UCF Senior Design I

Auto-Gardener

Department of Electrical Engineering and Computer Science
University of Central Florida
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Divide and Conquer
Ver. 2

Group 12

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Project Narrative

As climate change continues, the ecological impact of purely aesthetic lawns becomes apparent. The ultimate goal of this project is to automate the daily tasks required in the maintenance of a home garden: watering and weeding. By automating the more time consuming tasks we can encourage more people to replace portions of their lawn with a home garden.

The auto-gardener should be able to perform regular maintenance of the garden which includes navigating around the garden area and performing gardening tasks. The gardening tasks may also include planting, applying garden compost, insecticide, digging, and trimming if the main components of the project are completed successfully. It will have several sensors including a moisture meter and pH reader. The device should be durable and weatherproof, it will display statistics of area completed, water consumption, and time of operation to a pc using wireless communication.

Having additional functions such as identifying when the leaves are not at optimal health is under discussion. Yellow leaves could indicate not receiving enough water or receiving too much water. Brown leaves could indicate root rot, over watering, sunburn, or fertilizer burn. The auto-gardener would adjust according to the data received and the current data. Recognizing disease and fungus could also be a possibility.

Specification

For hardware, it is expected that the device will be able to traverse both the X and Y axis of its planting area; with minor Z axis movement in order to move the shovel for planting and weed destruction. In addition, a camera mounted on the underside of the carriage of the device will be used to take pictures of the planting area. This picture will then be transmitted using an attached wifi module to a local computer for image processing and floral identification in order to determine a desired plant versus an undesired weed. The device shall be equipped with several monitoring sensors such as: water capacity, soil moisture and position monitoring. An attached pump and water supply will allow the device to perform automated watering of the planting area either on a timed schedule or when the soil moisture sensor dictates the need. A shovel, moveable in the Z axis direction, that is able to open and close will also be included, allowing the device to remove weeds.

Software specifications are split between onboard and offboard programs. The onboard program will reside on the microcontroller of the device itself and govern key functions such as: motor movement controls, automatic watering, and position control. In addition, the onboard program will collect data and take pictures at regular intervals, transmitting this information to the offboard program. The offboard program consists of a laptop that is connected to the wifi generated by the device's hardware. It monitors for incoming data and provides image recognition for the onboard program. The offboard program will transmit back to the onboard location information of detected flora and provide desired or not desired plant feedback.

Table 1: Specifications

Specification	Description	Value
Weight	Total weight in pounds of project	<40lbs
Size	(L x W x H)	18” x 40” by 24”
Power consumption		<400 Watts
Voltage Supply		Aprrox. 11.1 V
Movement precision	L x W of smallest area of navigation	0.5” x 0.5”
Movement speed		>1”/hr
Water flow rate	Liters per hour	2L per hour
Camera Resolution		1080p
Available soil water content (AWC)	Measure of soil water availability to plants	0.2 to 0.4 grams water per gram soil
Soil matric potential (SMP)	depends on the plant	-35kPa to -58 kPa

House of Quality

			Functional Requirements									
		Direction of Improvement	▫	▼	▫	▲	▫	▼	▲	▲	▲	▫
Relative Weight	Customer Importance	Customer Requirements	Power Usage	Water Usage	Camera Resolution	Motor Precision	Sensor Accuracy	Motor Speed	Processing Power	Transmit/Recieve Speed	Floral ID Accuracy	Size
5%	2	Cost	⇈	↑	⇈	⇈	⇈	⇈	↑	↑		⇈
20%	9	Portability				⇈						⇈
5%	2	Maintanence		↑			↑		↑			↑
11%	5	Complexity	↑	↑		⇈	⇈				⇈	
7%	3	Size	⇈	⇈								
2%	1	Weight	⇈									
9%	4	Appearance										
18%	8	Convenience			⇈				⇈	⇈	⇈	
2%	1	Performance	↑		↑	⇈	↑	↑			⇈	
20%	9	Efficiency	↓	↑		↑		↓			↑	⇈

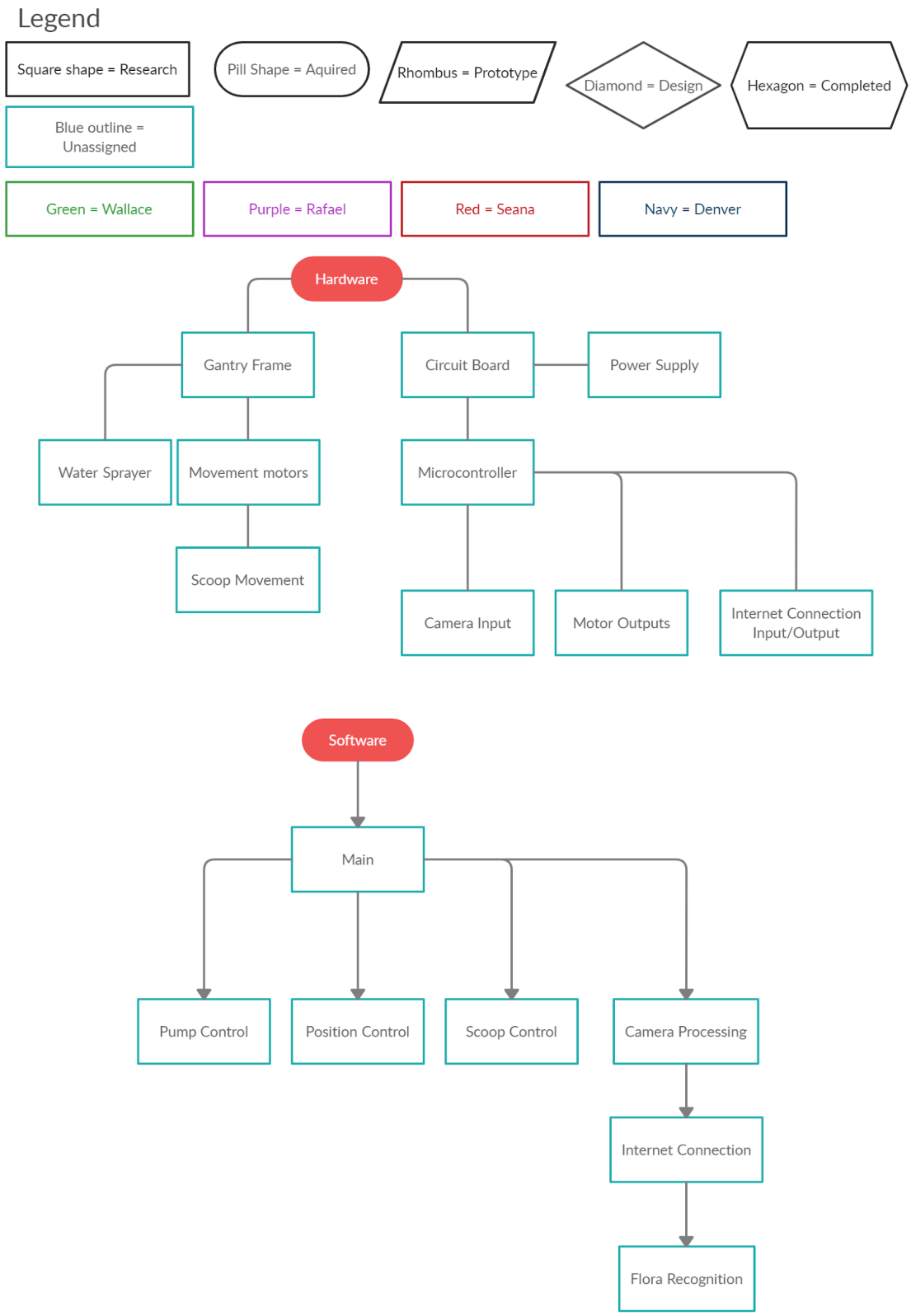
Direction of Improvement	
Maximize	▲
Target	▫
Minimize	▼

Relationships	
Strong Positive	⇈
Positive	↑
Negative	↓
Strong Negavite	⇊

Correlations	
None	
Positive	+
Negative	-

Block Diagram

Figure 1: Hardware assignments and Software Assignments



Budget and Funding

Table 2: Individual Item Pricing and Quantity

Item	Quantity	Price (estimated)
Microcontroller	1	$60
Custom PCB	1	$20
DAC module (Motor Control)	1-3	~$10
Wifi Module	1	$13
Camera Module	1	~$50
DC Motors	3	~$30
Liquid safe pump	1	$15
Moisture sensor	1	$8
Position sensor	6-10	$10
Water level sensor	4	$17
Frame materials	1	<=$50
Movement track materials	1	<=$30
Drip Irrigation Kit	1	$25
Water tank	1	$7-15
Hole digger or auger	1	~15
Hardware enclosure	1	$15
Garden (plot or pot)	1	$1-$20
Garden Soil	4-10lbs	$5-$10
Total		**$376-$400**

Project Milestones

Table 3: Projected completion dates

Milestone #	Description	Duration	Dates
Senior Design 1			
Research, Documentation, & Design			
1	Frame Design		10/2 - 11/1
2	PCB design		
3	Research agriculture		
4	X and Y axis motor assembly and control		10/2 - 11/1
5	Scoop Motor assembly and control		
6	Water nozzle assembly and control		
7	Camera integration		11/15-12/1
8	Movement integration		
9	Ethernet integration		
10	Flora image recognition		1/15/2021
11	Camera to image server communication		1/15/2021-2/1/2021
12	Hardware cover, waterproof design		2/1/2020-3/1/2021
Project Report			
13	Table of Contents	4 weeks	10/5 - 11/15
14	First Draft	4 weeks	10/5 - 11/15
15	Finalizing Paper	2 weeks	11/15 - 11/30
16	Final Document Due Date	-	12/8
Senior Design 2			
17	Build Prototype	4 weeks	1/11/2021 - 2/11/2021
18	Master control program	2 weeks	3/15 - 4/1
19	Testing & Redesign	3 weeks	4/1 - 4/21
20	Peer Presentation	-	April 2021
21	Final Report	TBA	April 2021
22	Final Presentation	TBA	April 2021