FollowBot: A motorized platform to follow the user with collision detection

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Section 1: Project Narrative and Goals

This project aims towards a solution in industry that is long overdue. The platform being built allows users to be completely hands-free when taking along a suitcase at an airport within a few simple steps. The applications for such a solution are endless: making disabled lives easier, simplifying working with large tools, and even avoid carrying around a cooler at events, just to name a few. By building FollowBot, we aim to make a visually representative demo of a working product that could eventually be scaled into a marketable design. The motivation comes from something which we can all relate – having to carry or roll around a suitcase at an airport. This is not too bad but becomes exponentially worse when having to do something else or having to rush to your next flight while dragging along a heavy suitcase. The solution we propose aims to squash these issues by creating a platform with versatile applications. The platform will be able to carry or mount a suitcase, a cooler, or any reasonable object while maintaining the ability to follow the user wherever they go. The product will use ultrasonic sensors for triangulating the position of the transmitter regularly as well as collision detection to avoid obstacles along the way. In this project, collision detection is one of the main priorities due to its importance in an actual demo environment. The platform should be able to: follow the user close, avoid hitting all obstacles, keep up at a reasonable speed, and maintain connection and tracking throughout the process. The project should be relatively low cost due to ultrasonic sensors being inexpensive, and the motors for the wheels being our main cost. The idea, however, is that the platform itself should be easy to use and portable. The user should be able to simply pair their transmitter to the receiver on the product and it should be ready to follow at command. Along with this, a portable device would allow for flexibility while travelling or moving whenever needed.

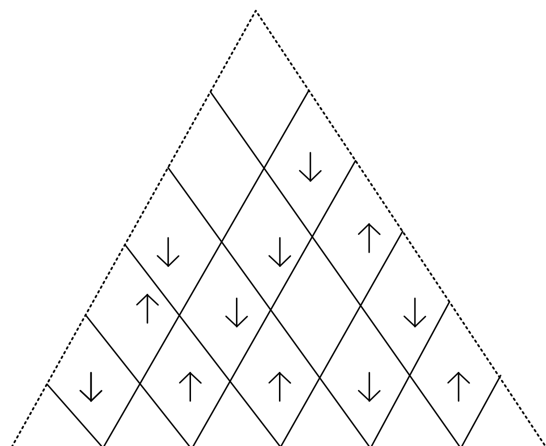
The goals and overall objectives of this project are to deliver a product that can resolve a common inconvenience people run into every day. For people that travel very often, a solution such as this at the airport could mean time saved as well as ability to do other stuff on the go. For this reason, the platform needs to be reliable and portable. The user should never have to lift the platform off the ground, even for charging, ideally. The product will include wheels that can maneuver around busy hallways and keep the objects close for maximum security. The PCB will reside under the platform, enclosed, keeping the top surface flat and aesthetically pleasing. There will be railings around the top to ensure that items kept on top will be safe for the duration of the ride. The ultrasonic sensors connected to the PCB will receive signals from the transmitter constantly updating its location. Other sensors will be used to bounce back against objects to determine whether there is an imminent collision, and if so, the wheels and motors need to be adjusted as needed.

Section 2: Project Requirements & Specifications

- Device weight should be less than 25 lbs.
- Should be able to autonomously follow user
- Has collision detection system to avoid obstructions
- Battery powered, allowing it to be recharged
- Has effective range of at least 30 ft.
- Can carry at least 40 lbs.
- Device should be able to fit in a standard sized elevator
    - The width should be less than 36” and the height less than 6’ 8”
    - Length should be less than 40”
- Should be able to carry at least two standard sized suitcases
- Should cost no more than $600
- LED to display when battery needs to be recharged
- Remains in a low power usage mode if not being utilized
- Device should be able to be operated utilizing a smartphone application
- Returns to an owner specified location once its task is complete
- Front wheels should turn to change the carts direction
- Anti-theft protocol to prevent cart from leaving specified area
- Weight sensors used to measure the amount of weight on device
    - LED light is triggered when weight limit is reached

Section 3: House of Quality Diagram

The house of quality diagram is utilized to determine the tradeoffs, marketing requirements, and engineering requirements needed for the project. The correlation between the marketing requirements and engineering requirements are then determined. This allows for the designer to quickly and clearly see how each requirement affects another requirement.



			Dimensions	Weight	Cost	Load Size	Range	Battery Life
			-	-	-	+	+	+
Marketing Requirements	Durability	+	↑↑	↑	↑↑	↓		
	Ease of Use	+	↓	↓↓			↑↑	↑↑
	Low Cost	-	↓		↑↑	↓		↓↓
	Battery Size	+	↓	↓↓	↑↑	↓	↑↑	↑↑
	Targets for Engineering Requirements		H: <60 in. L: <40 in w: <36 in.	<25 lbs	<$600	≥40 lbs	≥30 feet	<$250

Table 1: House of Quality Diagram

Section 4: Cost Analysis & Budget

BUDGET			
PARTS	EST. AMOUNT	EST. QUANTITY	EST. TOTAL
Platform (Physical Design)	$50	1	$50
Wheels	$10	4	$40
Servo Motor	$10-30	1	$10-30
Ultrasonic Sensors	$1.8	1-5	$9
Weight Sensor	$10	1	$10
Microcontrollers	$15	1-3	$45
Resistors/Capacitors	$0.10	100	$10
Voltage Regulators	$1.50	5	$7.5
PCB	$150-300	1	$150-300
Battery Charger (Wall Mount)	$52	1	$52
Rechargeable Battery	$4.50	5	$22.50
Subtotal			$576
Predicted Total			$800

Table 2: Budget Breakdown

This project will not be supported by any sponsors. Each group member will contribute to the total amount needed to develop this project which is shown in the table above. However, the amount that each group member will contribute has not been discussed yet.

As shown above, the total amount predicted for this project is around $800. Our goal is to not exceed pass the predicted total. Since at this moment our budget is being estimated, we plan to minimize the entire cost of our project as much as possible.

It is expected that the majority cost of this project will be spent on PCB manufacturing. This will be determined by the number of components we design on our PCB, and the company that we choose to manufacture our PCB. Miscellaneous components such as resistors and capacitors can and should be purchased in quantities. For hardware components, this is an important factor to consider for minimizing the overall cost.

Software assets are expected to require absolutely no dollar value. This is because our project will assimilate a free programming software.

Section 5: Hardware & Software Block Diagrams

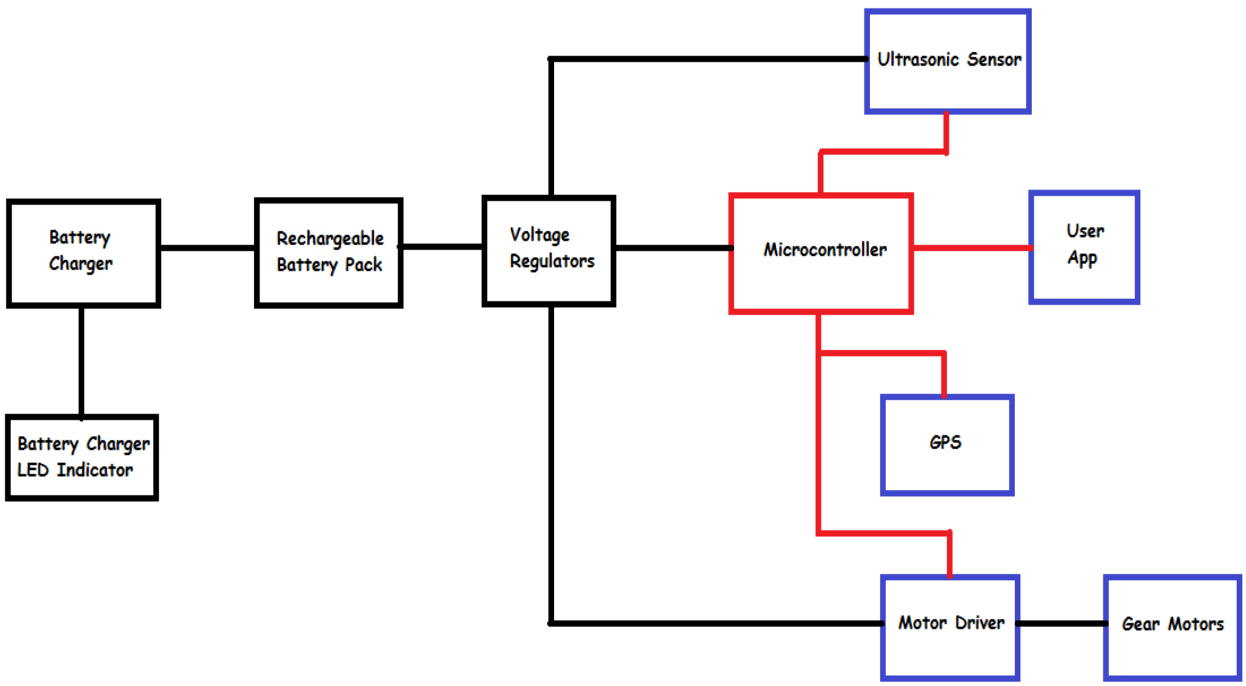
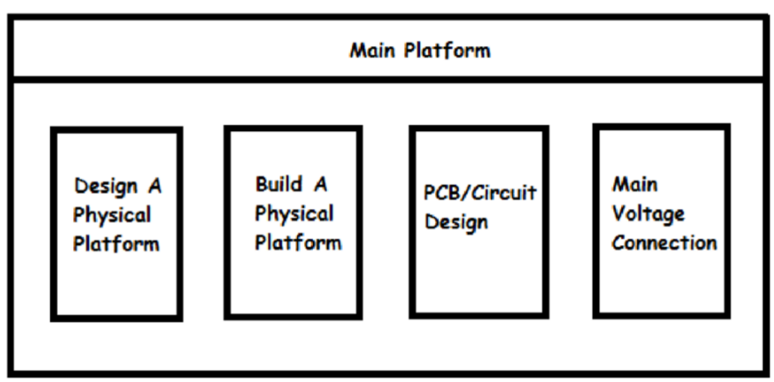


Figure 1: Hardware Block Diagram



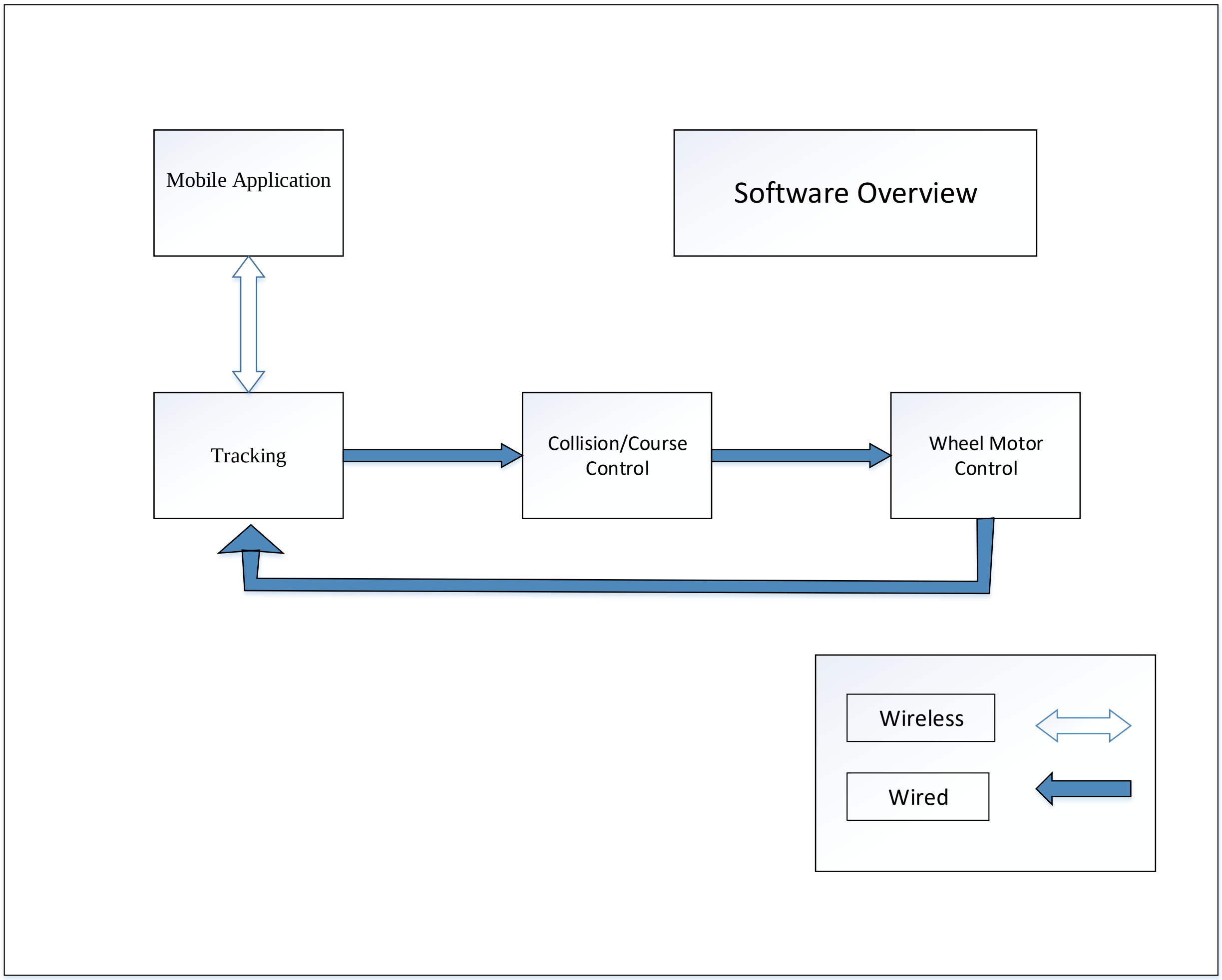


Figure 2: Software Block Diagram

Mobile Application Block

Status: Research

Input: User will input commands such as Connect, Follow, Disconnect, and

Output: Wirelessly communicate to tracking block on who to follow

Owner: David Falter

Additional Details: Will more than likely be developed in Java for android or Objective C

Tracking Block

Status: Research

Input: Information on new direction of vehicle from Wheel Motor Control block and location of mobile phone using GPS from Mobile Application block.

Output: Suggested direction and distance to Collision/Course Control block

Owner: David

Additional Details: Will likely be using FollowMe GPS based framework frequently used in modern tracking drones

Collision/Course Control Block

Status: Research

Input: Potential threats from collision detection sensors and direction/distance to the target mobile phone from the Tracking block and

Output: Will recalculate path based on foreign object threats so it can pass on the Information about the desired direction and how far in that direction the vehicle should go to the Wheel Motor Control Block.

Owner: Abhinav

Wheel Control Block:

Status: Research

Input: The Collision/Course Control block will give information change of direction and how far in that direction the vehicle must go.

Output: Give commands to the motors on the speed and number of rotations. Will then give information back to the Tracking or maybe even the Collision/Course control block on the new direction of vehicle

Owner: Abhinav

Section 6: Initial Project Milestones

Given that in today's day in age many engineering companies operate in Scrum due to its flexible and highly productive nature, we will be planning our process in sprints rather than in milestones. These sprints will take between one and two weeks.

Senior Design One Sprints:

Sprint 1: Begin research on compatible parts for each block of the project and software options for each of major hardware components.

Sprint 2:

Software- Research, design, and document languages, framework, architecture and connections to potential GPS tracking frameworks such as follow me.

Hardware- Research and begin design for wireless receiver and gps tracker.

Sprint 3:

Software- Research, design, and document of the tracking block and the logistics behind connecting to the Collision/Course Control Block.

Hardware- Create design for

Sprint 4:

Software- Research, design, and document motor control software and logistics behind connecting to the Collision/Course Block
Hardware-
Sprint 5:
Software- Research, design, and document the Collision/Course Control software and functions to take in inputs and deliver commands to the rest of the project
Hardware-
Sprint 6: Review and refine the designs and documentation from the earlier sprints.