



Drawing Robot using Inverse Kinematic Algorithm

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Abstract:

Many of the drawing applications such as Drawing in 3D, Wall painting, Decorating manufactured goods, Animation, etc. can be done manually but it's very time consuming, so drawing robot is less time consuming than manual process and this can be the solution for this. The project can be very useful for the PCB design. A servo motor uses pulse width modulation from Arduino unomicro-controller to know the position for the movement for its pen. The robot can move in both clockwise and anti-clockwise directions for drawing the picture. Servo motors are required to make support for ends. Caster wheels are required at the bottom of the arm with the pen for proper balance and support. Pen can be attached to the servo motor using cloth-pin. The robot will draw the picture based on changing the image in MATLAB using canny edge detection. Drawing command given by MATLAB Simulink via UART protocol.

Keywords: MATLAB Simulink for Arduino, Canny EDGE Detection, Arduino UNO, Servo Motor, UART (Universal Asynchronous Receiver Transmitter),

1. INTRODUCTION

Using this project one can save his/her self from humiliation in drawing. This project gives sufficient knowledge of Arduino, MATLAB Simulink for Arduino and mechanics. This project involves application of inverse kinematics. Servos are small but powerful motors that can be used in a multitude of products ranging from toy helicopters to robots. In this project the use of inverse kinematics is to determine the joint parameters that provide a desired position for drawing robot's arm. Servo motors are required to make support for ends of robot. By inserting the picture in MATLAB which we want to draw, robot will draw that picture.

2. LITERATURE SURVEY

Canny's edge detection algorithm is a classical and robust method for edge detection in gray-scale images. The two significant features of this method are introduction of NMS (Non-Maximum Suppression) and double thresholding of the gradient image. [1]. Image segmentation is an essential step in image analysis. Segmentation separates an image into its component parts or objects. The most commonly used edge detection techniques for image segmentation and also the comparison of these techniques is carried out with an experiment by using MATLAB software [2, 3]. The traditional canny edge detection operator was a good tool for detecting image edges, but it was too sensitive to noise and under the environment with noise, the canny operator was too easy to detect edges mistakenly. Edge detection is the process of finding quick contrasts in intensities in an image. This process significantly reduces the quantity of data in the image, while preserving the majority important structural features of that image. MATLAB is a high-performance language for technical measures as well as computations. It combines calculation, apparition, and programming in an easy-to-operate environment [4, 5]. Servo motor is position controlled motor. It can easily control physical movement of objects due to its position controlled feature. Servo motor

cannot move continuously. Servo motors rotate in angle ranging from 0 to 180 degree. Servo motor has many applications in robotics and industry for position based motion control system. With Simulink Support Package for Arduino Hardware, we can use Simulink to develop and simulate algorithms that run standalone on our Arduino [6].

3. PROPOSED SOLUTION AND WORKING

The working of the algorithm is very simple; it is just the matter of visualizing how the bot approaches the image drawing. This is an elaborate explanation. Firstly, we convert the image that we want to draw in png format using some image editor, and then we save the Image in the MATLAB directory. Now our algorithm converts this image using canny edge detection as given in the image above. The mysterious part is drawing this image. What the algorithm does is it starts checking the pixels of the converted image and when it finds 1 which is indicated as the white pixel in the image above, the pen tip reaches that and puts the pen down then it checks neighboring 8 pixels, if it finds a 1 it reaches that point without lifting the pen up and deletes the previous pixel to avoid repetition. Now this continues till it finds no 1s in the neighborhood (this is a recursive function) hence it draws smooth line deleting it simultaneously. Then it completes other branches of lines that emerge from the drawn line as it checks every neighboring pixel. This algorithm ultimately creates the whole image.

4. BLOCK DIAGRAM AND MAJOR COMPONENTS

4.1 Servo Motors

Servo Motor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. Servos are controlled by sending an electrical pulse of variable width, or pulse width modulation [PWM] through the control wire. The PWM sent to the motor which defines the position of the shaft, and based on that pulse duration the rotor will turn to the desired direction. PWM is the analog output by digital means which is taken by Arduino in this project for drawing the image. Servo motors are small in size and light in

weight which enables robot to draw image smoothly. Servo motors have three wires: power, ground, and signal. The power wire is typically red, and should be connected to the 5V pin on the Arduino board. The ground wire is typically black or brown and should be connected to a ground pin on the Arduino board. The signal pin is typically yellow, orange or white and should be connected to a digital pin on the Arduino board.

4.2 Caster Wheels

A caster is a wheeled device typically mounted to object that enables relatively easy rolling movement of the object.

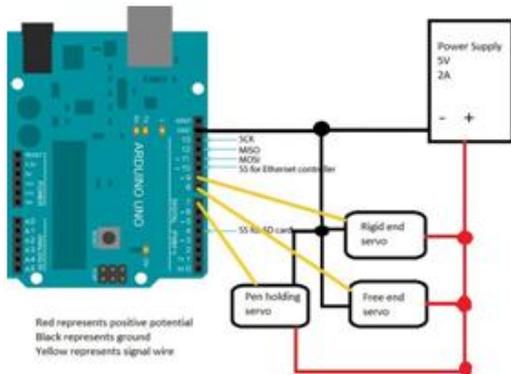


Figure.1. Block diagram

4.3 Arduino UNO

The Arduino Uno is a microcontroller board based on the ATmega328. It has 32k Byte in system programmable flash, 14 digital I/O pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack 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. "UNO" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino and it is the first in a series of USB Arduino boards, and the reference model for the Arduino platform.

5. HARD WARE AND FLOWCHART

As shown in Figure 2 there are three servo attach with Arduino. 1. Pen holding servo move pen up and down for drawing. 2. Rigid servo moves the arm to left side and right size. 3. Free end servo used for curvature motion for small arc drawing. Arduino control servo position through PWM pulse. Arduino and MATLAB communicate through UART protocol with 9600 baud rate. Using canny edge detection method MATLAB control servo position through MATLAB Simulink Arduino and draw complete picture on paper.

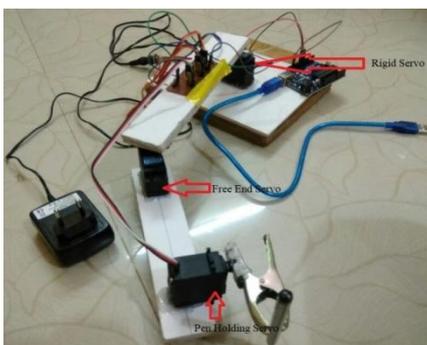


Figure.2. Working of Hardware

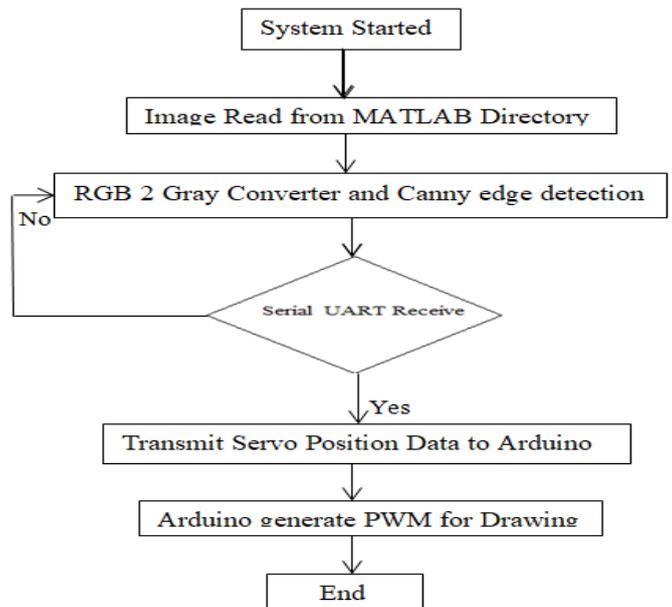


Figure.3. Programming Flowchart



Figure.4. MATLAB Output

As shown in Figure 3 First we take an image and find its edges with the help of canny edge detection which output given in Figure 4 and we are going to draw this image. Drawing the image has two parts:

PART 1: First we find the pixel which is 1 as our image is now in the form of 0s and 1s and then check its local pixels if any one of them is also 1 then the pen reaches that pixel and deletes the previous 1. The function repeats itself recursively and creates smooth lines.

PART 2: The second part involves the inverse kinematics part of how to reach that particular pixel. It simply takes in the coordinates of the pixel and calculates the corresponding angles for the pivots, the calculations are shown in the below picture.

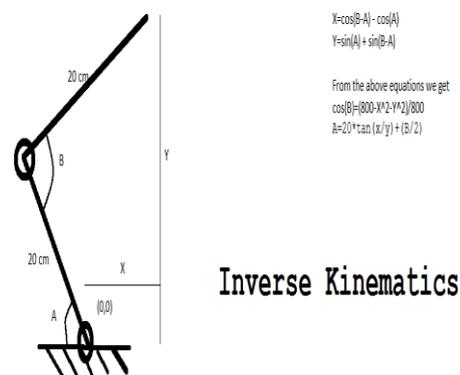


Figure.5. Equation of Inverse kinematics

6. APPLICATION

There are many of the applications of drawing robot are Drawing in 3D, PCB Design, Wall Painting, Decorating manufactured goods, Animation.

7. CONCLUSION AND FUTUREWORK

By interfacing Arduino with IOT we can operate over drawing robot through internet. All the physical objects (things) are connected together using internet infrastructure. Arduinoboard is one of the most important objects in this ecosystem.

8. REFERENCES

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