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WHITE BOARD ROBOT

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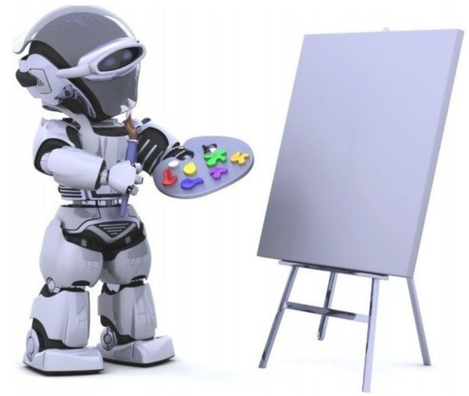

Abstract

The quality of education can often be improved by improving the tools available for teaching. Many teachers utilize whiteboards to display information to help students learn and/or remember important information. With the rise in online remote learning, it is all the more useful for teachers to be able to use their whiteboards remotely.

Our solution is to implement a robot that can remotely write, erase, and scan a whiteboard. The robot can be used anywhere through an internet connection, allowing anyone the ability to send images to the robot to draw on a whiteboard. In order to see if anything is already on the whiteboard before drawing a new image, a camera mounted on top of the whiteboard is used to view the whiteboard. These images can also be saved for later, and then the user is able to control the eraser on the robot to erase the whiteboard. The robot can also be stored above the whiteboard when not in use so it will not interfere with in-person use of the whiteboard.

Introduction

The robot had to fulfil the requirements listed below in Table 1. We based our design around using a polar-plotter as it is the most mechanically simple type of drawing machine to construct. We found many examples of polar-plotters, but none of them were internet-controllable. We used a Raspberry Pi to control the robot, and then configured the Pi to be remotely controlled through the internet via VNC Viewer.

Table 1: Customer Requirements

Customer Requirements
Write on whiteboard
Erase the whiteboard
Operate remotely via internet
View whiteboard remotely
Save images of whiteboard
Scan the whiteboard
Accurate within 1 cm
Does not interfere with local use of whiteboard
Safe
Work on any size whiteboard

Design Overview

The base of our design uses a polar plotter that moves a gondola suspended between two motors around the whiteboard. The gondola contains the marker and eraser, as well as electronics to control the positioning of them against the whiteboard. The marker position against the whiteboard is controlled by a servo, while the eraser is position is controlled by an electromagnet embedded in the eraser. The polar plotter motors are operated by a Ramps 1.4 motor control board controlled by a Raspberry Pi. The Raspberry Pi has an open-source polar plotting software, Makelangelo, installed to perform image processing and send commands to the polar plotter. An HD webcam is also plugged into the Raspberry Pi and mounted on a servo-controlled arm above the whiteboard to extend and retract the camera when needed. The Raspberry Pi is remotely accessible anywhere via VNC Viewer, allowing users to use the robot from anywhere.

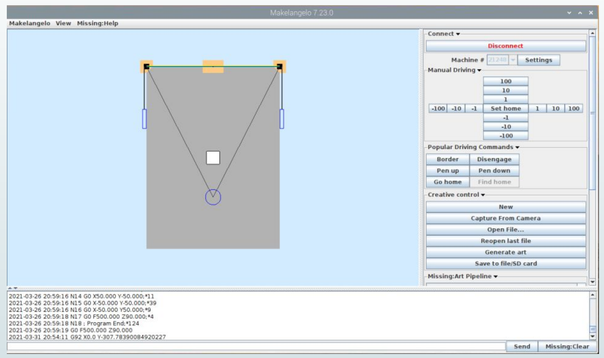

Figure 1: Makelangelo Software on Raspberry Pi

Figure 2: Initial Build of Whiteboard Robot

Design Process

Our design process is summarized in the list below.

- Drafted requirements with client
- Researched methods related to project
- Collaborate in weekly meetings
- Created a prototype design
- Constructed prototypes
- Integrated and tested subsystems
- Redesigned systems as necessary based on results and client feedback
- Report

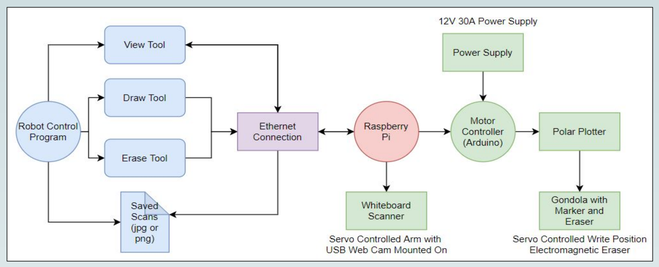

Figure 3: Design Architecture

Results

Our design and implementation resulted in a functional robot. Images are able to be uploaded by the user and then drawn on the whiteboard. The eraser can also be utilized, and the camera is able to view and scan the whiteboard. All of the functions are usable remotely through the internet. However, not all of the initial design requirements were met. Initial testing showed that the robot was not as accurate as required. Also, the electromagnet embedded in the eraser was not strong enough to provide sufficient contact to erase the whiteboard. But, all of these issues could be resolved with just a few improvements, and overall the robot is functional and usable.

Conclusion

The whiteboard robot is a useful tool that could improve the teaching process for teachers. It is functional and able to be used from anywhere. It is able to be adapted to virtually any whiteboard size. However, there are still improvements that can be made to our design to improve the accuracy and eraser performance.

Acknowledgments

We would like to acknowledge Dr. Kyle Winfree, the client of our project for assigning such a great idea for learning new things, providing motivational support and helping us in difficult times. Also, we want to thank Dr. Robert Severinghaus and Han Peng, the professor and the GTA, for the wise guidance that has made this project a success so far.

References

[1] H. Hua, “A web design mode for browsers to CSS compatibility Issues”, Nov 04, 2012, published by IEEE.

[2] W. Jiang, “Responsive Web Design Mode and Application”, Sept 30, 2014, published by IEEE.

[3] Z. Zhang, “Whiteboard scanning and image enhancement”, March 2007, Vol. 17, Issue 2, Pages 414, 432 Digital Signal Processing.

[4] K. Fodge, “Turbo-coding Whiteboard Scanner”, available [online], https://kaptivo.com/