University of Central Florida
Department of Electrical Engineering and Computer Science

Senior Design I

Initial Project and Group Identification

LookSee

Group 6

Group Member	*Major*
Stavros Avdella	Computer Engineering (BSCpE)
Austin Pena	Computer Engineering (BSCpE)
Tyler Wallace	Computer Engineering (BSCpE)
Jade Zsiros	Computer Engineering (BSCpE)

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1 Security Rover

1.1 Project Narrative

The motivation for this project is to design and implement a new, low-cost way to provide mobile security. The objective is to create a low-cost security patrol robot that can monitor small businesses, arenas, temporary outdoor work sites or campsites, unattended homes, or anywhere else that is vulnerable to intruders but would be cost-prohibitive or dangerous to install a closed-circuit surveillance system or human security guard. The robot is intended to be small, easily affordable, and used in situations where monitoring is desired but high security is not a priority.

The objective for this project is to design, build, and implement a robot that suits this situation. The intention is for this robot to be activated when no normal building occupants are around, and to patrol the space that it is left in. The robot will roam the environment in a semi-random path with the assistance of LiDAR technology, and use a camera to scan for any unauthorized personnel. If an intruder is detected, the robot will automatically send an alert message to the human operator, a contact designated to be alerted if a problem occurs. The robot will begin an audio call between the human operator and the person detected, and the human operator can verify whether the person detected is indeed an intruder. From there, the human operator can take over control of the robot to view the intruder's actions via camera feed, release the robot to its previous behavior, or call the authorities.

The goal for this project is to use sensors such as LiDAR, camera, and thermal sensors to aid in detecting human intruders. We will have a camera mounted that will aid in our image detection algorithm. The camera will also record its surveillance and provide a live feed for the user. The robot will be built on an RC car chassis, and will be approximately the size of an RC car. As it is important to the concept of the project that the product is affordable, we will keep the cost of parts under 1000 dollars.

1.1.1 Example Use Scenario

The owner of a neighborhood grocery store is concerned about potential night break-ins or vandalism, but isn't in an area where the cost of installing a surveillance camera system or hiring a night guard would be justified. He purchases a robot like the one we are building, and before locking the store doors at night, he turns the robot on.

During the night, the robot drives around the store intermittently, staying between two walls and at forks in the road selecting a random path. It uses the camera to scan for a person. If a person is detected, it drives closer, and uses its thermal sensor to verify that the person-shaped object detected is indeed warmer than its surroundings. In the case that a human is detected by both the camera and the thermal sensor, a call is placed to the store owner, and the store owner can view the camera feed remotely.

From here, the store owner can review the footage and decide what to do. If it turns out that the intruder is an employee who forgot a personal item at work, the store owner can instruct the robot to resume normal patrol. If the intruder appears suspicious, the store owner can conduct an audio call with the intruder, and can decide to call 911 if necessary.

The product keeps costs for security down while keeping the store owner, or any security guard they may otherwise hire, safe from any danger. The product is not intended for any high-risk areas or high-value facilities.

1.2 Project Requirements and Specifications

Core Requirements

- The robot must have an autonomous driving mode.
- The robot will drive behaviorally using a "find-the-gap" navigation algorithm.
- The robot must be able to detect when a person walking normally passes in front of it in clear view with at least 70% accuracy.
- If an intruder is detected, the robot will attempt to initiate a voice call with the human operator
- The human operator will have a desktop or browser application that allows it to see the robot's camera footage in the case of an intruder
- The human operator desktop or browser application will allow the human operator to speak through the robot's speakers and listen through the robot's microphone.
- The battery should be able to last at least six hours. To accomplish this, the robot may not move constantly.
- The robot shall use the chassis from a COTS remote-controlled racing car, as shown in Figure 2.
- We will complete project goals in accordance with Table 3: Project Milestones.

Advanced Requirements

- If an intruder is detected, the robot will begin recording video footage for later retrieval. The duration of this video will be ten minutes.
- The human operator will have the option to record a path for the robot to traverse.
- The battery should be able to power the robot for nine hours.

- The robot should be able to start its routine automatically on a schedule by having a time of day to begin its route.
- The robot should contain a gyroscopic sensor and alert the human operator if any unwanted motion is being inflicted on the robot. This motion would be a sustained motion outside of normal operating ranges for longer than one second.

Stretch Requirements

- If an intruder is detected, the robot will begin recording video footage for ten minutes and back the footage up to an external location over wireless connection.
- If an intruder robot loses connection with the human operator's station for more than one minute, the human operator is contacted and informed of possible tampering
- The battery should be able to power the robot for twelve hours.

1.3 House of Quality Diagram

- Table 1 shows our trade off matrix for our partially autonomous night-guard rover.The matrix depicts the correlation between design specifications requested by the consumer and design limitations imposed by the engineering requirements.

Table 1: House Of Quality

			Engineering Requirement					
			Power Output	Signal Quality	Cost	Response Time	Accurate Detection	Transmission Range
			-	+	-	-	+	+
Marketing Req.	1) Citizens Band Frequency	+	$\uparrow$	$\uparrow$	$\uparrow$	$\downarrow$	$\uparrow$	$\uparrow\uparrow$
	2) Measurement Accuracy	+	$\uparrow\uparrow$	$\uparrow\uparrow$	$\uparrow\uparrow$	$\downarrow$	$\uparrow\uparrow$	$\downarrow$
	3) Cost	-	$\downarrow\downarrow$	$\uparrow$	$\uparrow\uparrow$	$\uparrow$	$\uparrow\uparrow$	$\uparrow$
	4) Moderate Power Consumption	-	$\uparrow\uparrow$	$\uparrow$	$\uparrow\uparrow$	$\uparrow$	$\uparrow\uparrow$	$\uparrow$
	5) Transmission Range	+	$\uparrow\uparrow$	$\uparrow$	$\uparrow\uparrow$	$\uparrow\uparrow$	$\uparrow$	$\uparrow$
	6) Simple GUI	+	$\circ$	$\circ$	$\uparrow\uparrow$	$\uparrow$	$\circ$	$\circ$
	Target		TBD	TBD	50ms	$753	70%	TBD

Legend:

- $\uparrow\uparrow$ Strong Positive Correlation
- $\uparrow$ Positive Correlation
- $\circ$ No Correlation
- $\downarrow$ Negative Correlation
- $\downarrow\downarrow$ Strong Negative Correlation
- TBD = To be determined.

1.4 Project Block Diagram and Illustrations

Figure 1: Block Diagram

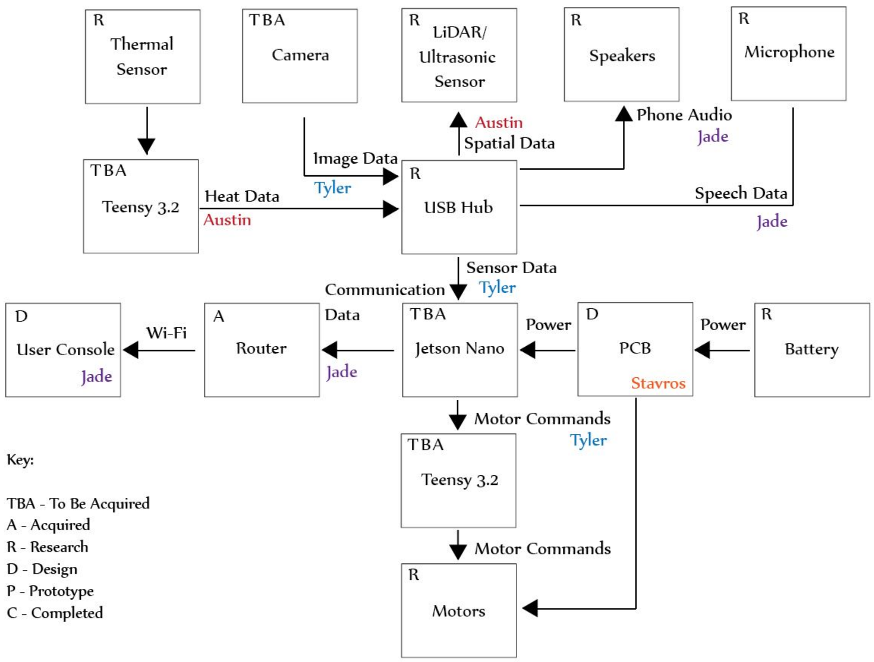
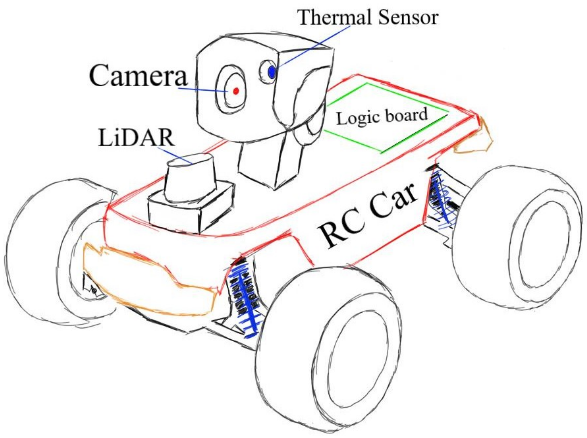


Figure 2: Artist Rendering



1.5 Project Budget and Financing

Rather than having one member of the team pay for the majority of the project and take it home, we will be expecting to deconstruct the project at the end of Senior Design II. Members will purchase components they will take home at the end of the project, with each member's contribution being approximately equal. For components that cannot reasonably be salvaged at the end of the project, we will split the cost equally among all four members. Members who donate their own personal hardware and supplies will be able to take them back at the end of the Senior Design 2.

We will be asking the manufacturers of the components that we are using to sponsor us or provide a discount, but we will be selecting components under the assumption that we must be ready to pay for the components out of pocket if no sponsorship or discount is available.

Our aim is for the project to cost no more than 300 dollars to each member of the team.

Our anticipated parts list is detailed in Table 2.

1.6 Project Milestones

Table 2: Parts List

Phase	Item	Quantity	Responsible	Estimated Cost
Development	Bread Board	1	Stavros	$3
	Teensy 3.2	1	Austin	$30
	Camera	1	Jade	$0 (Donated)
	Wiring/Sleeving	1	Stavros	$10
Final	Router	1	Tyler	$0 (Donated)
	Battery	3	Stavros	$50
	LiDAR	1	Austin	$100
	Jeston Nano	1	Jade	$100
	RC Car	1	Stavros	$200
	Thermal Sensor	1	Austin	$70
Total Estimated Cost				$563

Table 3: Project Milestones

Senior Design I				
Familiarize ourselves with project	Group 6	05/18/2020	05/29/2020	Completed
Role Assignments	Group 6	05/18/2020	05/29/2020	Completed
Identify Parts	Group 6	05/29/2020	06/12/2020	Completed
Project Report				
Divide and Conquer	Group 6	05/18/2020	05/29/2020	Completed
Updated Divide and Conquer	Group 6	05/29/2020	06/05/2020	Completed
New Assignment on Standards	Group 6	06/05/2020	06/26/2020	In progress
60 page Draft Documentation	Group 6	06/26/2020	07/03/2020	In progress
100 page Final Report Documentation	Group 6	07/03/2020	07/17/2020	In progress