IMAGE PLOTTER

Team : Technoids

Introduction

Our project, Image Plotter, enables us to plot any image on paper. It takes in an image as input, and plots in on paper.

Technical Aspects

The project is divided into 3 parts : Mechanical, Electrical and Coding.
Coding is done on MATLAB and includes serial communication with arduino to drive the motors. Image processing of the image to be plotted is also done. This is done in MATLAB. The image is converted into an array.
Our project is actually based on moving the pen pixel by pixel, according to the image and drawing the image.

Theory

The theory can be divided in 3 parts - mechanical, electronics and coding.

Mechanical Part

Basic Mechanism
For the x and y movement of the pen, stepper motors are used since they are precise and easy to use.
More on stepper motors :
https://learn.adafruit.com/all-about-stepper-motors/what-is-a-stepper-motor

To control the stepper motors via arduino, 2 step controllers for each motor are used.The advantages of a step controller:
1. Easy functionality with arduino
2. Provides more precise movement via micro stepping
3. Acts as current amplifier
4. Sturdier than conventional drivers as it doesn't get heated easily.

To convert the rotational motion of motors to linear motion, timing belt and pulley is used.
More on timing belts: https://en.wikipedia.org/wiki/Belt_(mechanical)#Timing_belts

The movement on both the axes is carried out by linear bearings joined to stainless steel rods which allow for almost friction-less movement.This movement is guided by the timing belt which moves as per the rotation of the motor.
More on linear bearings: https://en.wikipedia.org/wiki/Linear-motion_bearing

Pen mechanism:
A simple up and down motion of pen is carried out by servo motor.
A hinged pen holder is held by servo motor. As it rotates to 90 degree, the propeller pushes the pen holder upwards(penup) and the pen holder comes down (while writing) as the propeller comes to 0 degree of the servo motor.

Electronics and Coding

Arduino Uno is used to control the motion of the motors.
Basics of arduino : https://stab-iitb.org/electronics-club/tutorials/arduino/

Image processing is done in MATLAB.(thresholding, edge detection etc.)
 Instructions to Arduino, to move motors, are sent by MATLAB through serial communication.

Logic of Code
Idea is to read an image and then convert it to a binary array of 0's and 1's (for white and black) [through thresholding] and store it.Then the nearest 1 from the origin is found and the motors are made to go to that point . Now all the 1's in its adjacent positions are found and the motor is made to move such that the pen goes to the coordinates of each and the same process is repeated with every 1 in the matrix. Once a 1 has been read then it is replaced by 0 so it can not be found again.

Image Processing
Thresholding is done on the image first and then edge detection carried out by inbuilt Matlab functions to convert image into a binary array.
Basics of image processing :
https://docs.google.com/presentation/d/1apvpjjkD3lApLPuWaqCmP0G7aEnkLFm9XU0d4GowG2s/edit#slide=id.g1419aa392d_1_10

Reference Links

Thresholding in image processing:
http://in.mathworks.com/videos/color-based-segmentation-with-live-image-acquisition-68771.html

Serial communication:
http://allaboutee.com/2011/07/04/how-to-send-data-from-matlab-to-your-arduino/

Servo motor:
http://playground.arduino.cc/ComponentLib/Servo

Step controller for stepper motors:
http://bildr.org/2011/06/easydriver/

Stepper motor working:
https://www.youtube.com/watch?v=4MSILOXYRoY

Belt and pulley
https://www.youtube.com/watch?v=cYIL5gxRogM

Lead screw vs timing belt:
http://www.marketwired.com/press-release/screw-driven-vs-belt-driven-rodless-actuators-how-select-drive-trains-reliability-efficiency-2012757.htm

Plan of Action

Week 01
(24th-31st May 2016)
- Decided the final design of the project.
- Studied about different motors and decided which one to use.
- Chose dimensions for the bot.
- Chose the material for the frame.

Week 02

(1st-7th June 2016)

- Started looking for the machinary parts.
- Bought most of the stuff and ordered for those which could not be found.

Week 03
(8th-14th June 2016)

- Started with cutting and drilling of bars and rods.
- The basic frame was set up.
- Studied MATLAB, image processing and arduino.
- The basic mechanism of the machine was made.
- Coding for Image processing was done.

Week 04
(15th-21st June 2016)

- Checked motors and started working on final placement of motors.
- Base of the machine was set up.
- Pen mechanism was prepared.
- Basic code on MATLAB and arduino was written and tested for simple figures on machine.
- The final code was also written.

Week 05
(22nd-28th June 2016)

- The bot finished by mounting all motors and attaching arduino and step controllers on the machine.
- Final code was tested and debugged.

Component List

component	price	place of purchase
2 stepper motors (4.2 kg-cm torque)	700	lamington
2 step controllers	1500	lammington
1 12V adapter	125	lammington
6 linear bearings (12 mm diameter)	1741	ravi transmission,masjid

servo motor 9gm	200	bombay electronics,lamington
arduino uno	400	bombay electronics,lamington
cable A to B	30	bombay electronics,lamington
2 m timing belt and 4 pulleys	920	ordered online
aluminium bars	800	pawan metal,bhandup
ss rods	440	suresh metal,bhandup
plywood for base	150	swastik plywoods,powai
other miscellaneous items like jumper wires,nuts,bolts,araldite	450	mangaldeep,powai

Photos and Videos

https://drive.google.com/open?id=0B2bp_OMm6nd9cnNEMTh4VjZwaWM