Paint by Bits

Senior Design Project Proposal

Tim Bontrager

Sarah Divel

Kelsey Han

Elizabeth Huschke

Introduction

The paint-by-joystick design project was first introduced by ADEC. The premise of this project is to create a system in which a user utilizes a joystick that controls a robotic device which dispenses paint on to a piece of paper. Our goal is to design a cost efficient and user friendly system that improves the quality of life of the individuals at ADEC.

Problem Description

ADEC provides a range of services for people with developmental and physical disabilities to help them "live, learn, work, play, and achieve the same as anyone else,"[1] including family services, employment services, supervised group living and supported living services, and day services.

One of the goals of ADEC's day services in particular is to provide adults living with developmental disabilities with meaningful days by helping them to discover their natural abilities and interests. Many of ADEC's clients enjoy painting, but some lack the motor skills necessary to grasp and maneuver a paintbrush. Currently, ADEC employees have to manually assist clients by holding the client's hands on the canvas. This is not in keeping with ADEC's mission of independence for its clients. The goal of this project is to create a system that can take the role of the second hand, giving independence back to ADEC's clients. They will be able to control a painting utensil using a joystick in order to create a painting on their own.

Proposed Solution

Our proposed solution can be divided into three broad areas. The first area is the user interface, where the client will manipulate a joystick. The user interface will also include an LED alert system that will give necessary information to the user about if the power is on, if the "paint brush" is in motion, etc. This will optionally be paired with an LCD screen to convey appropriate

[1] adecinc.com/our-services

messages. The second area is a microprocessor unit, which will receive signals from the user interface, as well as feedback from the dispensing unit. The third area is a color dispensing unit. This unit will be physically placed onto an easel, and will dispense a coloring agent onto the canvas. Figure 1 shows how these parts are logically organized.

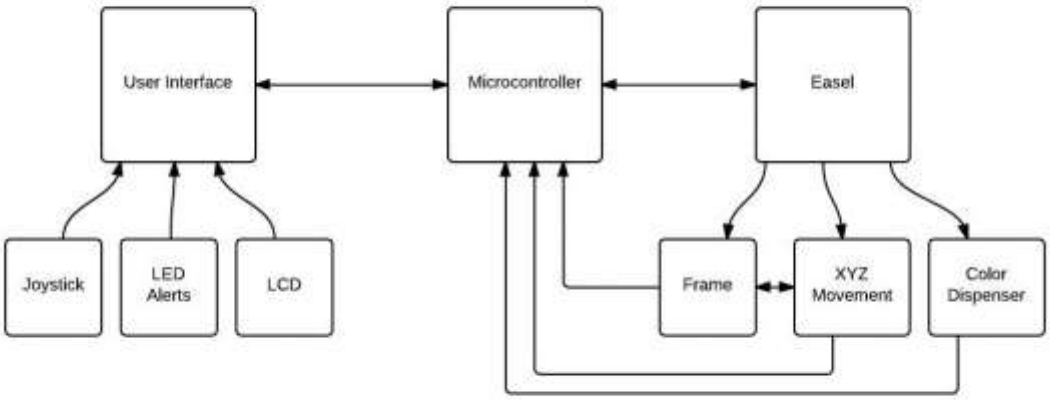

Figure 1. Functional Block Diagram

Demonstrated Features

The user interface's primary purpose is to allow the user to control a color dispensing unit by joystick. It will consist of, minimally, a joystick and several Light Emitting Diode (LED) warning lights. These lights will indicate whether power is reaching the system, as well as indicating whether the device is in an error state. Possible error LEDs include indicating if the motor is color dispensing unit is near the edge of the track, if the paint is out, or if the device requires cleaning. The UI may also include the LCD screen to communicate current color selection, and to simplify troubleshooting.

The microprocessor component will take input from the UI, and communicate these inputs to the mobile platform, as well as the color dispensing unit. Additionally, the microprocessor will receive position and color data from the color dispensing unit. The positioning data will be used to ensure that the mobile platform does not overrun the edge of the frame, while the color data will be communicated back to the UI for display.

The color dispensing unit will be physically placed onto an easel. The primary goal of the color dispensing unit is to allow the placement of coloring agents onto the canvas. Possible candidates for coloring agents include paint, Crayons, Indelible Markers, and Pencils. The methods for applying these agents must ensure that the device can be used repeatedly, safely, and with minimal wasting of coloring agents. Proposed methods for applying the agents include contact application, such as with pencils, Crayons, markers, or a physical paintbrush. Other methods include spray nozzles, such as a spray paint application, or current methods of 3-D printer nozzles.

The color dispensing unit will also be mounted on a moving platform, which will allow the movement of the color dispensing unit in accordance with how the user manipulates the joystick. The mobile platform will move the in at least two dimensions around the canvas, with a possible third degree of freedom if the color dispensing unit requires being lifted from the canvas (such as with Crayons or paintbrushes.) Possible solutions for the mobile platform include tracked motors, and robotic arms.

Available Technologies

Interfacing with a simple analog joystick is a technology that has already been implemented in various ways. There will be some configuration issues with the joystick depending on the brand, but the interface is feasible.

There are various motor tracking technologies already in place. A simple linear motor may be used. In order to get X-Y tracking, inspiration will be taken from a project constructed using T-Slot frames, found on instructables.com.[2] This example uses an Arduino to control the tracking system and therefore should be feasible to translate to the PIC microcontroller to be used. This setup also is reasonably priced and should fit into the budget constraints.

The paint dispensing technology has been implemented by a variety of robotic groups. A variety of spray application devices are already used, particularly in the automotive industry. However, these spray painters are dangerous, producing toxic fumes. The most common coloring method used by hobbyists appears to be physically dragging a paintbrush or marker across the canvas. Additional technologies for printing include using inkjet devices, both homemade and ripped from a printer.

Engineering Content

The first major design issue will be interfacing the joystick with the microcontroller. This will require research on the outputs of the joystick and be able to connect it in a useful way to the microcontroller. Choosing which joystick to use will also be important in finding the best way to communicate with the microcontroller.

The second design issue will be interfacing the motors on the tracks with the microcontroller. This will require feedback from the frame structure that will let the microcontroller know when it's position as well as if it has reached the edge of the frame.

The last design issue will be figuring out how to connect the paint dispensing mechanism to the frame. It is anticipated that the frame will have space constraints, which will limit the size of the paint mechanism. Deciding which coloring agent to use (paint, colored pencils, etc.) will also impact how the fixture will be implemented. For example, if a spray nozzle is used, a

[2] http://www.instructables.com/id/Internet-Arduino-Controlled-T-Slot-XY-Table/

mechanism will be required to turn on and off the spray. If a colored pencil is used, a mechanism will be required to lift the pencil off of the paper, to get the desired z direction movement.

Conclusions

As described in the above sections, this project is feasible, cost effective, but will require some interfacing configuration. The goal of this project is to fulfill the base requirements of the design, which includes X-Y motion tracking, Z motion that allows for discontinuous strokes, and using a joystick as the user interface. Additional features may be considered for future revisions of this design, such as being able to change the color of the dispenser, using a wireless joystick, or implementing an alert when the coloring agent is low. The secondary goal of this design is then to allow for future revisions such as these, in order to be able to continually improve the design.