Initial Project Document and Group Identification
Divide and Conquer

Trashporter

A Robot that Transports Trash

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Project Description

In our growing world of technology, it is going towards making people's lives easier when there are so many responsibilities to take care of already. Our team aims to innovate on the idea of home appliances that make these chores faster and more efficient to manage with The Trashporter, an autonomous trash robot that goes around the house and collects garbage from each room to be brought back to a singular unit docking station. This project will be developed throughout 2022 and the process will be detailed within the report.

Project Motivation

The motivation behind this device was to create a user-friendly device that's lightweight, portable, and convenient to consumers to complete a tedious household task. The device was heavily inspired by other autonomous vacuuming robots already in the market, using the concept of completing a task, then returning to the designated location where the robot can be cleaned out by the user. The device has many avenues to be enhanced with many unique features making the idea very flexible in the direction we would like it to go, some features that could be developed are a trash sorter where it can scan the item or bin to determine if it is considered trash or recyclables, being fully autonomous where it can map each room knowing where to pick up the bins and return back to its original docking location, and many other possibilities. Our team can use previous knowledge on boards to develop this project for example in previous classes we used microcontrollers to control the main functionality of devices, so boards like the Texas Instrument MSP430FR6989 and the Arduino Uno boards knowledge can be directly used in this device where there are many available libraries to help construct it. There were many discussions on how the robot would transfer one bins trash to the main bin, and after brainstorming the pros and cons of each idea, we have concluded that it would be easiest to build and external arm on the trash bot connected to a track to lift the sub-bins and dump the contents into the main bin. There is also a great area to implement software, being a mobile application to either manually be sent out to collect garbage at will or schedule when it should be sent out on a consistent basis. Some exciting things we will get the opportunity to work on is machine learning to train the bot to know how to navigate around the room and reach its desired target, this is possibly one of our biggest challenges that will be faced during our projects, making it that much more satisfying to succeed in this project.

Goals

The Trashporter plans to satisfy three main goals at the end of the term. It will autonomously seek out the sub-bins from the docked location to the desired location while avoiding obstructing objects. Additionally, it will pick up the targeted bins with a robotic arm, be lifted by a track system, and empty all the contents of the sub-bin into the Trashporter and return to a centralized location to have all the trash in one easily accessible space. Finally, The Trashporter will be connected to a mobile application where it can be set on a schedule to go out and collect all of the trash, or manually told by the user to go out and picked up immediately, the mobile application can also let the user know when the main bin has reached its capacity limit.

Objectives

The objectives of the creation of The Trashporter isn't only to create a autonomous robot that collects trash for the convenience of the consumer, but also to demonstrate the knowledge and abilities of the team on how we have come together to collaborate, communicate, and execute all of the hard work and research that went into developing this project. We will connect the hardware aspect of construction to the mechanical mechanisms so that it functions properly with the software logic so that the bot knows how to navigate to the desired target, accurately pick up the sub-bins, collect it, and navigate back to the docking station seamlessly. Our team will research, experiment, and develop a device using the knowledge we have gained throughout our engineering career, as well as furthering our knowledge with new challenges that have not been explored yet within our educational journey.

Project Constraints

Supply Shortage: The current supply shortage can affect the time it will take to receive parts and will also affect the prices.

Cost: We have decided to have a budget of $800 dollars for this project which we hope is more than enough to buy everything we need. We are willing to spend more if needed but this should be more than enough for our goals.

Time: As I mentioned before, the possible wait for parts can delay our development process for this project. We will plan to order items as soon as possible to try to avoid this.

Trash weight: One thing we have to take in account is the weight of the trash. Some bins we will have to pick up will be heavier than others. Because of this we will make sure the bot is strong enough to pick up most bins and have a weight limit.

Specifications & Requirements

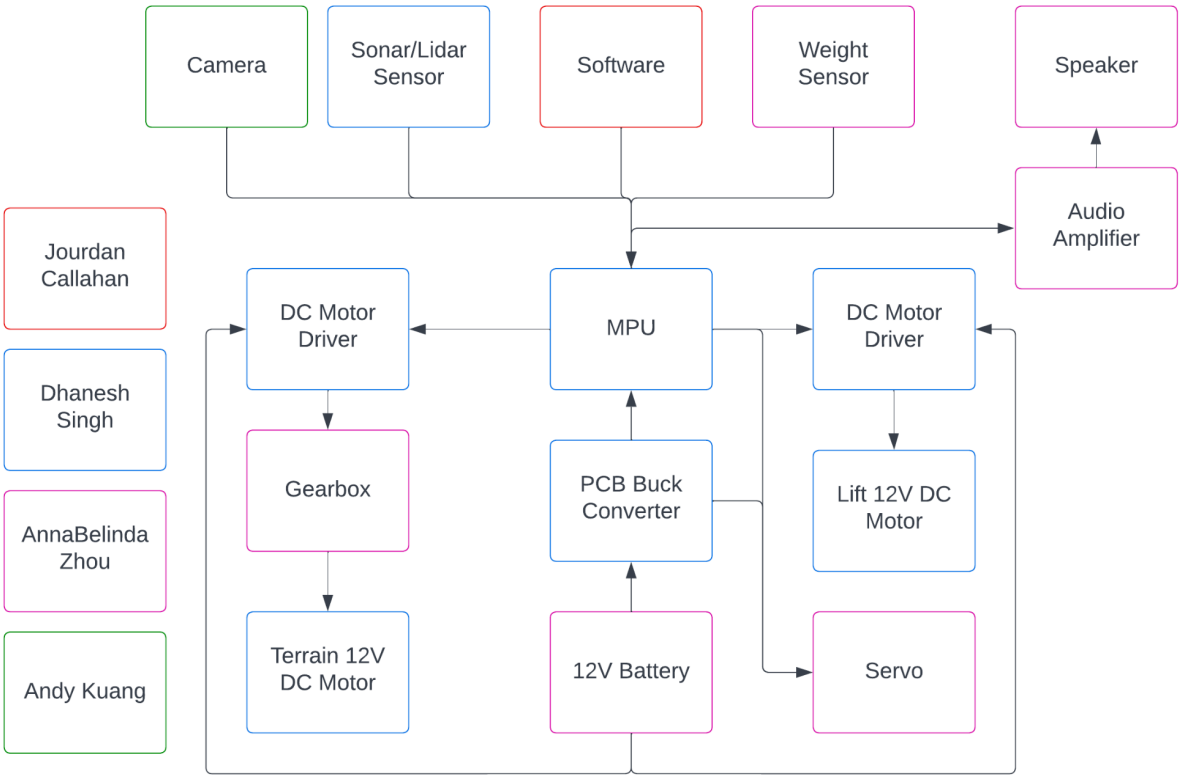
Hardware

1.0	The device shall use a plastic trash can that is 10-13 gallons.
1.1	The device shall consist of a trash can, wheels, a camera, and a lift system with a claw.
1.2	The device shall be able to pick up a trash can that it will be able to track.
1.3	The device shall be strong enough to pick up a smaller trash can that is 1-2 pounds
1.4	The device shall have a sensor that detects when the trash can is full.
1.5	The device will be autonomous and will be able to detect wall collisions.
1.6	The device will be able to make status sounds depending on state.
1.7	The device should cost no more than $800.
1.8	The device shall be able to recognize objects with a camera.
1.9	The device shall be able to pick up multiple smaller trash cans until full.
1.10	The device shall stop when the trash can is full.
1.11	The device shall move away when close or collide with a wall.

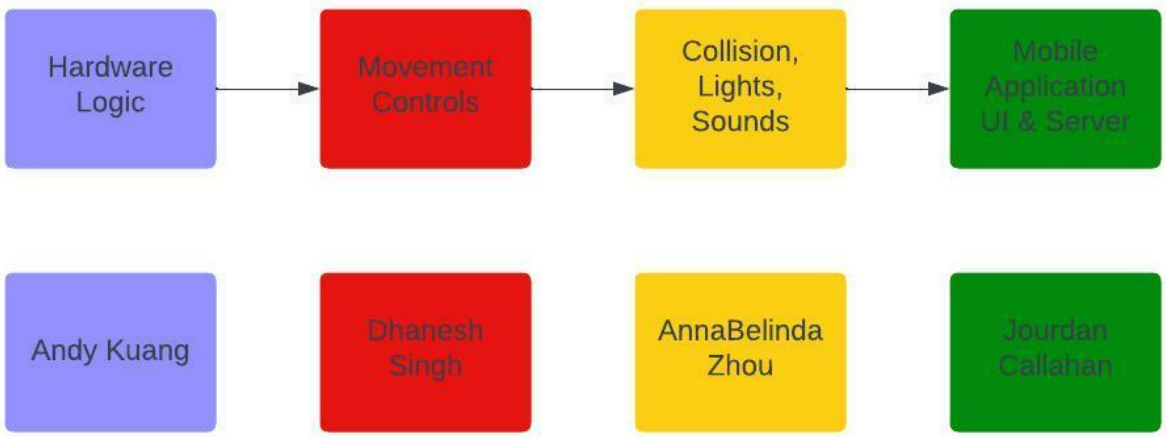
Software

2.0	The device will be paired with an application on a mobile device.
2.1	The app shall be able to power it on and off
2.2	The app shall be able to control is manually
2.3	The device shall be able to receive a notification when the trash can is full.
2.4	The device will be able to track how many bins have been collected.

Hardware Block Diagram



Software Block Diagram



Material List and Budget

Each of us will contribute at least $200 towards this project, totalling $800 for the entire project.

Parts	Quantity	Cost ($)	Purpose	Link
12V High Torque DC Motor	2	$30	These will drive the locomotion of the robot	Motor
12V DC Motor Driver	2	$11	This will control the motor by PWM from the MCU	Driver
12V Battery	1	$20	This will power the entire system	12 Battery
MPU	1	$20-50	This will control the entire system	
Chassis	*	$100-250	Reserved cost for chassis equipment as well as the wheels	
Buck Converter	1	$2	This will lower the 12V to 5V which will power the MPU (Backup)	Buck Converter
12V DC Motor	1	$10	This will power the lift	Lift Motor
Gearbox?	*	$10-30$	Most likely used to adjust the torque for the lift	
Sonar Sensor	2	$4	Used for object collision	Sonar Sensor
Weight Sensor	1	$8	Used to measure the weight of the main bin	Weight Sensor
Speaker	1	$5	Used to create audio ques and sounds	Speaker
Audio Amplifier	1	$2	Used to amplifier audio signals	Audio Amp
Camera	1	*	Camera used for trash detection. Depends on the MPU used	
Resistor Resistance: 13.7 kΩ	1	0.01	This will be used for a designed buck converter	Buck Converter Design
Resistor	1	0.01	This will be used for a designed	Buck

Resistance: 100 kΩ			buck converter	Converter Design
Capacitor: 33 pF	1	0.01	This will be used for a designed buck converter	Buck Converter Design
Resistor Resistance: 30 kΩ	1	0.01	This will be used for a designed buck converter	Buck Converter Design
Resistor Resistance: 220 kΩ	1	0.01	This will be used for a designed buck converter	Buck Converter Design
Capacitor: 100 nF	1	0.01	This will be used for a designed buck converter	Buck Converter Design
Capacitor: 10 nF	2	0.05	This will be used for a designed buck converter	Buck Converter Design
Inductor L: 1.8 µH	1	0.2	This will be used for a designed buck converter	Buck Converter Design
Capacitor: 22 µF	2	0.1	This will be used for a designed buck converter	Buck Converter Design
Buck Convertor: TPS564242DRLR	1	0.45	This will be used for a designed buck converter	Buck Converter Design
Capacitor: 100 nF	1	0.02	This will be used for a designed buck converter	Buck Converter Design
Total		$390		

Project Milestones

Number	Task	Start	End	Status	Responsible
Senior Design 1					
1	Project Ideas	5/9/2022	5/20/2022	Completed	Group 7
2	Project Selection and Role Assignments	5/9/2022	6/3/2022	Completed	Group 7
	Project Report				
3	Initial Document - Divide & Conquer	5/30/2022	6/3/2022	In Progress	Group 7
4	Table of Contents & First Draft	5/30/2022	7/8/2022	In Progress	Group 7
5	Final Document	6/6/2022	8/2/2022	In Progress	Group 7
	Research, Documentation, and Design				
6	Map Construction	6/6/2022	7/7/2022	Researching	Jourdan
7	Localization and Navigation Module	6/13/2022	7/7/2022	Researching	Andy
8	Perception Module	6/13/2022	7/7/2022	Researching	Jourdan
9	IMU	6/13/2022	6/27/2022	Researching	Jourdan
10	Environment Sensors	6/6/2022	6/30/2022	Researching	Anna
11	Camera Detection	6/13/2022	6/30/2022	Researching	Andy
12	Motor Driver	6/6/2022	6/15/2022	Researching	Andy
13	Robotic Arm	6/6/2022	6/30/2022	Researching	Dhanesh
14	Power Supply	6/13/2022	7/4/2022	Researching	Dhanesh
15	Schematics	6/13/2022	7/25/2022	Researching	Anna
16	Microcontroller	6/20/2022	7/25/2022	Researching	Dhanesh

17	PCB Layout	6/27/2022	7/25/2022	Researching	Anna
18	List of Materials and Parts	8/1/2022	8/19/2022	Researching	Group 7
19	Order and Test Parts	8/3/2022	8/19/2022	Researching	Group 7
Senior Design II					
20	Build Prototype	8/15/2022	9/2/2022		Group 7
21	Testing and Redesign	TBA	TBA		Group 7
22	Finalize Prototype	TBA	TBA		Group 7
23	Peer Presentation	TBA	TBA		Group 7
24	Final Report	TBA	TBA		Group 7
25	Final Presentation	TBA	TBA		Group 7

Decision Matrix

Project Ideas	Costs	Familiarity with Technology	Motivation	Educational Goals
Trash Pickup Robot	~ $300	80%	80%	100%
Portable Salt Water Distiller	~ $100	25%	60%	60%
Sisyphus Table	~ $200	25%	75%	80%

All three project ideas are practical and feasible to build in 2 semesters. The main reason that the trash pickup robot was chosen is because all the team members had experience with building a robot. On top of that, there is more motivation for the trash pickup robot because it is more challenging. Especially compared to the sisyphus table since there are already YouTube tutorials made for building sisyphus tables. Looking at the Senior Design project requirements and educational goals, there is more room for hardware and software implementations for the robot compared to the other two project ideas. PCBs can be designed for different functionalities in the robot whereas there is limited functionality for the other two. Overall, the trash pickup robot takes more advantage in functionalities, project requirements, and the familiarity with the technology.