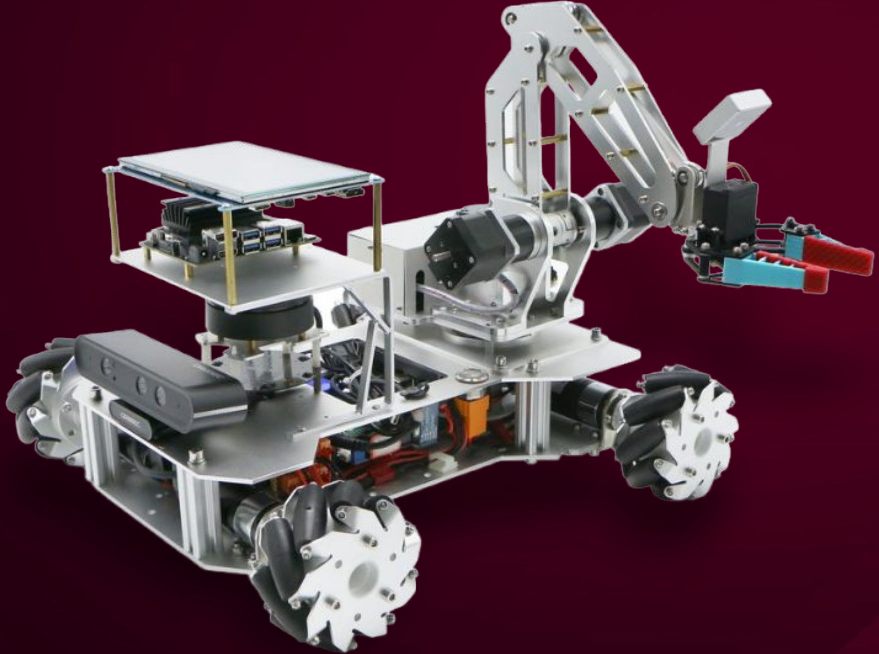
Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Team 5: Autonomous Object Picking Robot

Bi-Weekly Update 4



Christoffer Cox

James Dickson

Kathy Vo

Sponsor: Swarnabha Roy

TA:Niloofar Borzooei

Executive Summary

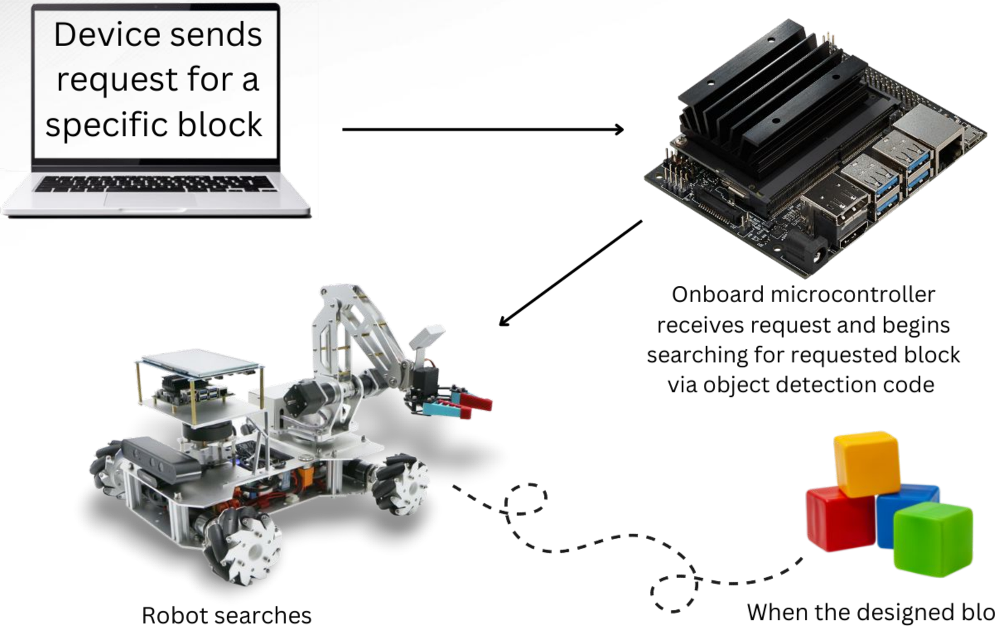
Problem statement:

- With millions of packages processed daily through warehouses, the need for safe and efficient sorting methods is of the utmost importance.
- Workplace injury rates are increasing as the demand grows.

The autonomous object picking robot offers:

- The ability to navigate through indoor environments with no human control
- The ability to differentiate between objects depending on the color
- The ability to grasp and transport designated objects to a given location

Integrated System Diagram

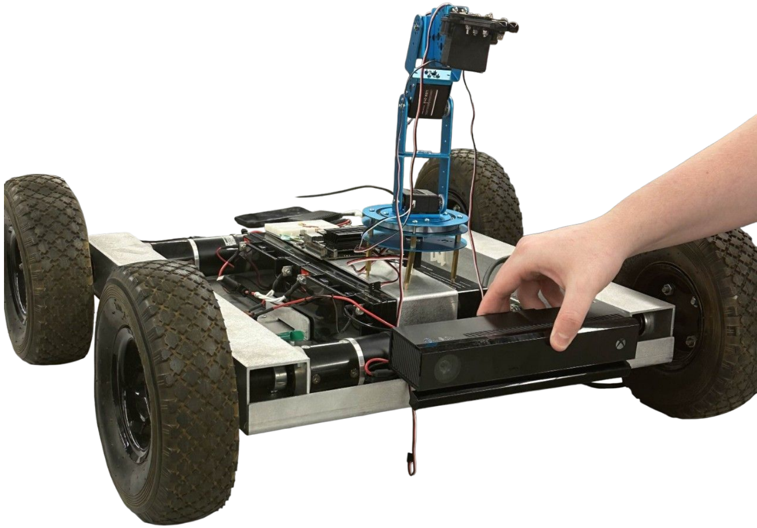


Device sends request for a specific block

Onboard microcontroller receives request and begins searching for requested block via object detection code

Robot searches location for designed block

When the designed block is located, the robotic arm will pick up the block and bring it to the designated home location



Project Timeline

Finalize initial subsystem codes to prepare for integration (completed 1/20)	Integrate code for the Kinect camera with the Jetson Nano and motor controller (completed 2/3)	Autonomously move robot and arm using real world detection (to complete by 3/4)	Fully make the robot independent and combine all parts together (to complete by 3/17)	Test system and refine any bugs or issues (to complete by 4/14)	Final Demo and report (to complete by 4/26)

Object detection and Grasping

Chris Cox

Accomplishments since last update 25 hrs of effort	Ongoing progress/problems and plans until the next presentation
- Created code that allows Kinect camera to extract 3D data using LiDAR - Assisted in creating environment that allows an external device to communicate with Nano	- Fix freenect2 compatibility issue and apply code to ROS

Object detection and Grasping

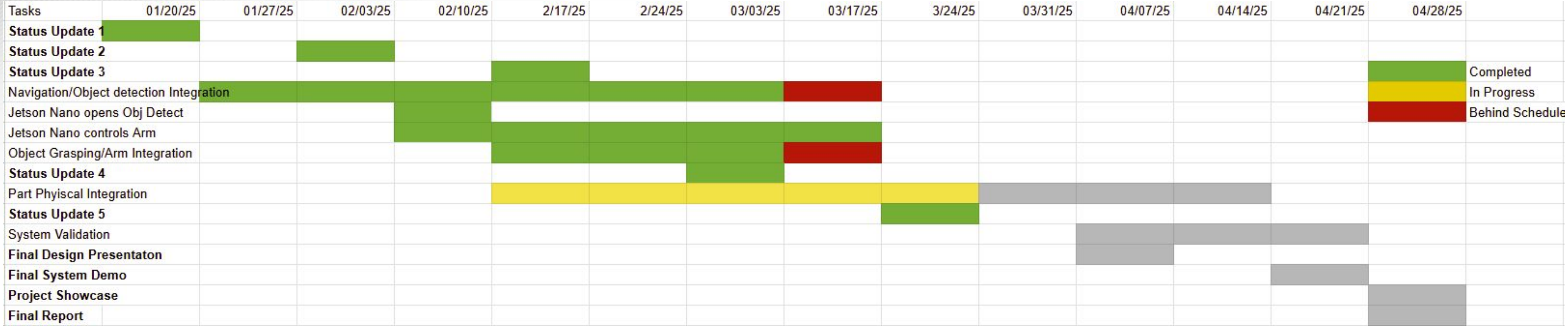
Chris Cox

Arm Manipulation

Kathy Vo

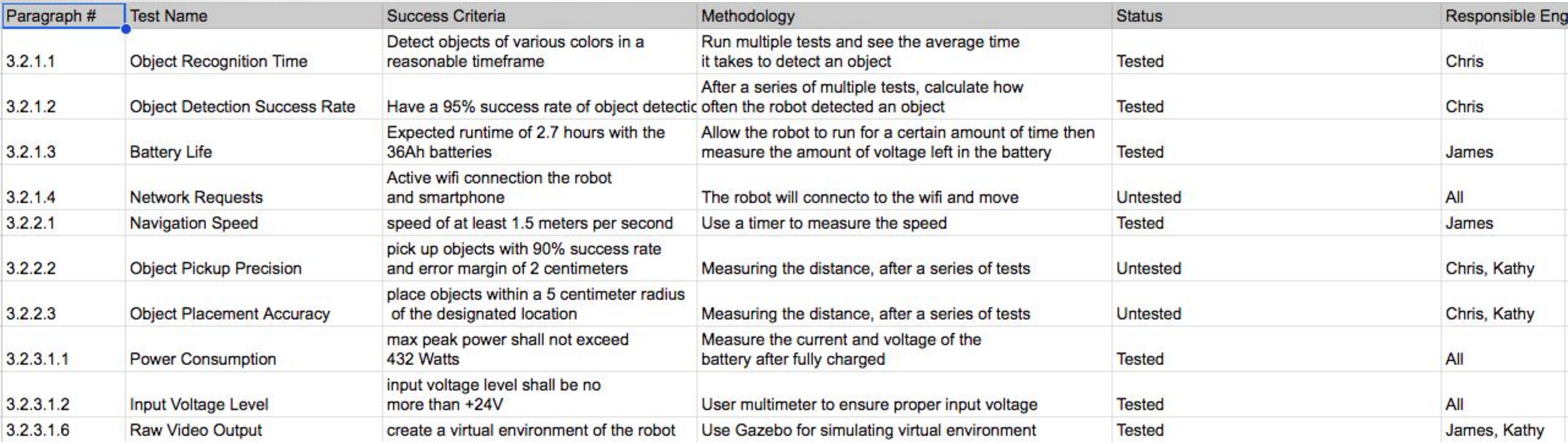
Accomplishments since last update 20 hrs of effort	Ongoing progress/problems and plans until the next presentation
- Can control all robotic arm servos with the Jetson Nano	- Continue Integration with the object detection system to move the servo with the Jetson Nano

Execution Plan



Tasks	01/20/25	01/27/25	02/03/25	02/10/25	2/17/25	2/24/25	03/03/25	03/17/25	3/24/25	03/31/25	04/07/25	04/14/25	04/21/25	04/28/25	
Status Update 1	🟩														
Status Update 2			🟩												
Status Update 3					🟩									🟩	Completed
Navigation/Object detection Integration		🟩	🟩	🟩	🟩	🟩	🟩	🟥						🟨	In Progress
Jetson Nano opens Obj Detect				🟩										🟥	Behind Schedule
Jetson Nano controls Arm				🟩	🟩	🟩	🟩	🟩							
Object Grasping/Arm Integration					🟩	🟩	🟩	🟥							
Status Update 4							🟩								
Part Phyiscal Integration					🟨	🟨	🟨	🟨	🟨	▨	▨	▨			
Status Update 5									🟩						
System Validation											▨	▨	▨		
Final Design Presentaton											▨				
Final System Demo													▨		
Project Showcase														▨	
Final Report														▨	

Validation Plan

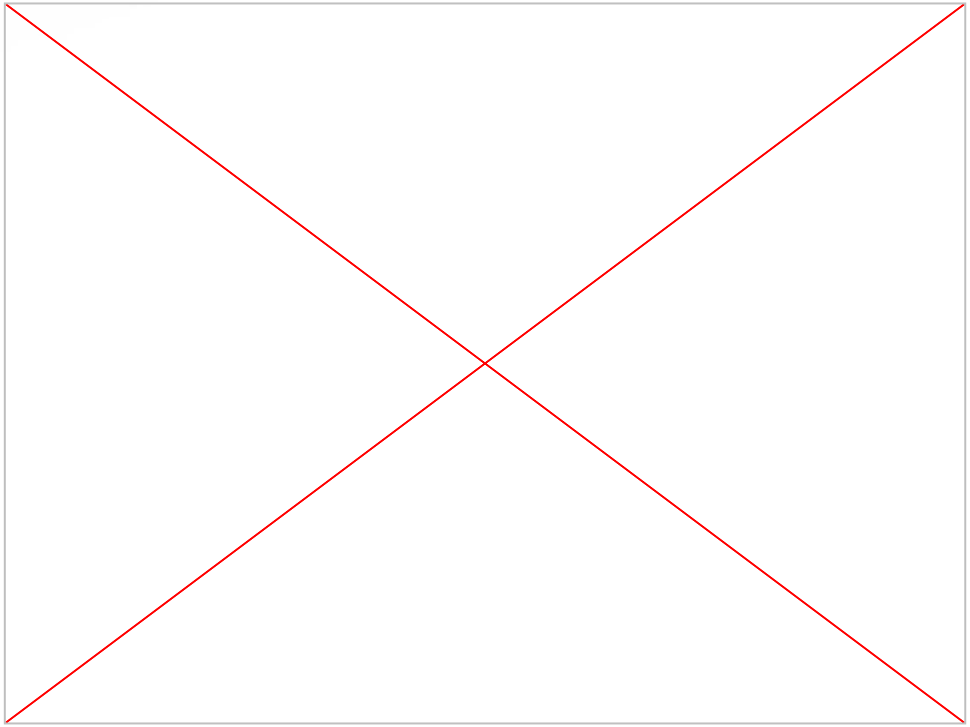


Paragraph #	Test Name	Success Criteria	Methodology	Status	Responsible Eng
3.2.1.1	Object Recognition Time	Detect objects of various colors in a reasonable timeframe	Run multiple tests and see the average time it takes to detect an object	Tested	Chris
3.2.1.2	Object Detection Success Rate	Have a 95% success rate of object detectic	After a series of multiple tests, calculate how often the robot detected an object	Tested	Chris
3.2.1.3	Battery Life	Expected runtime of 2.7 hours with the 36Ah batteries	Allow the robot to run for a certain amount of time then measure the amount of voltage left in the battery	Tested	James
3.2.1.4	Network Requests	Active wifi connection the robot and smartphone	The robot will connecto to the wifi and move	Untested	All
3.2.2.1	Navigation Speed	speed of at least 1.5 meters per second	Use a timer to measure the speed	Tested	James
3.2.2.2	Object Pickup Precision	pick up objects with 90% success rate and error margin of 2 centimeters	Measuring the distance, after a series of tests	Untested	Chris, Kathy
3.2.2.3	Object Placement Accuracy	place objects within a 5 centimeter radius of the designated location	Measuring the distance, after a series of tests	Untested	Chris, Kathy
3.2.3.1.1	Power Consumption	max peak power shall not exceed 432 Watts	Measure the current and voltage of the battery after fully charged	Tested	All
3.2.3.1.2	Input Voltage Level	input voltage level shall be no more than +24V	User multimeter to ensure proper input voltage	Tested	All
3.2.3.1.6	Raw Video Output	create a virtual environment of the robot	Use Gazebo for simulating virtual environment	Tested	James, Kathy

Thank you for listening. Any Questions

Arm Manipulation

Kathy Vo



Guidance on preparing status update 5

- Theme of this presentation is **System Validation**. Validation is different than testing and different from verification. Verification is conducted typically as a bench test in the lab during development to check if requirements are met. Tests are usually subsystem or integrated subsystem focused.
  Validation ensures that the system satisfies requirements, regulations, specifications, and complete cross-conditions of operation for the system. The test planning and execution that we have completed underlies the validation process. System validation is performed on the "full-up" system during or after system integration. System validation is done in real or an accurately simulated environment that system will be operating in.
- This update should cover what was accomplished in weeks 9 & 10 and what is planned for weeks 11 and 12 **(This period is completion of system test and validation)**
- Integration should be complete (possibly some reintegration with final PCBs, final ML models, final look/feel for app, etc) Functional system tests, requirements (range) testing, and error testing should be well underway or done.
- If you are still doing subsystem bringup and integration, you are putting your

Validation

- For validation, we need to move from bench test environment to more realistic lab or actual environment that the system would be deployed in. That means you should have scenarios that you have or will test in the field or in accurately simulated environments – same or representative location, terrain, real or accurately emulated users, physical & environmental condition, etc
- Fidelity of prototype should be very high – exact hardware and software that the final system will use, PCBs not breadboards, actual external equipment of systems that your system will interact with. Where prototype level hardware and software is used, it should be reported as such.
- We STRONGLY suggest using a scenario-based validation process. Scenarios should be developed, owned by one team member, carried out (may be done by 1 person or may require entire team), and results should be recorded. Scenario results should be presented in your demo and documented in your final report.
  - Scenarios are end to end targeted uses of your system that capture the operations of your system that you specified in your con ops (with specifics for operating modes, users, and sequences of actions).
  - Scenarios should cover all major normal uses of your system for all modes: eg. system setup/calibration process; use by general user, user by someone with additional responsibility/authority .. Maintainer, auditor, manager,…; maximum demand usage; coverage of operation ranges and environments, etc. Scenarios to show operation to minimum function depending on resource usage or system demand changes.
  - Scenarios can be developed to show correct operation for one or more requirements that you specified in your FSR.
  - Scenarios should also include operation outside normal operation – incorrect request/actions by a user; failures and disaster recovery scenarios; recover processes;

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Team 99: Project Name
Bi-Weekly Update 5

Team members list
Sponsor: Sponsor Name
TA: TA Name

Intro should take 30 seconds

Project Summary (30 seconds)

- What is the problem that we are solving
- High-level summary of what system does to solve the problem

Picture / Diagram here

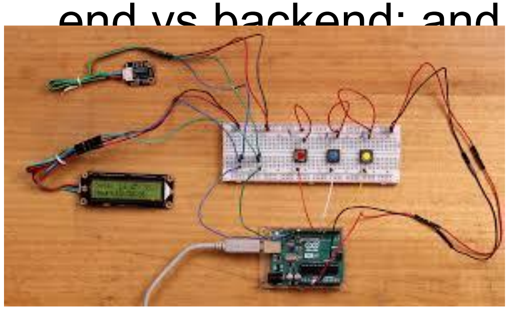
Integrated System Diagram (90 seconds)

UPDATE This if necessary to show final system organization, environment, and users!

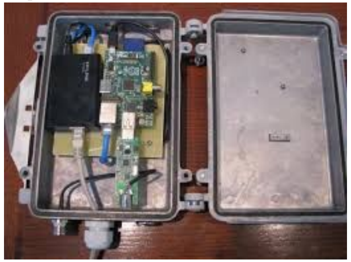
This should show the complete system – with picture of packaged solution or conceptual diagram of packaged solution.

Show how it connects to the outside world (communication, interfaces).
If appropriate show internal breakdown and interfaces.

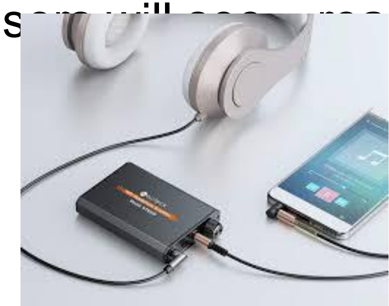
SW projects should show data repository/db; mobile/web app connectivity; front end vs backend; and give representative screens users will see – real



Unacceptable – not integrated



Good – shows enclosure, integrated



Perfect – Shows packaged amplifier, app for interface, and users headphones

Project Timeline (45 seconds)

Target or actual dates within or above boxes –
green done, yellow underway, red in trouble, white not started

Subsystem Designs and Testing (completed 9/11)	Integration of motor subsystem and MCU (completed 9/17)	Integration of Bluetooth and iPhone App (completed 9/28)	Final Integration (completed 10/15)	System Test (to complete by 11/2)	Validation (to complete by 11/26)	Demo and Report (to complete by 12/5)

-- Just quick overview…do not talk about work completed weeks ago, concentrate on past few weeks and upcoming activity.

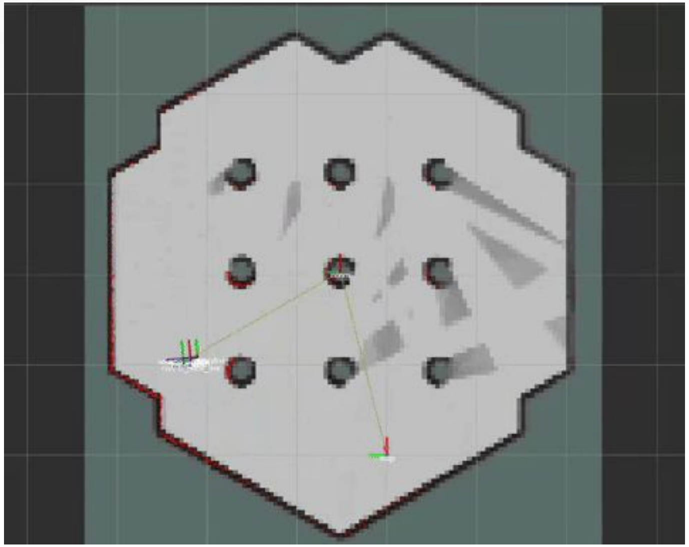
-- Save detail for individual team member updates and execution/validation plan

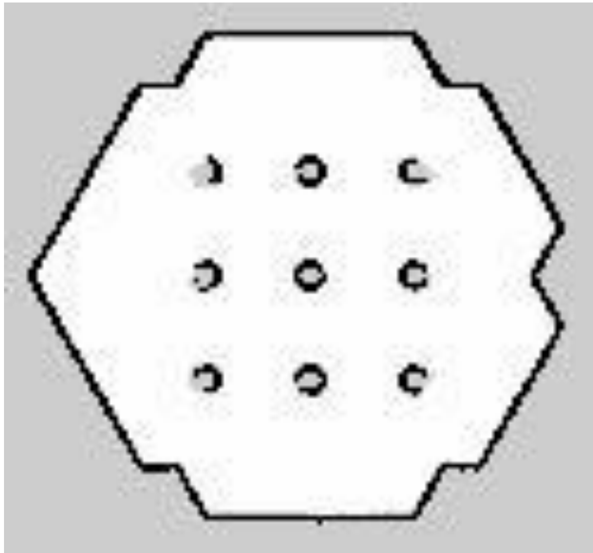
Object Navigation and Object Avoidance

Accomplishments since last update 40 hrs of effort	Ongoing progress/problems and plans until the next presentation
- Continued navigation integration with detection system (90 percent complete) - Continued navigation integration with arm system.	- Fix compatibility issues - Complete integration by next lab

Object Navigation and Avoidance

James Dickson





You should be putting 7-10 hr/week on capstone!

Team Member 1 (30 seconds)

Accomplishments since last update XX hrs of effort	Ongoing progress/problems and plans until the next presentation
What has been accomplished since last review	What are you going to accomplish in the next 2 weeks

This should not be just subsystem status!

It should be review of the System Test and Validation activities led by Team Member 1

For 5th review Accomplishments should include system testing and specific validation scenarios results:
“Validated correct system operation for temperatures from 25C to 50C”
“Completed battery lifetime system test for maximum workload and simple workload cases”
“Validated back end database loss and recovery”
“Tested image detection in flight Pi-4 on drone with detection accuracy of XX”
“Validated all app error handling for valve failures”
“ON-GOING 5 day field test of monitoring system”
“Developing validation scenarios for mobile user operating through App and dispatcher

Team Member 1 (1 minute)

This should all be test and validation results! – show things working, functional test results, error checking, etc, what validation is planned using what scenarios

Show test and validation results for integrated systems

Execution Plan
(Show for 45 seconds)

- Execution plan
  - Your team planned milestones for completion of any remaining integration, functional, range, and error test, and validation plans should be presented.
  - Milestones should have owners … system tests, and full system integration can be group owned
  - Engineering milestones only [presentation, demo, document due dates are project milestone that do not belong on this chart]
  - Gantt chart.
  - DO NOT try to discuss all milestones in the plan – just high priority present and next engineering milestones

SYSTEM Validation Plan (Show for 1 minute)

- Validation plan
  - This is not a gantt chart.
  - Validation plan is a table showing:
    - Name: descriptive short description of what is being validated,
    - Requirement: Identifer to link to requirement # from conops/fsr/icd
    - Success Criteria for validation – range/lifetime/performance metric/physical limit…that must be met.
    - Methodology – test procedure followed/observations made/simulations completed/.. to satisfy the validation
    - Responsible party