

EE-31, Executive Summary 3

Kevin Destin, Team Vitellary

A description of the deliverable, its functionality, and demonstration

The goal of Phase 3 was to implement the color sensor and hall sensor and contract a team to create a collision detection system

Sensors

Color Sensor

We were tasked with integrating a colored light sensor with the Arduino, that needed to detect red, blue, and yellow.

The deliverable for this section were the following demos

- Move robot forward and stop on blue
- Move the bot in a straight line along a strip of blue paper.
- Move bot along a curved path, ultimately turning 90 degrees
- Turn right on red and left on blue
- Move along a blue line, turn right on red, stop on yellow patch.

Hall Sensor

We were also tasked with creating a circuit that lit an led when a hall sensor was in the presence of a magnetic field.

Collision Detection Spec

We were also tasked with outsourcing a collision detection system to another design team. The deliverable for this requirement was the specification document.

The duration of the design tasks for the phase showing the original planned dates and any delays or changes from the original projections.

Work on phase 3 began after the completion of phase 2, delivered on 2/7. We projected that we'd be finished with phase 3A on 2/26 and phase 3B on 2/19 as suggested by the schedule.

We started working on phase 3A initially, and were able to read data from the color sensor properly. We then switched gears to the collision detection spec during the week of Feb 12, in order to deliver the spec by our projected date.

On 2/19, we returned to working on reading data from the color sensor along with completing the circuit for the hall sensor.

From then onwards, we spent time working on the algorithm for the line following demo. Due to some delays and David being in China for a conference for a week, we had to delay our demo of 3A by 3 days to 3/1

A brief description of the conceptual and design activities.

Conceptual and Design Activities revolved around the completion of the Prestudio assignments. Prestudio assignments provided the initial push to start thinking about how we would approach this design sprint, like the problem we were trying to solve and the requirements that we would have to meet.

Once finished with the Prestudio assignments, we would also meet to discuss and plan all the details of how we would implement the the various circuits, along with the components of our collision detection system

A short technology summary of the theory of operation for the team's design, any drawings, sketches, schematics, block diagrams, and flow charts to clarify the design that are appropriate to convey the design intent of the team

Color Sensor

Circuit

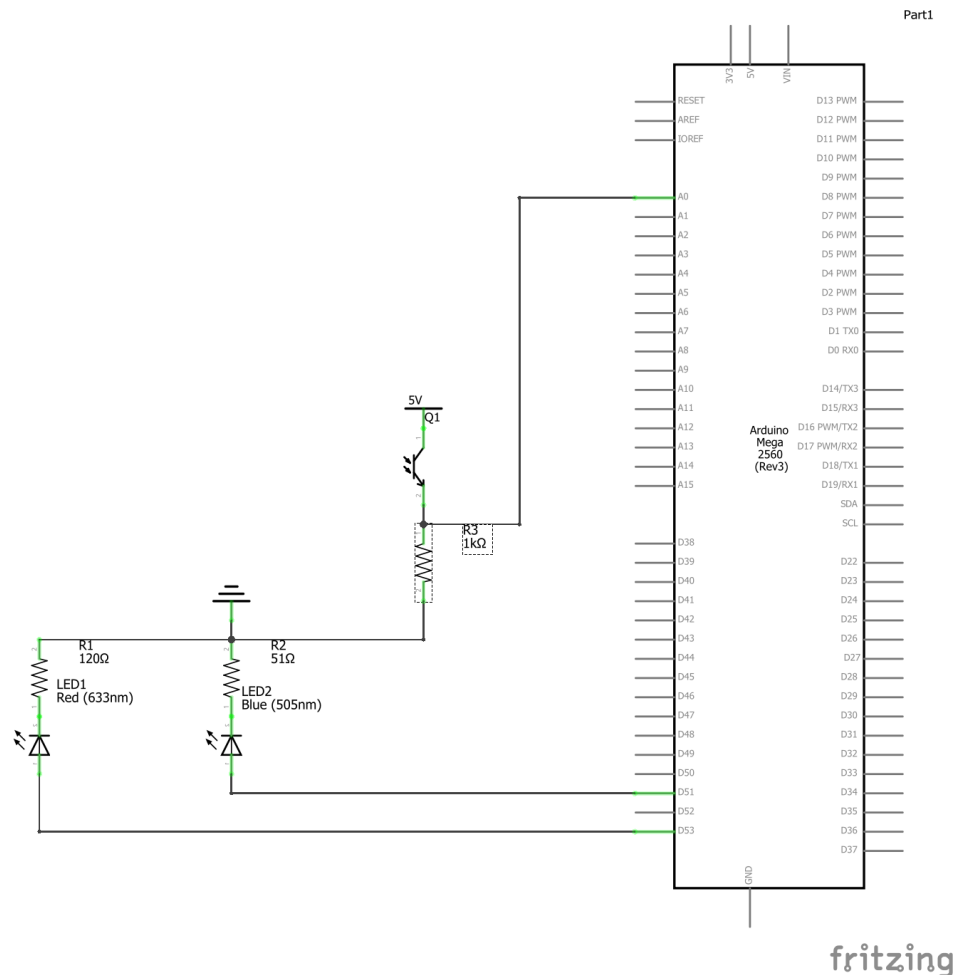


Figure 1: Color Sensor Circuit

The color sensing circuit was not very complicated. All that was required was that the leds could receive a high voltage from the Arduino, and that the value from the color sensor could be read.

We calculated resistor values for the LEDs to maximize their light output.

Algorithm

In our program, we represented color as a triplet of values: the sensor readings when only the red led is on, only the blue led is on, and when both are on. We stored calibration values for each of our target colors.

We implemented a simple line following algorithm for our demonstration. In more conventional line following applications, there is typically an array of sensors use to determine the bot's position relative to the line it is

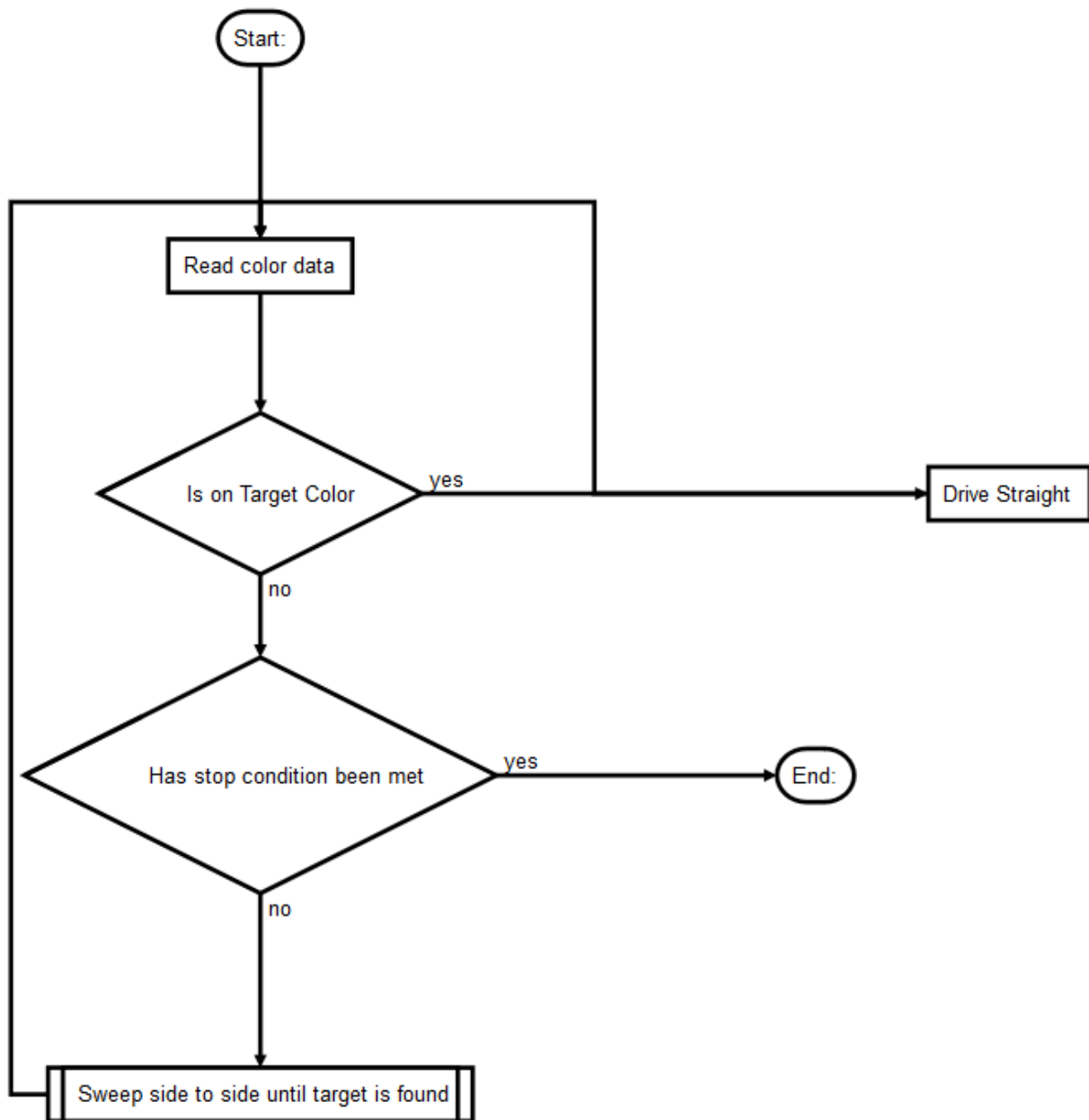


Figure 2: Algorithm

following. Since we only had one, the challenge in line following revolved around how to recover when the bot inevitably went off course. Since the bot had no way of knowing whether it should turn left or right, we had it do both until it found the color that it was trying to follow. By sampling colors frequently enough, this allowed our bot to follow lines well. It even was able to complete to zigzagged “human robot” test track on the ground in lab 225.

Depending on the challenge, we specified different stopping conditions for the algorithm (if current color is yellow, if color not target color, etc. . .)

Hall Sensor

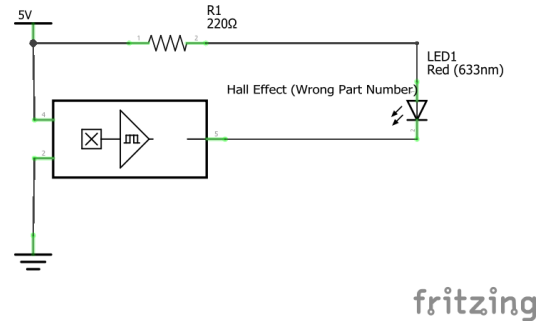


Figure 3: Color Sensor Circuit

The complexity of working with the hall sensor was identical to the color sensor; we a minimal circuit to probe the sensor value, here with an LED to indicate whether the sensor could detect a magnetic field.

Collision Detection

The design document stated that we needed to detect collisions in all directions. But after some deliberation and some guidance from Prof. Lasser, we decided that it was only necessary to detect collisions from the front and back and omitted any requirements for the sides.

What follows is an excerpt from our collision detection spec:

"We would like you to create twelve bumpers for us. Each bumper consists of a 1.5x1.5in square of foam board attached to a switch.

Milestones / Deadlines

One bumper should be prototyped by 2/22/2019.

All remaining bumpers must be delivered on day prototype meets the specification. This must be on or before 2/26/2019.

Acceptance test criteria

(1) Fragility Test

Structural integrity is of paramount importance to us. Therefore we expect the product to be well constructed. We will perform a test to verify the sturdiness of the product. We will drop the product off of a 225 lab bench, and verify that it does not break, and that it still functions correctly in a simple circuit (test 2).

(2) Functionality Test

We need the product to work. We will integrate it into a simple led circuit to verify that the product allows us to detect when the switch is actuated."

A complete list of the experiments performed, the success or failure, an assessment of the quality of the reflection on failure, and the learning that occurred from the experiments. Consult the reflection on failure rubric to perform the assessment.

Color Sensor

(1) Color Differentiation

We started by making sure that our bot could in fact tell the difference between the calibrated colors. This test consisted of first calibrating the bot, then continuously printing the color read by the sensor on the serial monitor. Some failures in the test caused us to rethink the way that we identified colors. We initially read colors as triplets, and interpreted them as vectors. To determine the current color, we would determine the cosine of the current color vector with each of the reference vectors, and return the color that had the largest cosine (i.e both vectors point the same way). This proved inadequate, as blue and black “point the same way” and are instead differentiated by magnitude of the vector. We then resorted to using the difference between the current and reference vectors instead.

(2) Line following

All the other challenges revolved around being able to follow a line accurately, so our test fixture consisted of the provided test fixtures along with the zig zag tape pattern on the floor of lab 225. Our testing didn’t reveal any major failures, but instead allowed us to tune various parameters of our algorithm for better performance.

Hall Sensor

(1) Turns on in presense of magnetic field

This test was somewhat trivial, as it essentially was passed once we implemented the circuit correctly.

Collision Detection System

(1) Fragility Test

We verified the structural integrity of the system delivered to us. We dropped the product off of a 225 lab bench, and it in fact did not break and still functioned perfectly.

(2) Functionality Test

We integrated the bumpers into a simple led circuit and verified that the product allows us to detect when the switch is actuated.

A list of who was assigned which tasks and the quality of their work

General Design Tasks (Prestudio) were divided equally between all team members. Our design was well suited for the spec and allowed for efficient completion of the deliverable.

Circuit Design - David Janowsky. The circuit worked perfectly and performed all required tasks to spec.

Software Design - Kevin Destin. The software was adequate and also met the spec.

Collision Detection spec was completed as a team and resulted in a good first draft.

Incurred Costs

Labor

$$20hr * \frac{50\$}{hr} + 10hr * \frac{50\$}{hr} = \$1500$$

Parts

Hall Sensor = \$2.52 each

Photosensor = \$3.77 each

LED = 2 * \$0.12 each

Contractors

- The switches cost \$2.16.
- The foam board and glue should cost \approx \$1.00.

So we expect parts to cost $\$2.16 * 12 + \$1.00 = \$26.92$.

- The assembly rate is \$30.00.

We expect you to work for 1 hour.

So the final cost should be $2 * \$30.00 + \$26.92 = \$86.92$

Team stage assessment: strengths, weaknesses, difficult personality types present on the team, improvement plan, and success of respect and working together.

As a whole, the team is functioning well. We are respectful of each other, communicate well, and are respectful of each other's time. We are able to bounce design ideas off each other well, discussing the merits of various ideas to finally settle on the best ones. We have not faced problems related to personalities. We worked well as a team, and for the most part were able to plan around one member being away for an extended amount of time.

Recommendations to the next project leader on how team operation and design work may be improved. For subsequent executive summaries after the first one, a statement of how the recommendations were implemented, or the reasons for discarding them must be included.

No recommendations