Initial Project Documentation and Group Identification
Divide and Conquer

Self-Powered Automated Refuse Cart (SPARC)

Group 12	
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Funded by:

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Project Overview

Trash collection is a standard ritual for any domestic setting, and for many homes that involves a weekly schedule of days for trash collection by a municipal vehicle along the street. Despite its banality, the failure to remember to take out the trash can result in a number of problems; rotting food and other waste can draw the attention of unwanted pests, and the odor can make human living quarters quite uncomfortable. The curbside trash collection system poses problems of accessibility for those who cannot maneuver a heavy trash can to the street, as well as logistical problems for those who have abnormal working schedules.

The premise of SPARC is to design a rechargeable, motorized, load-bearing crawler that can mount a compatible garbage bin that is able to automatically deliver a garbage bin and its contents to a predetermined location for it to be collected with accordance to a defined schedule. Users will be able to program their garbage collection schedule into the SPARC by using an intuitive companion smartphone app for the Android OS. Automating this domestic chore prevents the chances of oversight, and answers accessibility and logistical concerns for those who struggle or are unable to deliver garbage bins to the curb.

Project Features

Software features that SPARC will include are GPS and RFID positioning, and Machine Learning driven path determination. Hardware features will consist of waterproofing of electrical components, durability to withstand a garbage load up to 50 pounds, and a charge capacity to traverse an average driveway and make a return trip, and recharge using a wireless induction method.

Project Functionality and Operation

Theoretically, when a consumer would open this product, There will be two pieces. The SPARC unit itself, and a platform that would act as the SPARC's "Home-Base." Initially, the SPARC unit will need to be charged, initially through a wall outlet, much like a laptop computer. Future Charging will be conducted autonomously through solar panels built into Home-Base. Once charged, the user can pair his/her smartphone to SPARC through Bluetooth. Then the user should select which days of the week their local garbage collection takes place and select a GPS location for the SPARC to navigate to.

The SPARC will be designed to accommodate the square garbage bins utilized by semi-automated, side-loading garbage collection vehicles. This garbage can will be firmly attached to the SPARC unit, primarily via a clamp to the wheel axle of the garbage can in the rear, and grips in the front corners. The weight of the SPARC unit needs to be heavy enough to offset weight from the trash can to prevent toppling while moving.

Once a location for the Home Base has been chosen, the platform has been placed on the ground, and the SPARC unit has been initially charged and programmed with a schedule, the SPARC will wait in standby mode until a set time in the middle of the night on the designated collection day. At that time, the device will power on and check its location compared to the selected GPS location.

The SPARC will pilot itself using a pathing algorithm in order to reach the destination. The path from the home base to the bin collection location can be primed by remotely controlling the SPARC using the mobile app, moving it there manually, or automatically using an iterative process. SPARC will utilize collision avoidance technology to prevent collisions with parked cars or other obstacles on its trip, and will automatically correct its direction with as much accordance to the path as possible. Repeated deviations in the path with result in the algorithm modifying the path for a greater chance in a collisionless trip.

Once the cart has arrived at the indicated GPS location, the SPARC will then use its sensors to determine where the actual curb is in relation to the SPARC, at which point the SPARC will use this information to rotate itself, and move up against the curb. Then it shall switch to a low power state, and wait for garbage collection.

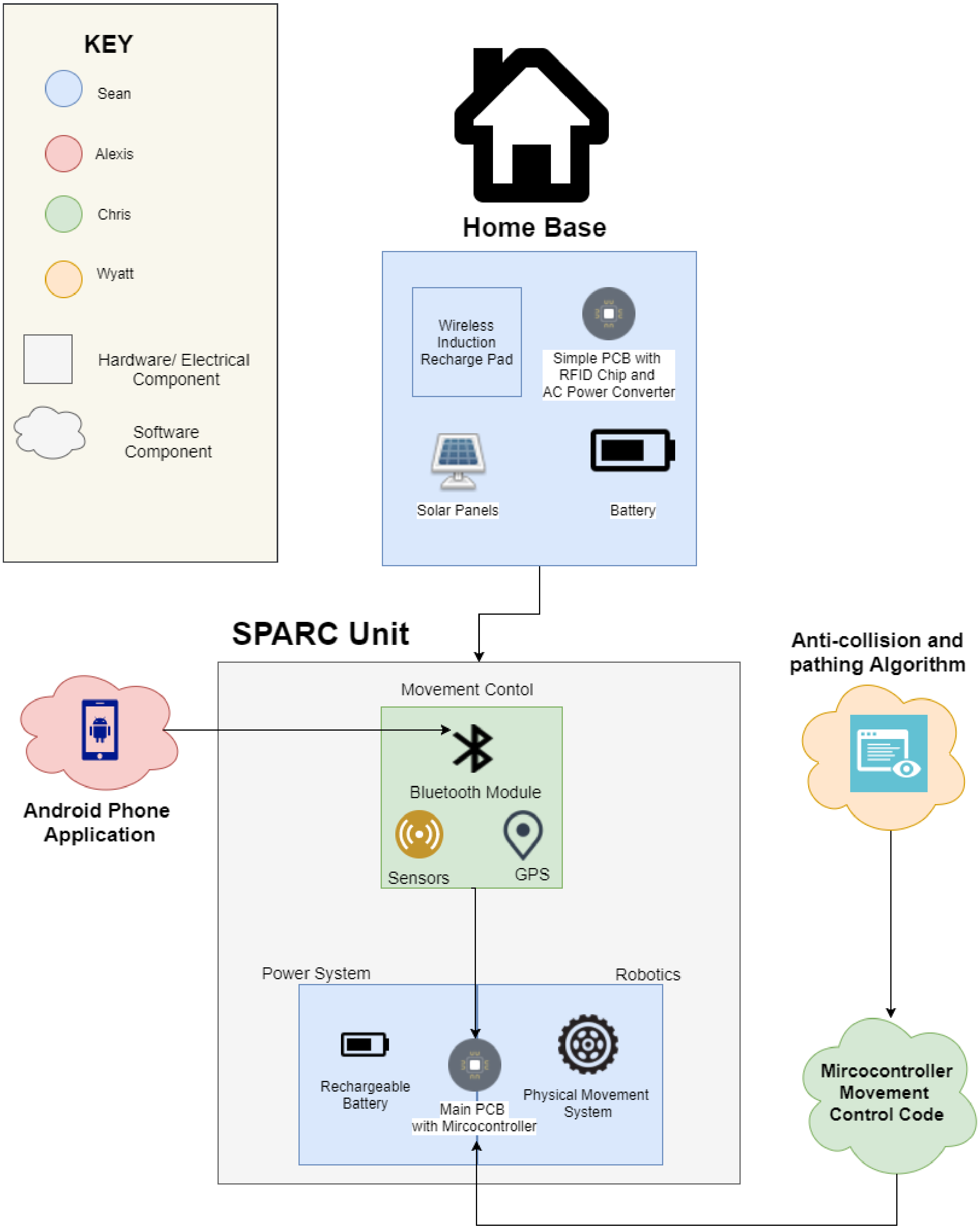
After garbage collection, during the next night, the SPARC unit will power on again, and locate an RFID signal generated by the Home-Base. It will use the same pathing algorithm to return to the pad safely. Once at the Home-Base, SPARC will deploy a “charging arm” on the underside of the unit, which will make contact with a wireless charging pad, to facilitate recharging of the battery built into the SPARC unit.

At any given time, the user should be able to use the smartphone app to assume direct control of the SPARC unit, which is connected to the microcontroller via bluetooth, using a GUI control system to pilot the SPARC at will.

Requirements Specifications

- GPS Positioning
- Collision Avoidance
- Mobile Application
    - Manual Motor Control
    - Service Scheduling
    - Anti-theft device locator using GPS
- Fully capable of carrying up to a 50 lb load
- Bluetooth Connectivity
- Wirelessly rechargeable device

Hardware / Software Block Diagram



The above block diagram shows the concept flow of both the home base and the main SPARC unit. The home base will be constructed as a purely hardware powering service for the SPARC unit, with a solar panel, battery, and a wireless induction charging pad. The home base will be connected using a simple PCB equipped with an RFID chip for SPARC positioning. The SPARC unit has three major connecting components; the movement control, power system and robotics. The movement control components include the bluetooth and GPS modules, which will connect to the main PCB equipped with a microcontroller. The main PCB also controls the physical movement system which will consist of the motors, chassis and treads. The software components connect ad the mobile app controls the SPARC unit via the bluetooth module and the pathing algorithm and movement code is for the microcontroller directly. The status for each component is stated below:

Project Block Diagram Status (as of 1/28/2018)

- Home-Base: <u>Research</u>
- SPARC Unit:
    - Mobile Application: <u>Design</u>
    - Pathing Algorithm and Microcontroller code: <u>Research</u>
    - Movement Control: <u>Research</u>
    - Power System: <u>To be acquired</u>
    - Robotics: <u>Research</u>

Budget

Shopping List					
Item	Details	Vendor	Price / Unit	Quantity	Total Price
Lithium-Ion Battery	11.1V, 5Ah	Superdroid Robots	$80	1	$80
Lithium-Ion Battery	11.1V, 2.2Ah	RobotShop	$27	1	$27
Trash Can	32-gallon	Home Depot	$60	1	$60
Chassis	Steel, support ~60lbs	Research	Research	1	$150

12V DC Motor	4.47 oz-in torque	RobotShop	~$7	2	~$14
Gear Box	81:1 gear ratio	RobotShop	~$68	2	~$136
Microcontroller	MSP432 (Possible)	TI, Digi-Key	~$20	1	~$20
Coupled Circuits	Research	Research	Research	2	Research
PCB	Research	Research	~$40	1-2	~$80
Copper Wire	80’, bare, 14 gauge	Amazon	~$15	1	~$15
Bluetooth Module	HC-06	Amazon	~$3.00	1	~$3.00
RFID Chip	Research	Research	Research	2	Research
GPS Module	Research	Research	Research	1	Research
Acrylic	2’ x 2’	Research	~$20	1	~$20
Proximity Sensor	Research	Research	~$20	2	~$40
Bike chain	Research	Amazon	~$10	2	~$20
Solar Panel	10W, 12V	Amazon	$20	2	$40
				Total	~$700

Project Milestones

#	Task	Finish By	Status	Responsibility
Senior Design 1				
1	Brainstorming Assignment	1/16/2018	Completed	N/A
2	Group Formation	1/18/2018	Completed	N/A
3	Initial Project Documentation	1/28/2018	Completed	N/A
4	Microcontroller Selection	1/26/2018	Completed	N/A
5	Finalize Parts List	2/2/2018	Researching	N/A
6	Microcontroller Pin Mapping	2/9/2018	Researching	Sean

7	Mobile Application Class Diagram	2/9/2018	In Progress	Alexis
8	Interface sensors and modules to Microcontroller	2/16/2018	Researching	Chris
9	Final Documentation: Table of Contents Finalized	2/23/2018	N/A	N/A
10	Pathing Algorithm Flowchart/UML Diagram	3/2/2018	Researching	Wyatt
11	SPARC Chassis Design	3/9/2018	Researching	Sean
12	Final Documentation: Draft 1	3/23/2018	N/A	N/A
13	Mobile Application interface with Microcontroller via Bluetooth Module	4/6/2018	N/A	Alexis
14	Basic Movement Control via Microcontroller	4/6/2018	N/A	Chris
15	Proof of Concept Prototype Finalized	4/6/2018	N/A	N/A
Working on Final Documentation				
16	Final Documentation: Finished Copy	4/26/2018	N/A	N/A
Senior Design 2				
17	Finalize PCB Designs and Order	6/1/18	N/A	Sean
18	Design Home Base and Build	6/8/18	N/A	Sean
19	Finalize Physical Movement System Design and Build	6/15/18	N/A	N/A
20	Integrate Pathing Algorithm to Microcontroller Movement Control Code	6/29/18	N/A	Wyatt
21	Finish Build Initial Prototype	7/6/2018	N/A	N/A
Testing and Revisions				
22	Finalize Prototype for Presentation	TBA	N/A	N/A