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P.I.C.A.S.S.A.U.

Painting Implementation Crafting Artwork of Subjects Selected at Auburn University)

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Executive Summary/Abstract

The purpose of this proposal is to detail the process of designing and constructing an automated painting robot, P.I.C.A.S.S.A.U (Painting Implementation Crafting Artwork of Subjects Selected at Auburn University). This document covers the technical and management approaches used in the project as well as the budget, timeline, facilities and potential problems that were involved in the development of P.I.C.A.S.S.A.U. Finally, this paper concludes with the disposition agreement that describes what will be done with the robot at the end of the semester.

Problem Statement and Solution

Photographs capture the world as seen through a lens. However, they do not carry the same emotional effect or artistry as a painting. The problem with this is that not everyone has the skills necessary to craft a beautiful painting. The solution to this problem is to create a robot that can paint a picture given a user-supplied image.

The goal of the P.I.C.A.S.S.A.U. project is to autonomously render an image from a photograph onto a canvas. We plan for P.I.C.A.S.S.A.U. to accept an image either by loading it onto the main computer or taking it with a webcam. After obtaining an image, the computer will filter the image to simplify it. This process will identify the important edges in the picture and reduce the number of colors required to paint it. Next, the computer will vectorize the image. From the vectors, it will create a series of commands and coordinates to send to the Arduino on the structure. A paintbrush will be suspended from the two stepper motors at the top of the structure. The Arduino will move the paintbrush to the specified location by controlling these stepper motors to paint the picture. At the end of this process, P.I.C.A.S.S.A.U. will be able to generate a simplified painting from a photograph.

Note that this is the basic plan for the future of this project. More features will be added as time permits.

Technical Approach

Design Summary

The frame and supports are made out of PVC pipe. A piece of particle board serves as the backboard onto which paper or canvas can be fastened. Two stepper motors are mounted outside and above the top corners of the canvas area. Spools are attached to the motors with fishing wire wrapped around them. The fishing wire is tied to a carriage that hangs in front of the canvas area and holds a brush. The brush is connected to a servo that allows it to both perform brushing motions and move away from the canvas when the carriage moves to a new location. The carriage can be moved around the canvas by controlling the motors with the Arduino. Counterweights hang on the outside of the spools to ease the load on the motors. To paint, an svg file is parsed by our Python script that extracts path information and formats it to be read by the Arduino. A diagram of the structure is shown below in Figure 1.

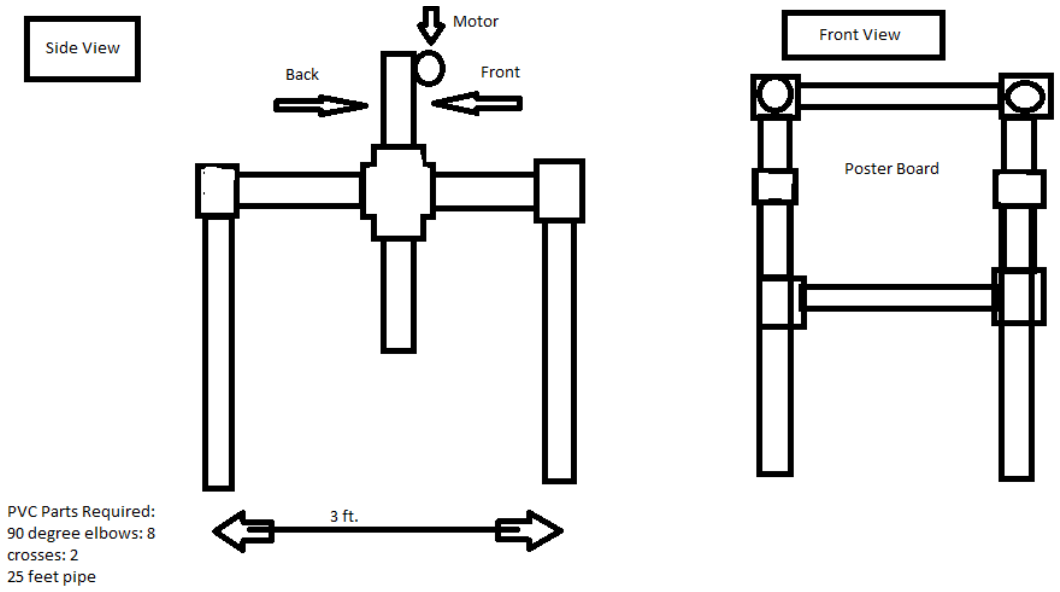

Figure 1: Diagram of the PVC structure of the robot

Standards Utilized

1. RS-232 Serial Connection - Between computer (Raspberry Pi) and Arduino
2. SVG (Scalable Vector Graphic) file format - Format of image files
3. XML (Extensible Markup Language) - SVG files are written in XML

Constraints Considered

1. Limited colors (three or four)
2. Limited brush size and resolution of paintings
3. Weight of brush carriage
4. Canvas size (22” by 36”)
5. Time to paint
6. Cost of final parts ($300 total cost limit)

Potential Problems

Below is a list of anticipated problems, broken into categories.

Hardware

1. String hitting support bar when carriage is at bottom corners of canvas could distort picture
2. Effect of motor vibrations on picture quality
3. Stability of structure, i.e. need more supports as we add components and weight?
4. Balancing brush carriage
5. Prevent swinging brush carriage
6. Motor or motor controller overheating, melting plastic

Software

1. Undetected bugs in Arduino-Python script interface
2. Controlling motors based on coordinates from svg file
3. Tuning the servo brush strokes

Miscellaneous

1. How long will it take to paint a typical picture?

Further Tasks to Accomplish

1. Filtering/simplifying pictures from webcam
2. Generating svg files from simplified pictures
3. Cleaning brush between colors
4. Mounting the paint source
5. Re-wetting brush routine

Management Approach

Our team will strive to perform all team functions evenly and justly. All major decisions will be discussed amongst the team. The various options will be considered and then the team will collectively decide which route to go. During the Cycle 1 and Cycle 2 weekly status meetings, we plan to rotate meeting duties. We plan to allow every member to run the meeting at least twice, including making an agenda and preparing for the meeting. Additionally, we will cycle through a weekly secretary. It will be the weekly secretary's job to record meeting minutes. The minutes will be posted as a document on our team's website, to allow all members to easily access them.

Communication will be handled through a variety of channels. One such channel will be through tigermail, the official email service of Auburn University. This allows for quick communication. Another channel is through the announcements page on the website, a private page where team members can discuss various non-urgent issues and/or research. Posting an announcement also allows members to comment on it, allowing for discussion on various topics. Additionally, the announcements page provides a convenient way to look at a complete history of discussion on the project, as all announcements are saved on the website.

Meetings will be held during our regularly scheduled senior design class time, on Monday, Wednesday, and Friday at 2:00, as needed. Additional time may be scheduled on Tuesday and Thursday afternoons, or in the evenings, as workload and deadlines may require.

Budget

Funds will be provided by the team members. A goal of no more than $60 per person, or $300 total, is set for our project. Team members will buy the materials and items themselves, keeping track of their purchases on a shared expenses log as well as keeping receipts. Then, at the end of the project, the expenses will be tallied and we will even out the expenses, paying each other back as needed. After getting the project working, there is a potential to recoup some of the expenses by selling the robot's painting services.

Shown below are some of the potential costs facing the project, and their estimated costs.

Item	Purpose	Estimated Cost
Stepper Motors	to replace the underpowered motors used in the prototype	$100
Frame Hardware	to support the hardware	$20
Mounting Hardware	to mount the spindles onto the motors	$15
Painting Supplies	brushes, paint, and canvas/ posterboard	$15
Motor Controllers	to drive the stepper motors	$20
Raspberry Pi	to run the software	$35
Display	to interface with the raspberry pi	$15
Webcam	to take pictures to paint	$15
Microcontroller	to interface with the hardware	$10
Miscellaneous Electronics Hardware	wires, sensors, servos, etc.	$20
TOTAL		**$265**

Table 1: Proposed budget for the project.

Timeline

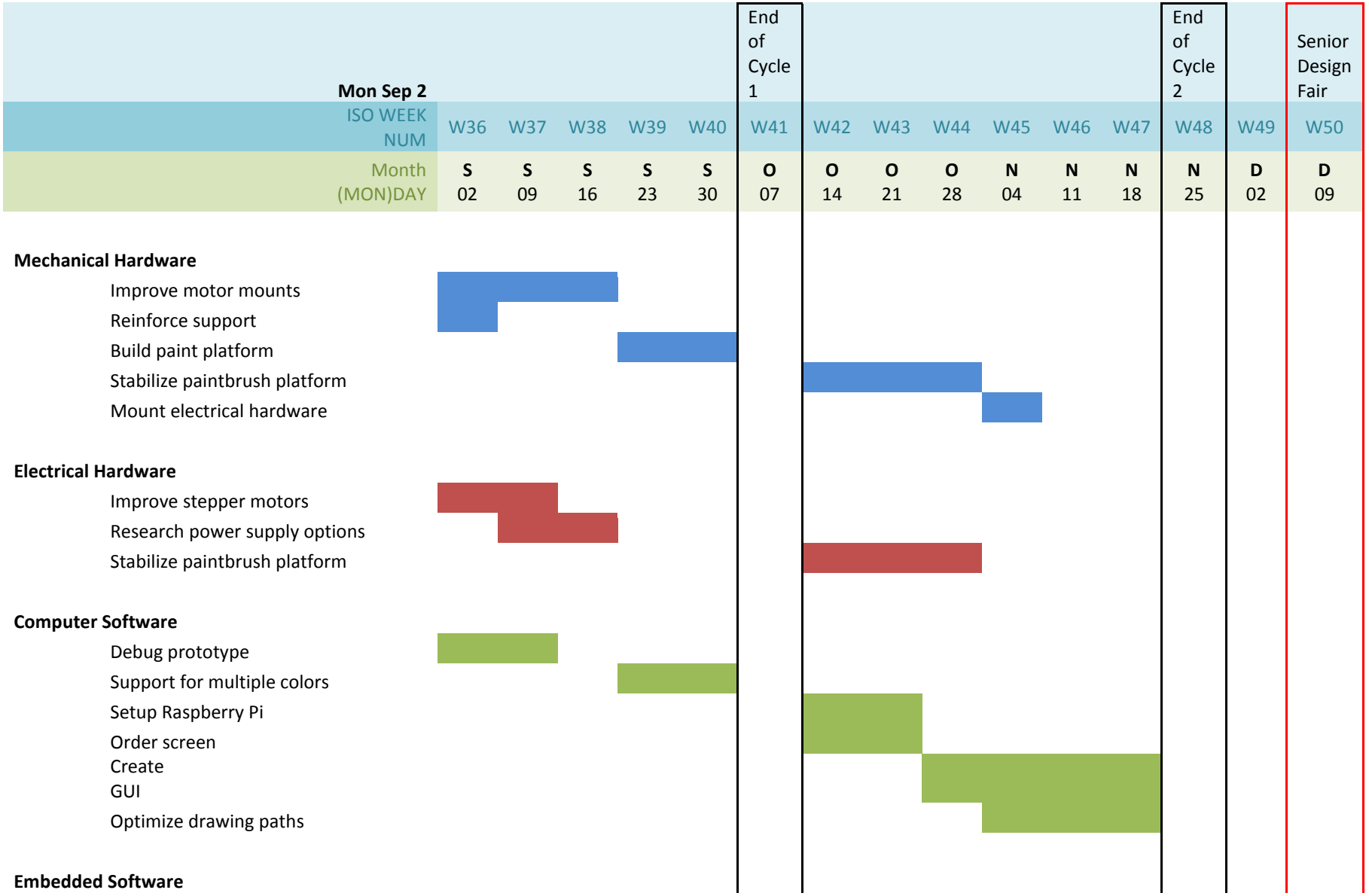

Table 2: This Gantt chart outlines the timeline for the project

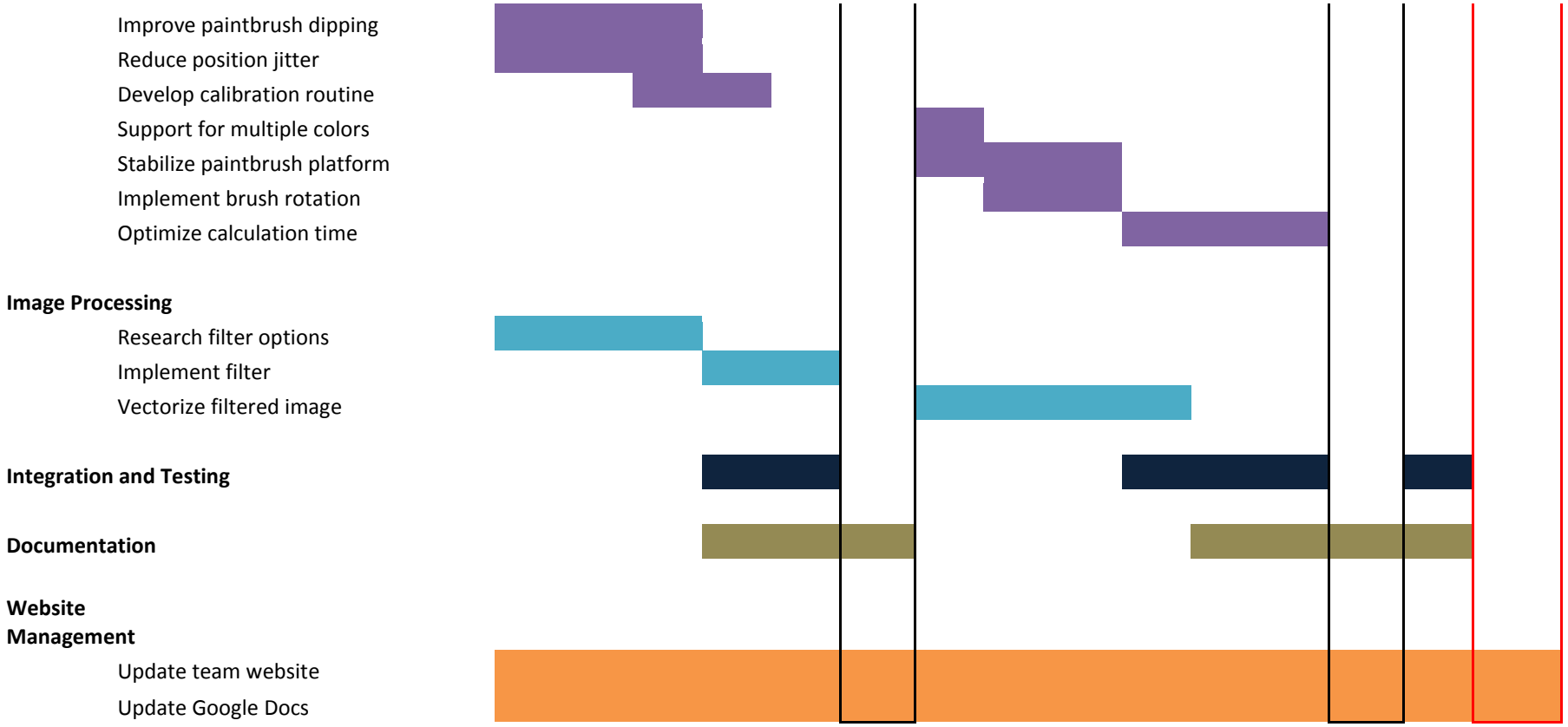
Improve paintbrush dipping
Reduce position jitter
Develop calibration routine
Support for multiple colors
Stabilize paintbrush platform
Implement brush rotation
Optimize calculation time
Image Processing
Research filter options
Implement filter
Vectorize filtered image
Integration and Testing
Documentation
Website
Management
Update team website
Update Google Docs

Table 2 (ctd.)

Facilities

We have used both the SPaRC and Senior Design Labs during the initial stages of our senior design project. We use the Senior Design Lab primarily for meetings regarding planning and other administrative tasks. On the other hand, SPaRC has graciously allowed us to use its lab space, equipment, and spare parts for building and testing our robot as well as writing code.

Disposition Agreement

When the PICASSAU project is finished, we will leave all of the components together and it will be left with the department to be used as a display. Our goal is for it to be used in recruiting efforts such as E-day. We plan to leave it in the Senior Design Lab (306). Optionally, it can be claimed by SPaRC if they so choose. If there is not enough room in either lab to accommodate the robot, it will be deconstructed and the parts donated to SPaRC.

Signed:

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