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Epitome

We are building a spectacular drawing unit that is easily controllable and programmable for everyone without any relevant professional knowledge via the self-designed image processing software developed specifically for this machine.

Project I.

Drawing machine

***Specification***

# Introduction

We are going to implement an automatic drawing machine, with a user friendly image processing software designed and written for this specific task.

The aim of this project is to make this machine usable for people with no related programming knowledge. Also, with this robotic arm, we can draw figures very precisely to avoid human mistakes, or to be able to draw under different extreme enviromental circumstances. For example, using an air-brush combined with this tool, no worker has to suffer from the negative side effects of the toxic gases emitted during the painting.

We are splitting up the project described above into 2 parts.

In the first part we are going to assemble a self-designed manipulator which can move along all 3 dimensions.

In the second part, we are going to develop the user friendly driver software for this hardware.

# Requirements

We have the following requirements stated against the final produnct: the arm can paint and reproduce the same picture that we loaded into our software. Then, this software should be able to calculate the drawing routes from the input image and save them as individual projects, so that we can load them later in case we want to reuse them. Finally, anyone without related programming knowledge should be able to program the robotic arm with the help of our image processing software.

In the end, the manipulator should reach 2mm precision.

As for the time requirements, the drawing machine will be able to draw a 500x500 pixel image in 5 minutes.

At the end of the whole project, after the 2 semester, it will be able to draw a picture using one color. The plan is to make it easy to implement an improvement, where the unit will be able to use several colors.

# Features

The robotic arm is portable, and can reproduce the input image under extreme enviromental circumstances. Also, with this software we can observe and monitor the ongoing process.

# Input

At the end of the first semester for the input we will load a pre-defined coordinate map which will contain the colored points of the final image that the unit will draw.

By the end of the second semester the input of our tool will be a single BMP image, that we have to load into our software, which will define the final picture.

# Output

The drawn black and white picture of the robotic arm on a piece of paper.

# Block diagram



# Implementation description

1. **Harware list**
   * Microcontroller
     + Arduino Leonardo
       - Microcontroller ATmega32u4
       - Operating Voltage 5V
       - Input Voltage (recommended) 7-12V
       - Input Voltage (limits) 6-20V
       - Digital I/O Pins 20
       - PWM Channels 7
       - Analog Input Channels 12
       - DC Current per I/O Pin 40 mA
       - DC Current for 3.3V Pin 50 mA
       - Flash Memory 32 KB (ATmega32u4) of which 4 KB used by bootloader
       - SRAM 2.5 KB (ATmega32u4)
       - EEPROM 1 KB (ATmega32u4)
       - Clock Speed 16 MHz
       - Length 68.6 mm
       - Width 53.3 mm
       - Weight 20g
   * Laptop
   * Wooden skeleton and other components (gears etc.)
     + Birchplywood4 mm (1525x1525 mm BB/CP)
       - Density:Medium density, but excellent strength
       - Values (kg/m3):air dry: 650-830,  absolute dry: 610-800
       - Its strength characteritics are similar to beech, but it has lower density, so it is more optimal to manufacture furniture constrtuction
       - It has extraordinary flexibility and toughness
       - Quality: BB/CP  
           BB side: smaller, healthy ingrown knots and slight discoloration may occur  
           CP: smaller branch failures and slight discoloration may occur  
         Easily workable, it is possible to manufacture it rapidly
   * Self designed manipulator
     + 3 micro-servo
       - ES-07 JR
       - Size: 23,8 x 19,6 x 8,2 mm
       - Weight: 4,4 g
       - Setting torque: 5 Ncm at 4,8V
       - Setting time: 0,09s/60° at 4,8V
       - Material of drive: plastic
     + Breadboard
     + Jumper wires
2. **Software list**
   * Windows operation system
   * Graphic design software for eg. Paint
   * Self-developed image processing software
   * Arduino IDE
   * Manipulator controlling software developed in Arduino IDE

# Verification against requirements

We would like to show the unit while it is recreating the image from the pre-defined coordinate map that we loaded into the image processing software.

We would like to measure the precision with a ruler, and the time taken to draw the image with a timer.

# Timetable

# Cost estimation

# Milestones

* Connecting the circuit including the Arduino and 1 micro-servo and successfully drive the servo
* Manufacturing and assembling the wooden skeleton
* Attaching 1 gear-rack combination to a servo and moving it along 1 dimension
* Assembling the second servo and its gear(s), and being able to move to the desired coordinate in a 2D coordinate system
* Adding the 3rd servo, which will move the pen in up-down direction to touch the paper or lift it up from it