Meeting Purpose: Software Design Review for the Wandering Ambassador (Part 6) project (P11216).

Materials to be reviewed:

1. Project Description
2. Risks
3. Critical Customer Needs – Software
4. Critical Engineering Specifications – Software
5. Proposed Software Design
6. Example Use Cases
7. Example Sequence Diagrams
8. Tentative Schedule
9. Personality Framework
10. Sonar Placement

Meeting Date: January 21, 2011

Meeting Location: 70-2690

Meeting Time: 2:00 pm, Friday, January 20th

Timeline:

Meeting Timeline		
Start Time	Topic of Review	Required Attendees
2:00	Project Description	P11216
2:02	Risks, Needs, Specs	P11216
2:07	Software Design	P11216
2:20	Example Use Cases / Sequence Diagrams	P11216
2:35	Tentative Schedule	P11216
2:40	Personality Framework	P11216
2:45	Sonar Placement	P11216

Project #	Project Name	Project Track	Project Family
P11216	Wandering Ambassador (Part 6)	Vehicle/Robotics	Land Vehicle
Start Term	**Team Guide**	**Project Sponsor**	**Doc. Revision**
20102	George Slack	KGCOE EE Dept	2

Project Description

Project Background:

RIT has always been interested in finding new and exciting ways to build interest and showcase student activities on campus. The primary customer conceptualized a robot which slowly moves around campus caring for an onboard plant and runs on sustainable energy. This would serve multiple purposes, which include showing RIT's commitment to sustainable energy, student innovation and technical ability, as well as providing a talking piece for visitors to campus.

Problem Statement (*Robot Track (2009/2010/2011)*:

The main goal of this project is to raise awareness of RIT innovation by designing a robot that acts as a guardian of a plant and who acts in a symbiotic relationship with the plant. The robot will support the needs of the plant, as well as its own, by managing sunlight and soil water content.

P11216 will join the P11215 team to evaluate previous development and then develop or mature needed functionality as well as test all robotic functions and continue to refine the design, as needed.

Objectives/Scope:

1. Work with P11215 efficiently to complete robot functions.
   - Improve the robot's navigation functions so that it may wander unattended.
   - Have the robot be able to care for the plant for a period of at least 1 week.
2. Define detailed test routines to uncover reliability issues.
3. Continue the implementation process of debugging hardware and software as the integration process begins. (i.e., characterize and evaluation the various robot sensors and output devices.)
4. Make maximum use of natural conditions by managing sun, shade, temperature, rain, and watering to allow the plant to grow and thrive and robot power to self-sustain.
5. Establishment of an environment which allows software development to proceed before hardware is available and integrates with hardware.
6. Full definition and implementation of software application programming interface to the robot navigation and plant support functions.
7. By the start of the spring quarter, evaluate the test results and issues from the P11215 team, and create a plan to eliminate critical known software issues.
8. Perform outdoor field testing, and debug software issues.

Deliverables:

1. Improved design with improved safety features.
2. Implemented plant care system.
3. Testing routine for drivetrain features including drive transmission and safety issue.
4. Testing routine for transport scheme needs to be evaluated.
5. Testing routine for plant portion of the robot including water reservoir and dispensing.
6. Robot navigates autonomously at the Innovation Festival in spring of 2011.

Expected Project Benefits:

1. Showcase the creativity and technical abilities of RIT's Multidisciplinary Senior Design teams.
2. Navigate autonomously and take care of the plant at RIT's Innovation Festival in Spring 2011.
3. Reinforcement of RIT's devotion to innovation, sustainability projects and energy resources.
4. Excellent demonstration of good testing procedures for integrated systems of its kind.
5. Define robust application programming interfaces for higher-level on-board processing.
6. Work in conjunction with the initial team during the winter term to expand the range of plant maintenance, environment interaction, and navigation functions that are available.

Core Team Members:

Nick Leathe (ME)
Anna Gilgur (ME)
Rui Zhou (EE)
Ken Hertzog (CE)
Joseph Stevens (SE)
Philip Gibson (SE)
Dave Ladner (SE)
Terra McAndrew (ID)
Project Team P11215

Strategy & Approach

Assumptions & Constraints:

1. The robot will not be a safety hazard to observers and campus visitors.
2. Existing locomotion system and frame will be used as a base for modification.
3. The robot needs to function for 1 week unattended.
4. The robot will take care of the plant.
5. The robot will be able to fit through doors.
6. On-board processing power: dual core single board computer, Linux operating system.
7. Sensors and actuators for robot navigation and status, and plant support and status.
8. Prototype design of software interfaces to the robot navigation and plant support functions.

Issues & Risks:

1. Difficulty in software-hardware interaction previous groups experienced continues to hinder progress.
2. Reliability issues
3. Legacy documentation not fully developed.
4. Sensor blind-spots need to be filled in order to prevent collisions.
5. Additional safety mechanisms are required to make the robot safe for curious children.
6. Conflicting customer needs lead to a failure in creating an interesting project.

Risks:

Risk	Name	Effect	Cause	L	S	Importance (L*S)	Action Taken to Minimize Risk
17	qconn not loaded onto BeagleBoard	Must develop in proximity to board	Lack of knowledge of QNX	3	8	24	In contact with QNX tech support and/or forums
18	I2C not functional	Software unable to get sensor readings	Bad chip, lack of support in QNX	4	9	36	Making new chip, looking into how I2C works within QNX
19	Underestimating time needed for development	Schedule Lag	Overconfidence in language/ design	6	4	24	Working to stay on schedule, weekly status reports
20	Team member unavailable to work	Schedule Lag, More workload for other members	Family Emergency, Major Sickness	2	8	16	No real action available, try to get work done in advance.
21	Software not able to move robot	Incomplete MSD project	Lack of understanding of hardware, bad connections	2	10	20	Work with other team members to have a better understanding of motor functions

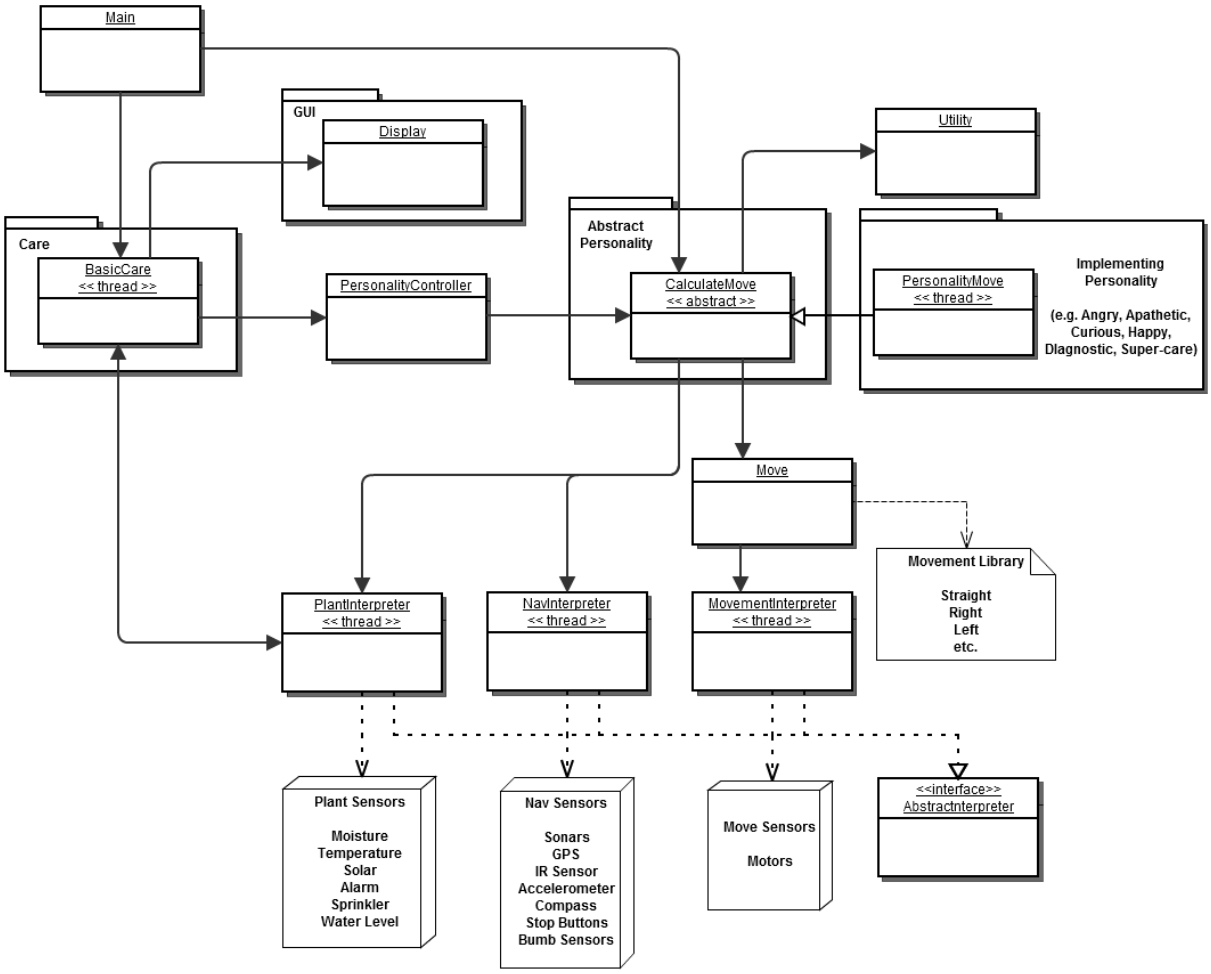
Critical Customer Needs:

Customer Need Number	Importance (1 = High)	Description	Comments / Status
CN9	1	QNX loaded on BeagleBoard with QConn	Currently working on internet connection to board, display
CN10	1	Store sensor input in registers	Possibly completed? Needed for software
CN11	1	Virtual Machine for development	Completed
CN13	1	Water plant when moisture low	
CN17	2	Needs to stay within certain area (GPS coordinates)	
CN19	1	Software senses people/objects and does not run into them	
CN20	1	Able to switch personalities	Currently Diagnostic, Happy, Curious, Angry, Apathetic, Super-care
CN28	1	Software must be able to run each motorized wheel independently	

Critical Engineering Specifications:

Engineering Spec. #	Importance (1 = High)	Related Customer Need	Description	Unit of Measure	Marginal Value	Ideal Value	Comments
ES9	1	CN20-27	Has personality	Binary	N	Y	
ES10	1	CN19	Does not bump into people/objects	Things Bumped/hour	6	0	
ES11	2	CN17	GPS Operation – GUI Selectable	Binary	N	Y	
ES18	1	CN9	QNX Loaded	Binary	Y	Y	
ES19	1	CN10	Sensor Input Stored in Registers	Binary	Y	Y	
ES21	1	CN13	Senses when plant soil moisture is low	Binary	Y	Y	
ES26	1	CN20	Number of personalities/ modes	Number	3	7	
ES27	1	CN13	Waters plant when plant soil moisture is low	Binary	Y	Y	

Proposed Design:

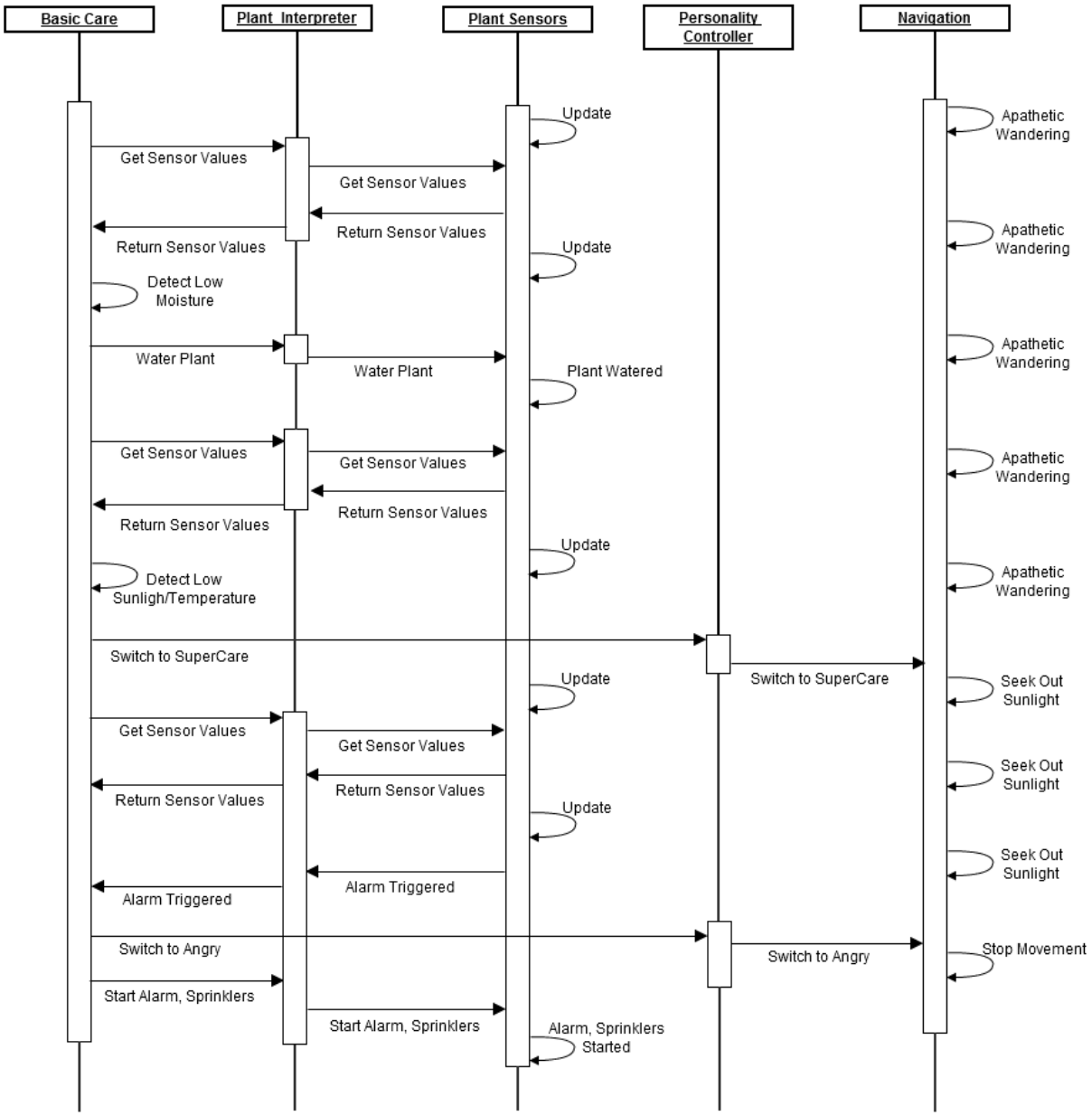


Example Use Cases / Sequence Diagrams:

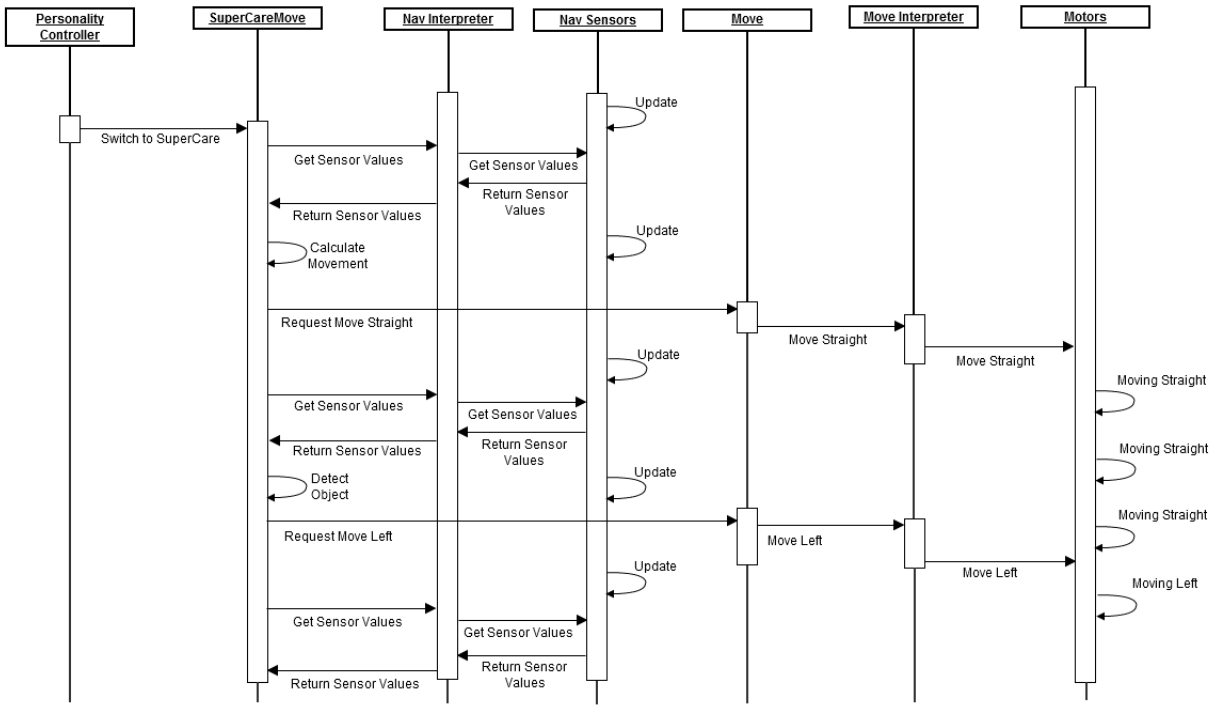
Use Cases:

1. Water the Plant
    - The moisture sensors detect that the plant needs to be watered. The system activates the water pump.
2. Plant gets Stolen
    - The plant is removed from its chassis, triggering the “Indiana Jones” switch. The system switches the current personality to “Angry” and activates the alarm and the water sprinkler. The water sprinkler will go off only one time for approximately 10 seconds (not yet decided), while the alarm will go off until the plant is placed back in the chassis or diagnostic mode is activated.
3. Switch Personalities Autonomously
    - The system will detect that there is a lack of sunlight. It will then automatically switch the personality to “SuperCare” mode, where it will actively seek out sunlight.
    - If the plant is removed from its chassis, the system will automatically switch to “Angry” mode.
4. Switch Personalities Manually
    - A person selects the “Change Personality” option via the robot’s touchscreen and selects either “Diagnostic”, “Apathetic”, “Curious”, or “Happy”. The system will change the current personality to the corresponding choice.
5. Apathetic Wander
    - The system will randomly move within the boundaries designated by the GPS. It will avoid any obstacles it detects, but will not attempt to interact with them in any way.

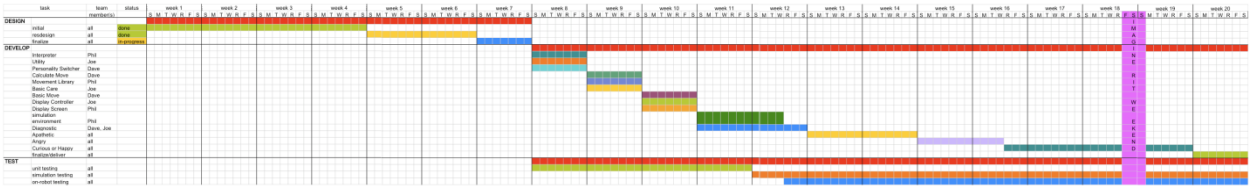
Sequence Diagram for Plant Care



Sequence Diagram for Navigation



Tentative Schedule:



(Will have a better image during presentation)

Personality Framework:

Personality Framework:

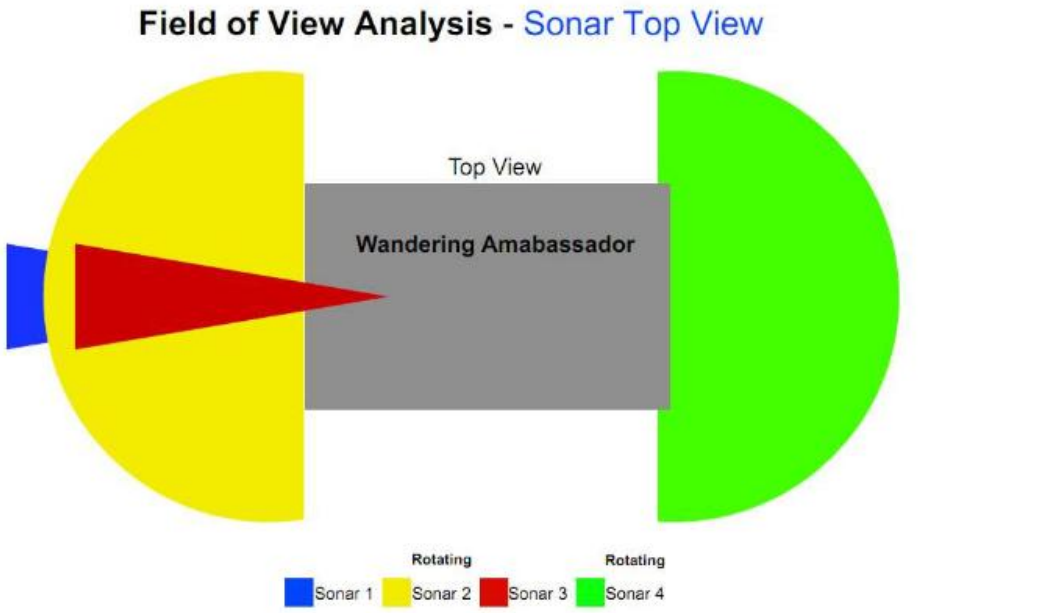
The current design of the Wandering Ambassador allows for personalities to determine the way that the robot will interact with the environment. Some of these personalities will have environmental triggers, such as the plant being stolen, while others will most likely need to be activated with the LCD screen. Below are two tables: the first includes a list of actions or ways for the robot to demonstrate its mood, while the second table is a summary of the five personality concepts.

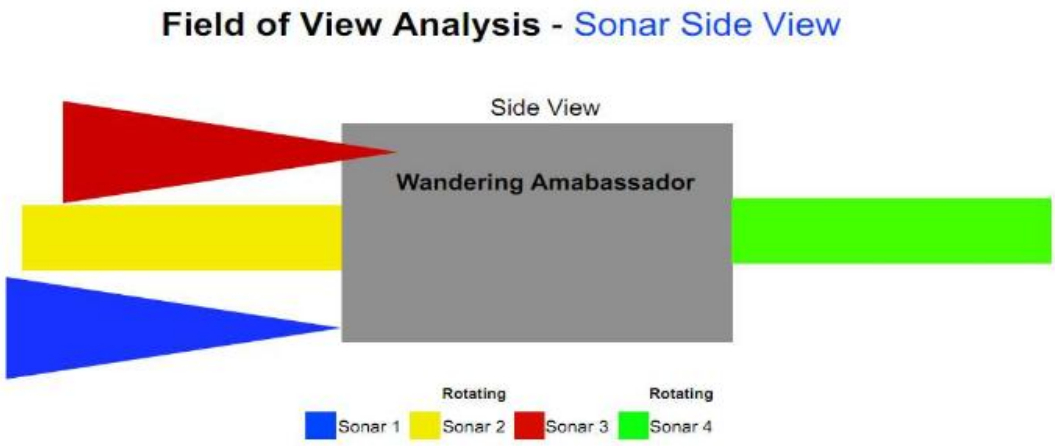
Output Options/Actions:	
Forward Movement	Sensor Servos (Possibly)
Backward Movement	LCD Touch Screen
Leftward Spin	Alarm System
Rightward Spin	Water Sprinkler

Personality / Mode	Activation	Reactions	Color Associated
Apathetic *	LCD Screen	Move at random, ignore inputs (minus plant and hitting objects)	Grey
Diagnostic *	LCD Screen	No movement, display information about plant and robot on touch screen	Blue
Happy	LCD Screen	Move in circles, seek out people, Chirp?, Spray people?	Yellow
Curious	LCD Screen	Looks to observe objects, but keeps set distance. Follows?	Orange
Super-Care	Plant Dying / Low Water or Sunlight	Water plant and/or seek out more intense sunlight. Ignore people.	Green
Angry *	Plant Stolen	Active Alarm/Sprinkler Return to Housing No Movement	Red

(* means more important, required for robot to operate normally)

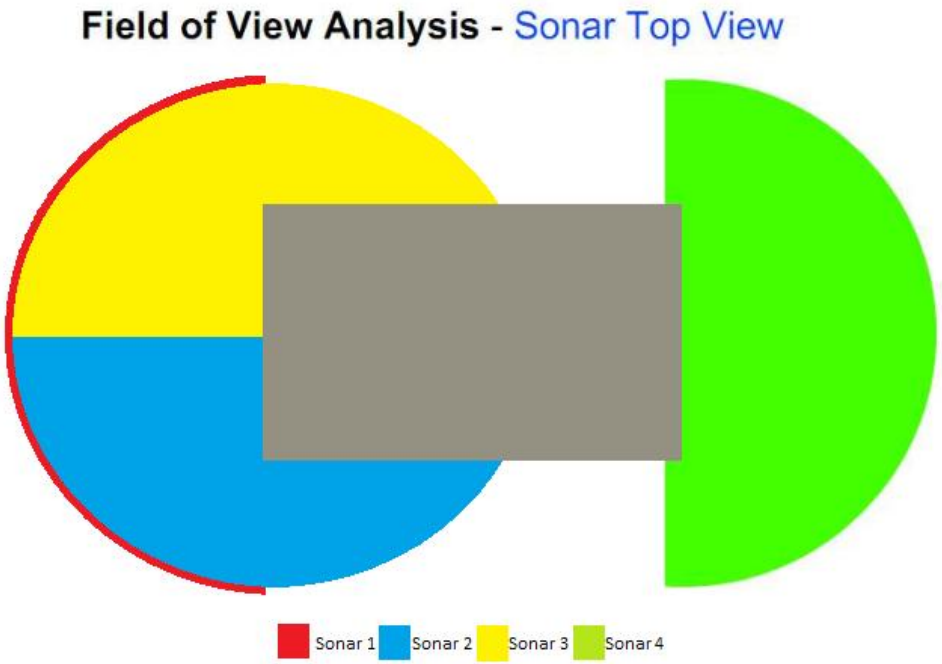
Sonar Placement:

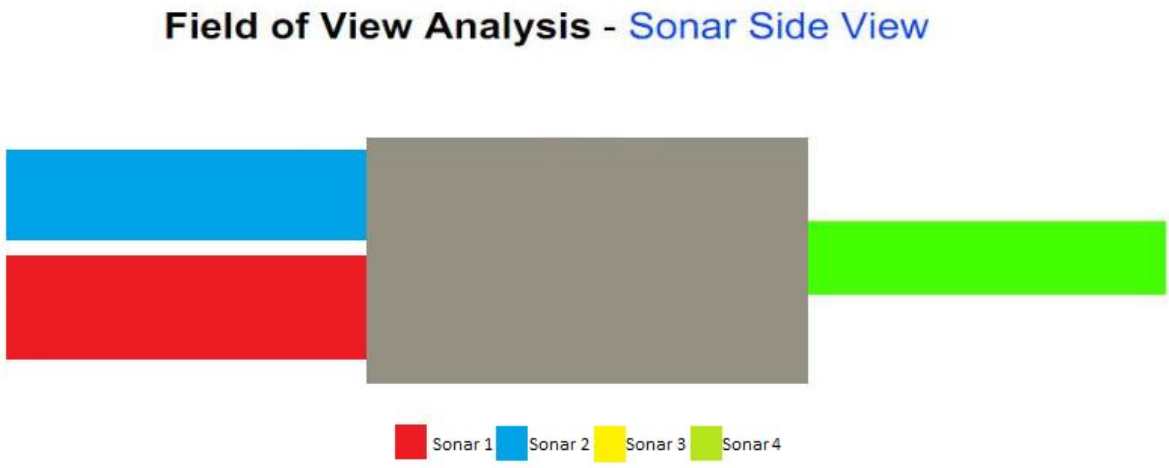




Old Sonar Arrangement

Currently the sonar sensors have a diameter of vision of two feet. The current design, as seen above, does not utilize this and results in significant overlap. By moving the sensors to the orientation below, the overlap is minimized and the field of view is dramatically increased.





Proposed Sonar Arrangement