

Sprint 1 - Endurance Design Document

October XX, 2019

This document contains instructions and examples which are for the benefit of the person writing the document. All text in RED should be removed and replaced with information pertinent to your project.

Text in the finalized document must be **BLACK**.

This is the System Design Document (SDD) and will include sections detailing system flow, algorithms, staffing plan, software/hardware, and Test Plan

You must complete all sections of this document.

Where required by the Sprint Checklist you must embed images of some artifacts in this SDD

To regenerate the TOC in Word, select all (CTL-A) and press F9.

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Executive Summary

Project Overview

Describe this project or product and its intended audience, or provide a link or reference to the project charter.

The project aims to demonstrate the capabilities of a robot navigating a predefined track, serving as a scaled showcase of its mechanics, which foreshadows the larger-scale implementations planned for future launches.

Purpose and Scope of this Specification

This specification aims to lay out the precise conditions and limitations for the creation and application of a small robot that is programmed to follow a predefined path. The project team, engineers, developers, stakeholders, and anybody else involved in the design, development, and testing of the robot are all expected to use this document as a reference and set of guidelines. The specifications for the little robot's design and operation in order for it to follow a predefined path. Included but not restricted to are the following: design parameters for the robot's mobility and maneuverability; safety and fail-safe systems for emergency scenarios and obstacle avoidance; and definition of sensor needs for track detection and navigation. The following items are out of the scope of this particular specification but may be considered in subsequent phases or other documents: advanced features beyond track following (such as object recognition or advanced decision-making capabilities), modifications to the track itself or changes to the environment that the robot will traverse and integration with other systems or robots not directly related to the predetermined track.

Product/Service Description

The efficacy of the robot's traversal along the track is contingent upon the impediments it encounters, such as obstructions like a chair or an individual's foot. Upon collision with any of these obstacles, the robot will deflect and endeavor to navigate around them, thereby deviating from its initial trajectory. To ensure optimal performance and prevent impediments to the robot's motion, it is imperative to maintain a clear track throughout its course of operation.

Product Context

While the small robot primarily operates independently, its capabilities might involve interfacing with related systems or components. For instance, the robot could interact with a control station or central server responsible for initiating its course or providing updates. It might communicate with external sensors placed along the track for data acquisition or safety monitoring. Additionally, it could have interfaces for recharging or receiving software updates, enhancing its functionality and performance.

User Characteristics

The compact prototype exhibits remarkable potential for deployment in educational institutions globally, serving as a fundamental tool for comprehending the intricate nuances of engineering and robotics. Its user-friendly interface facilitates accessibility, rendering it suitable for individuals aged 15 and above. While prior background knowledge is advantageous for optimal utilization and intended functionality, the product's design accommodates users with varying levels of expertise in the field.

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Other users may be hobbyists of engineering or anyone with the interest in robotics. The experience levels can vary ranges from minimal technical proficiency to advanced expertise, depending on the individual's background and interest in robotics.

Assumptions

Assuming that the necessary sensors, motors, and components for the robot's navigation are available and functional. If any of these components are not available or malfunction, the requirements might need adjustment to accommodate alternative equipment or reconfiguration. Also assuming that users or operators have a certain level of expertise in handling and maintaining the robot. If the users' expertise varies or is limited, the requirements might need adjustments to ensure the robot's usability and maintenance align with the users' skills.

Constraints

The design may be limited by the requirement for the new robot system to function in parallel with an existing, maybe older system. The old and new systems' compatibility, communication protocols, and interoperability will need to be taken into account. The necessity to include strong access control, efficient management procedures, and top-notch security measures will place restrictions on the system's architecture. The architecture and functionality of the system to guarantee data protection and restricted access to authorized workers will be impacted by these limitations. The design will be limited by the need for reliable audit functions, such as keeping an audit trail or log files. This calls for setting aside funds for logging and making sure the system conforms with audit trail requirements.

Dependencies

Certain modules or components within the system might be dependent on others. For instance, Module X (such as the navigation system) needs to be completed before Module Y (maybe obstacle avoidance or decision-making module) can be built. These dependencies influence the development order and integration of different functionalities within the robot. If the robot's operation is reliant on specific power sources or energy types, the requirements must accommodate these dependencies. This might involve ensuring the design is energy-efficient or has the capability to work with the available power sources.

Requirements

Functional Requirements

Req#	Requirement	Comments	Priority	Date Rvwd	SME Reviewed / Approved
ENDUR_02	The Sphere shall move forward until it reaches the end of the rectangle.	Use speed control to maintain a straight path.	3	11/1/23	Yes
ENDUR_03	The sphere shall be able to turn left and right to navigate its path.	Implement precise turning and speed within the Sphero's blockcode	3	11/1/23	Yes
ENDUR_04	The Sphero shall contain consistent speed and direction while moving.	Implement speed and heading control to minimize drift.	2	11/1/23	Yes

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Req#	Requirement	Comments	Priority	Date Rvwd	SME Reviewed / Approved
ENDUR_05	The code shall be written in maintainable and a well-documented manner.	Keep the code organized to reduce errors.	2	11/1/23	Yes
ENDUR_06	The code shall be tested on different operating systems.	Make sure it works on different devices.	2	11/1/23	Yes
ENDUR_07	The code shall be designed with security in mind.	Make sure its not copied or taken by somebody else.	1	11/1/23	Yes
ENDUR_08	The code should log its information.	This will be done with the sensor data diagram	1	11/1/23	Yes
ENDUR_XX	The sphero should be able to make a controlled stop.	Limit speed so it is able to be stopped gracefully.	1	11/1/23	Yes

Security

Protection

Putting in place access restrictions, like authentication procedures, to guarantee that the robot's control systems can only be accessed by authorized people or systems. Encryption is used in communication protocols to protect the information sent and received by the robot as it tracks, making sure that it cannot be intercepted or manipulated by unauthorized parties. In order to secure the data sent and received by the robot while it is tracking its path, as well as to prevent unwanted parties from intercepting or altering the data, communication protocols also use encryption.

Authorization and Authentication

Enforcing complex password requirements, regular password changes, and preventing the use of easily guessable passwords enhances the strength of authentication. Employing multiple layers of authentication, such as a combination of passwords, biometrics (fingerprint, facial recognition), security tokens, or one-time codes, significantly enhances security by requiring more than one form of verification.

Portability

- **Wireless Control:** The Sphero is controlled wirelessly through a smartphone or tablet app. This means you don't need any physical wires or connections, making it easy to use and carry around. The app communicates with the Sphero via Bluetooth, further enhancing its portability.

- **Rechargeable Battery:** Sphero is powered by a rechargeable battery, which eliminates the need for disposable batteries or cumbersome power cords. This

means you can charge it in advance and take it with you wherever you go without worrying about finding power sources.

- **Durable and Rugged Design:** Sphero is built to be rugged and able to withstand various terrains and conditions. Its durability allows users to take it outdoors and use it in a variety of environments without the fear of damaging the device.

Requirements Confirmation/Stakeholder sign-off

Meeting Date	Attendees (name and role)	Comments
11/5/2023	John Coscia (Co-founder)	All confirmed
11/5/2023	Linda Pimpinella (Co-founder)	All confirmed

System Design

Algorithm

- **Establish a Connection to the Sphero:**

- Use the SDK to establish a Bluetooth connection with the Sphero. This typically involves identifying the

Sphero device and connecting to it. • **Set Initial Position and Heading:**

- Set the Sphero's initial position and heading. You'll want to start with the Sphero at one corner of the rectangle, facing the first side.

- **Define Rectangle Dimensions:**

- Specify the dimensions of the rectangle, including its width and length. **Set Sphero's Speed and Turn Rate:**

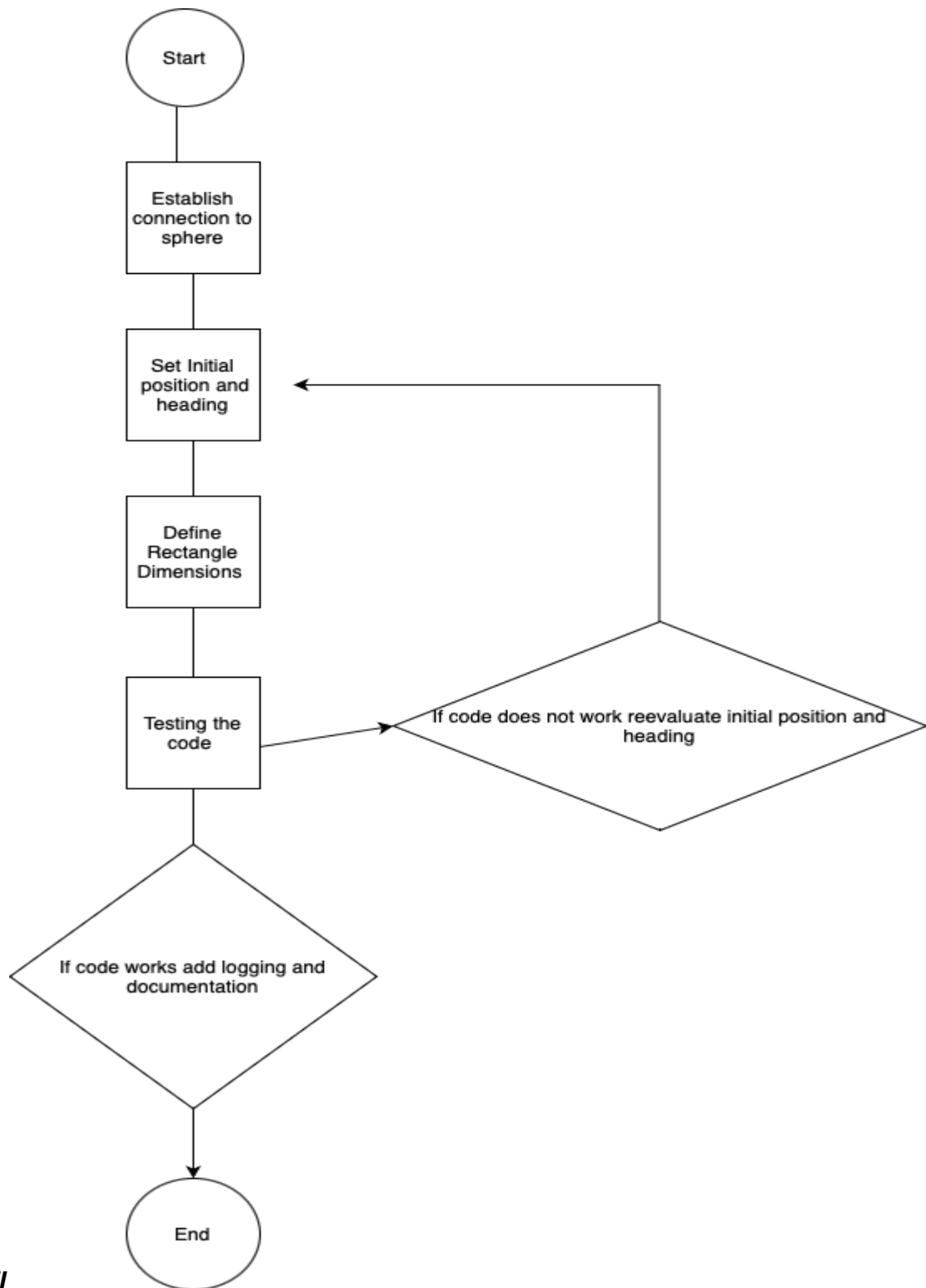
- Determine the Sphero's speed and turn rate.

- **Testing and Validation:**

- Test the code on your Sphero and validate that it drives the robot in a rectangle as expected. Make adjustments as needed. • **Logging and Documentation:**

- Add logging to capture relevant information such as start and end times, the path taken, and any errors encountered. Also, ensure that your code is well-documented to make it maintainable.

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System Flow

Software

The software program that we used was the shpero app block code.

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Hardware

The hardware used to code and test the sphero was a macbook.

Test Plan

Reason for Test Case	Test Date	Expected Output	Observed Output	Staff Name	Pass/Fail
Distance	7/11/23	Sphero will travel the complete distance	Stopped a couple of feet short	John	Fail
Distance	7/11/23	Sphero will travel the complete distance	When a couple feet too far	John	Fail
Distance	7/11/23	Sphero will travel the complete distance	Went to correct distance	John	Pass
Turning	7/11/23	Sphero will make a complete and accurate turn	Turned too shallow	Linda	Fail
Turning	7/11/23	Sphero will make a complete and accurate turn	Turned to wide	Linda	Fail
Turning	7/11/23	Sphero will make a complete and accurate turn	Turned on the correct line	Linda	Pass
Accuracy	7/11/23	Sphero will stay on the line throughout the whole course	Drifted too the right after first turn	John	Fail
Accuracy	7/11/23	Sphero will stay on the line throughout the course	Drifted too the left after second turn	John	Fail
Accuracy	7/11/23	Sphero will stay on the line throughout the whole course	Drifted off to the left after the last turn	John	Fail
Accuracy	7/11/23	Sphero will stay on the line throughout the whole course	Stayed on the line throughout course	John	Pass
Stopping	7/11/23	Sphero will stop at the end of course	Stopped at beginning after completing all four sides	Linda	Pass

Task List/Gantt Chart

[gantt chart.pdf](#)

Staffing Plan

Name	Role	Responsibility	Reports To
John Coscia	Coder	Code the Robot	Linda
Linda Pimpinella	Manager	Complete the SDD	John

