Senior Design Project Proposal

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ECE 445 Spring 2018

1. Introduction

1.1 Objective

Code is everywhere in the world and coding has become an essential skill for not only the engineers but also everyone who wants to dig in big data. Nowadays, many kids are exposed to coding at a very young age. Their brain is capable of handling different coding problems. According to VentureBeat, many good programmers started programming since 5 or 6 years old. However the steep learning curve of coding can scare off the kids before they really develop interests in it. Thus, it is necessary to have a good platform which could serve as a fun and easy coding environment. This platform should consist of both physical and virtual parts, where the virtual part is a coding software which should be simple to learn and the physical part should be responsive to execution instructions. Besides, safety precaution needs to be strictly imposed.

In this project, we aim at providing kids with a younger age (under 5) a platform to learn coding. These kids might not be capable of coding through software and hence our solution will be focusing on the hardware. Our goal is to create a color-coding based robot which converts detected color into different instructions. In order to provide the kids a feasible way of learning codes, the instructions will be executed as simple motions such as moving forward, backwards, turns, etc.

1.2 Background

Many companies target at kids and have different kinds of product which could be used to learn the knowledge of coding. However, color-coding based product is scarce and most of the existing products do not allow kids to write their own color code. So in our project, we aim at developing a kit which will cover these scarceness. The kit itself will be separated as different modules and have the ability to be built completely from scratch by kids. Once they construct the kits, kids will be able to use our intrinsic color-based code or design their own color-based code.

1.3. High-level Requirements

1. The control board can differentiate at least six different colors and is able to execute at least five different instructions accordingly.

2. The kit can be separated as at least three parts and all of them will be able to fit in their own cases. The cases should be adequate in size and affordable in cost.

3. The kit will have the ability to be re-programmed by the users with color-based coding and can be reset to default settings.

2. Design

2.1. Block Diagram

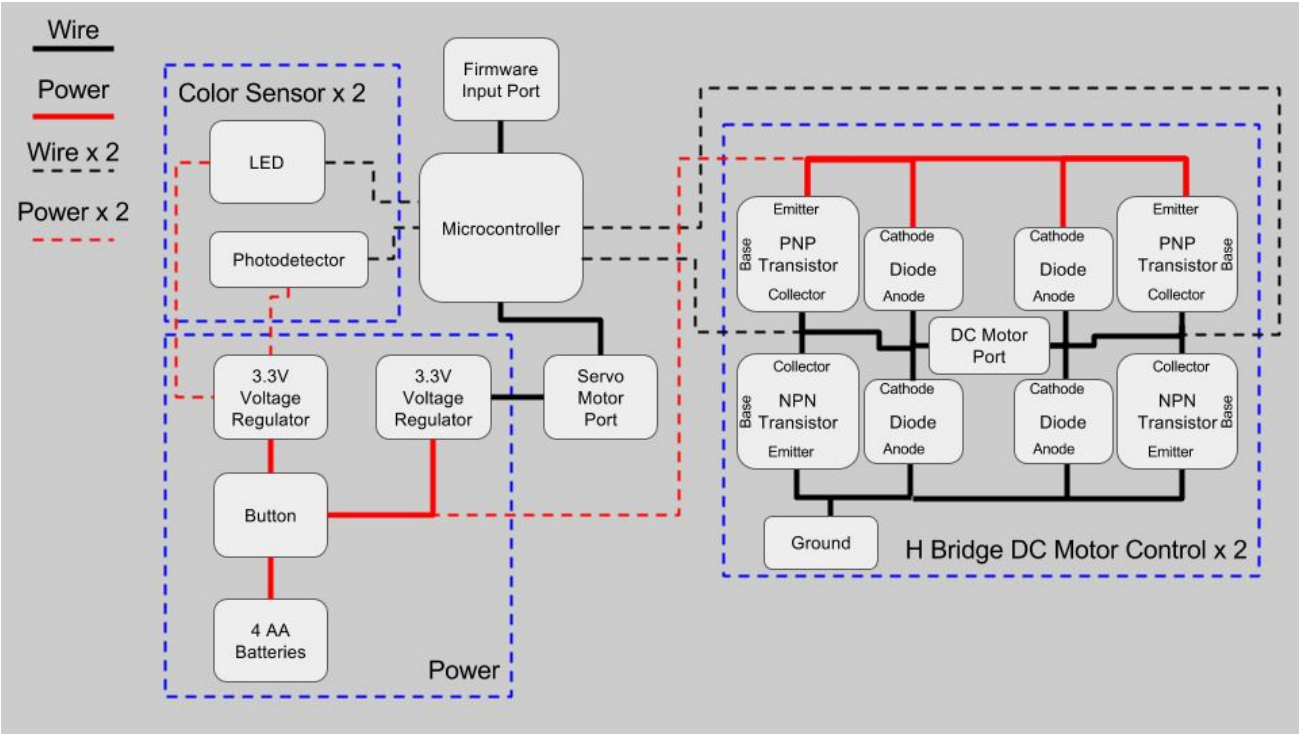

figure 1. Block diagram

2.2. Functional Overview and Block-level Requirement

Parts	Requirements	Functional Overview
Microcontroller	The microcontroller should be able measure voltage and send signals from 0 to 3.3 volts within a 0.1 volt accuracy. It should run off of 3 to 3.6 volts and less than 300mA of current. It should also have a CPU speed between 30 to 80 MIPS, a RAM size of 16 KB, a 16 bit architecture and operate under 100 degrees Celsius. It should also have at least 6 I/O pins for 3 color sensors, 2 DC motors, and 1 Servo Motor.	The microcontroller should be able to understand the signals coming from color sensors and be able to differentiate between different colors based on that signal. It should then be able to send appropriate control signals to DC and Servo motor control modules based on sensor input. Lastly, it should be able to accept flashed firmware onto it in the event that software changes need to be made.
Power Button	Should be able to withstand current up to 800mA.	The purpose of the button is to turn the board on and off by controlling current flow from the battery power supply to the rest of the system.
Batteries	Batteries should be rechargeable batteries that supply between 1.15 to 1.25 volts each. Each battery should be capable of sustaining 1500 mAh under a 500mA load before dropping to 1.15 volts. The cutoff voltage for operation will be 1.15 volts per battery. There should be a total of 4 of these batteries as the main power source.	The purpose of the batteries is to provide a mobile power source.
3.3 Volt Voltage Regulators	The voltage regulators should be able to take in between 4.6 to 5 volts as an input from the battery power supply and output 3.3 volts with a tolerance of 5% to be used as the Vcc for the sensors, the servo motors, and the microcontroller. One regulator will be allocated to the sensors and the microcontroller and the other will be allocated to the servo motors. Dropout voltage for these regulator should not exceed 1 volt and they must maintain a temperature below 50 degrees	The purpose of the voltage regulator before the sensors and the microcontroller is to provide a steady source of power. This helps the color sensors reduce the chance it misinterprets a color and ensures the microcontroller has reliable power.

	Celsius. They should also be able to handle currents between 50mA to 300mA.	
Transistors	There must be 2 PNP and 2 NPN transistors that are able to handle current flow between 100mA to 300mA to power the motors and maintain a temperature below 50 degrees Celsius. They must also be able to act as switches when provided a voltage to the base of 0 to 1.5 volts and 1.5 to 3.3 volts.	The purpose of the transistors is to act as switches in an H bridge for DC motor control.
Diodes	The diodes must be standard diodes with a reverse voltage of 200 volts.	The purpose of the diodes are to act as catch diodes in the H bridge for DC motor control.
Photodetector	The photodetector must be able to detect the color of a 1cm by 1cm area being illuminated by a white LED that is between 0.5cm to 4cm from the sensor. The photodetector must have a resistance that varies between 20 KOhms to 200 KOhms over a spectrum of 400nm to 700nm.	The purpose of the photodetector is to cause a change in voltage that would be detected by the microcontroller. It does so by changing its resistance based off the color of the surface being illuminated.
LED	The LED should provide a broadband white light across 400nm to 700nm	The purpose of the LED is to illuminate the area in front of the photodetector.

table 1. Block-level requirements and functional overview

2.3. Risk Analysis

For this project the component that provides the greatest risk for inhibiting our ability to complete this project would be the microcontroller. All other components are very relatively simple and we believe in the worst case scenario all components outside of the microcontroller can be quickly tested and replaced. The microcontroller is the heart of the whole project. It needs to be able to understand the sensor values and properly control the DC and servo motors depending on the colors and color combinations detected.
Other areas of risk can occur between all the major components. We may need additional circuitry, like extra capacitors for more current stability as an example, and the determining where this circuitry may be needed will ultimately be found out through testing.

3. Ethics and Safety

This project is meant to be used by children around the ages of 4-8 years old so we do have an obligation to make sure that everything is safe to use. This includes making sure there are no dangerous amounts of current or voltage present that might cause harm to the child as well as making sure that temperatures of all devices stay at a comfortably safe level. Current around 20-100mA can be lethal to the human body although our devices must not only prevent death but also ensure no children are even slightly hurt by using them. We will ensure that there is never a situation where even 5mA has a chance to flow through the user. The two areas where current flows the most would be directly from the batteries and from the DC motor ports. To safely protect users from these areas the ports must be encased such that the leads cannot be touched while the casing is on.

Since the children using these devices may be as young as 3 or 4 years old we must also account for choking hazards. Objects smaller than a cylinder with diameter of 1.25 inches by 2.25 inches deep are considered a choking hazard. The smallest component in our project would be the color sensors so we must ensure that they are larger than the above specifications.

Reference:

[1] Farr, ‘What’s the right age for kids to learn to code?’, 2013. [Online]. Available: https://venturebeat.com/2013/06/25/whats-the-right-age-for-kids-to-learn-to-code-debate/