Mechanical Artist

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1 Abstract

The aim of this project was to make a robotic arm that, when connected to a computer through an Arduino, can trace any image given to it as input. The arm has three Servo Motors attached to it giving it three angles as degrees of freedom. A MATLAB code pre-processes the chosen image and computes the values of angles for which the pen is to be up (or down). This computed information is fed to the Arduino through its Serial Port. The Arduino then moves the arm correspondingly.

2 Components

- 2 large Servo motors
- 1 small Servo motor
- Wheels (broken off a toy)
- 2 rigid Aluminium rods
- Lots of tape and glue

3 Description

The project consisted of two main parts-

- Mechanical Part : Designing an arm like structure with two motors as the joints (shoulder and elbow) to move the pen in a 2-d plane and a third to lift the pen and to place it back on the paper. The arm was further supported by two wheels for more precise movement and for reducing the strain on the joints. The base of the arm was clamped to the table.

- Coding Part : A MATLAB code that processed the image using its pixellated array to determine the shoulder and elbow movements of the arm and feeding this information line-by-line to the Arduino via Serial Port. An Arduino code that read the angle-values incoming from the Serial Port and instructed the arms to move correspondingly.

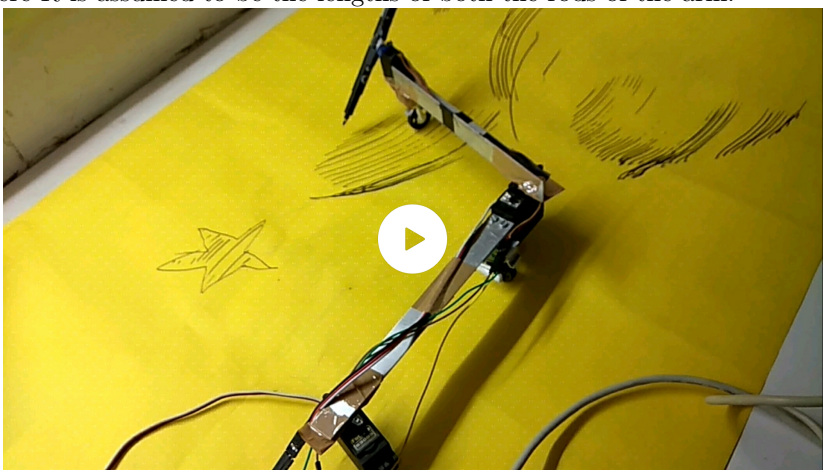
3.1 Details

If the shoulder joint makes an angle θ_1 with the x-axis and if the elbow joint makes an angle θ_2 with the shoulder, the corresponding coordinates of the end of the arm would be:

$$X = Rcos(\theta_1) + Rcos(\theta_1 + \theta_2)$$

$$Y = Rsin(\theta_1) + Rsin(\theta_1 + \theta_2)$$

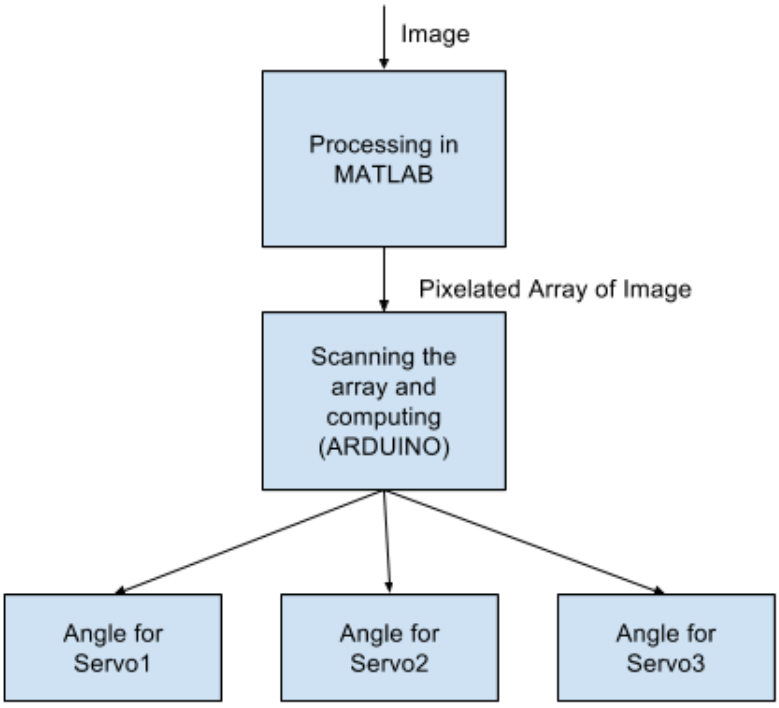
where R is assumed to be the lengths of both the rods of the arm.



A 60×60 black-and-white image is input to a MATLAB code which converts it into a 60×60 array. Starting from the initial angles the code computes the (X, Y) values for the (θ_1, θ_2) values to be covered in the next arc movement. These (X, Y) values are checked in the image-matrix to deduce whether the pen is to be kept up or down. The 60 such values are then fed to the Arduino.

The arm, starting from an initial position, moves the shoulder (θ_1) by 1 degree and consequently moves the elbow (θ_2) slowly in an arc of 60 degrees. All the while during this movement, it keeps its pen up or down according to the data sent by the MATLAB code. The elbow then goes back by 60 degrees (with its pen up), the shoulder moves by yet another degree and the iterations continue. After 60 such arcs the program ends.

4 Block Diagram



5 Timeline

- Week 1
  1. Started work on constructing the robot arm. Cut aluminium rods of desired lengths from the workshop.
  2. Collected the Servo motors and tested them.
  3. Tested small codes for serial communication between MATLAB and Arduino.
- Week 2
  1. Started work on MATLAB code to process the image.
  2. Fixed the motors on the robot arm.
  3. Tested small codes to move the arm as desired. Checked for precise movements and range.

- Week 3

    1. Fixed wheels on the arm to improve the movements.
    2. Fixed a pen on the third motor and tested using arbitrary inputs.
    3. Figured out an algorithm to convert a pixellated matrix to angles for the robotic arm.

- Week 4

    1. Completed the MATLAB code.
    2. Experimented with different parameters in the code and different kinds of images.

6 Distribution of Work

- Nandan Prince

    1. Major part of Arduino code.
    2. Mechanical design.
    3. Ideation, testing and experimentation.

- Abhijeet Melkani

    1. Major part of MATLAB code.
    2. Mechanical construction.
    3. Ideation, testing and experimentation.