause of misaligned pen holder.

VI. Nesting Software

We used greedy algorithm to arrange the given rectangles in such a way that there is compact packing of all rectangles to ensure minimal wastage of sheet. You can find related code on my github profile. Programming was done in Python. You just have to enter rectagle dimensions and program gives you coordinates of rectangles for compact packing.



```
C:\Users\HP\Desktop\My DL Projects\Nesting Software>python nesting.py
sheet dimensions are : 500 400
corner points :  set()
rectangles_tl_br :  set()
x_set :  set()
y_set :  set()
Enter the number of rectangles : 8
rect 1 length breadth : 200 250
rect 2 length breadth : 150 40
rect 3 length breadth : 50 70
rect 4 length breadth : 90 150
rect 5 length breadth : 90 120
rect 6 length breadth : 100 300
rect 7 length breadth : 250 60
rect 8 length breadth : 30 40
sheet dimensions are : 500 400
```

Fig. 4. Input given to the program

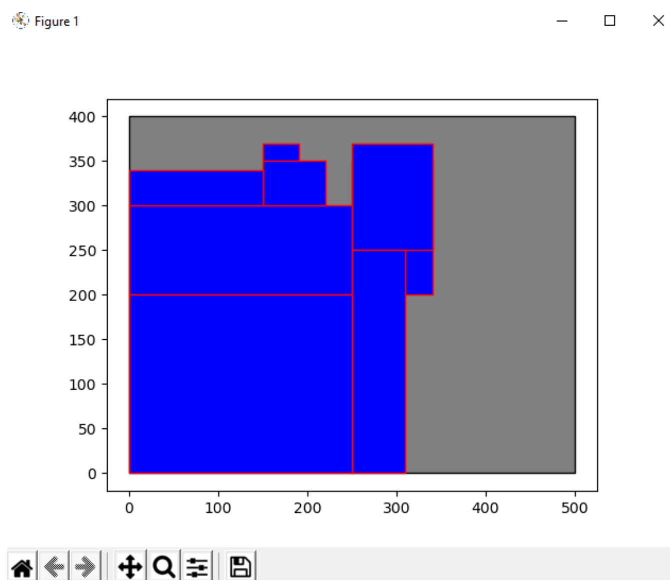


Fig. 5. Output by the Program

VII. Results

The robot is successfully making shapes with appreciable accuracy.
Slight error is observed due to the mechanical body, motor vibrations, improper floor point contact of pen, pen alignment and uneven surface.
Optimization of shapes is a tough problem statement there are a lot of algorithms for packing of shapes but we were not able to convert them into a code that could optimize shapes.
However, we tried to optimize rectangular shapes from scratch and we were successful.

PranavBhatane pranavbhatane33@gmail.com
7218314939