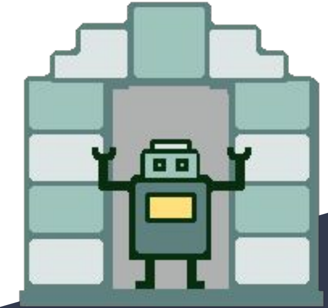
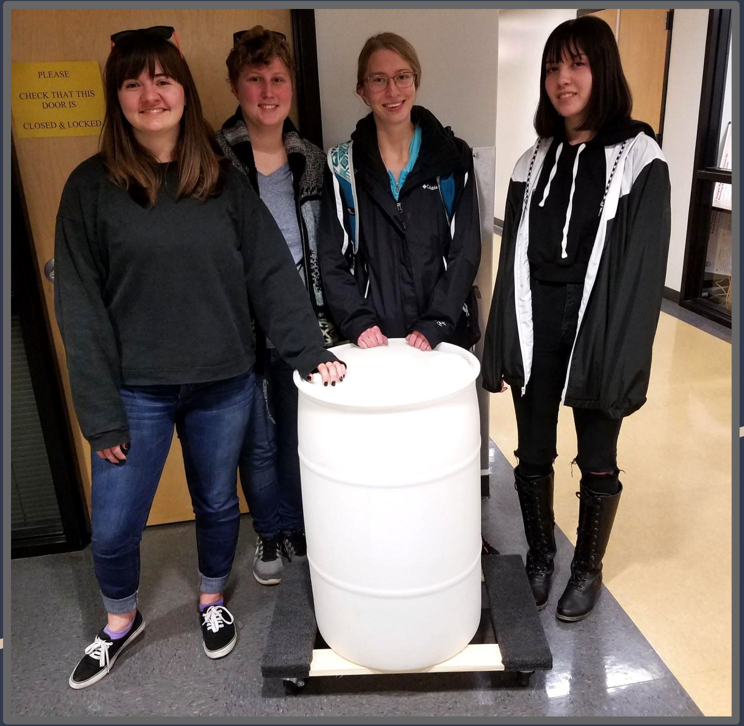
Robot Assisted Tours - Design Review I



Keystone Robotics

Introduction



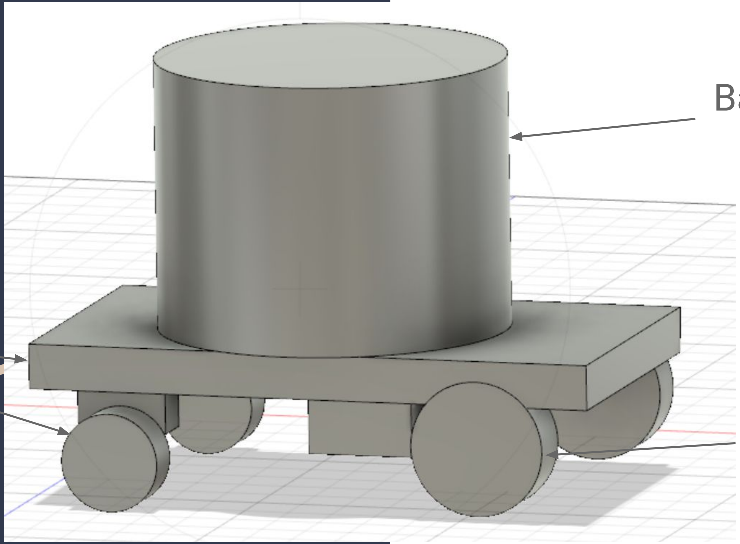
- Computer Science Team
  - **Hailey Ginther -**Team Lead, Customer Communicator
  - **Shannon Washburn -** Architect
- Electrical Engineering Team
  - **Gabrielle Halopka -** Recorder
  - **Falon Ortega -** Hardware Design Manager
- Mentors - **Austin Sanders & Jun Rao**
- Client: **Dr. Michael Leverington**, Faculty member and Lecturer in NAU's School of Informatics, Computing, and Cyber Systems

Problem Statement

- Overarching goal:
  - a robot that is able to give tours
- Building a robotics project foundation for future students
- Currently lack a robot that can give tours

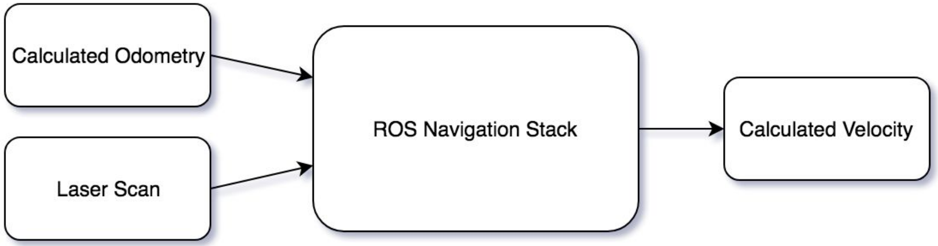
Solution Overview – Hardware

- Hardware
  - Building a physical robot
  - Robot should be able to move



Solution Overview – Software

- Software
  - A robot that can navigate the engineering building



Solution Overview – cont.

- Documentation of the process
    - Paper trail for other students to follow
- Integratable parts
    - Other projects can be derived from ours
- Cost effective parts

Key Requirements

Requirements Acquisition:

1. Meetings with our client.
   a. Understand client vision/expectations
2. Technical research
   a. What is feasible for a two semester project?

Top Level Requirements:

1. Will be capable of basic navigation
2. Will be expandable to future projects
3. Will operate safely
4. Will be usable for a technical end user

Key Requirements cont.

Functional Requirements:

1. Robot will be able to calculate and navigate a path between two points on a single floor
2. Robot will be able to create a 2D map of its environment
3. Robot will be able to reroute around moving and non-moving obstacles
4. Robot will be able to reroute to avoid drop-offs
5. Robot will be manually controllable

Key Requirements cont.

Non-functional Requirements:

1. Robot will be able to move at least 100 lbs
2. Robot’s maximum velocity will be at least 1.5 m/s
3. Robot will be able to run continuously for at least 2 hours
4. Robot will not pose a risk to its environment or itself
5. Robot will be expandable to future projects
6. Robot will be usable to a technical end user

Key Requirements cont.

Environmental constraints:

1. Parts must be cost effective (~$500 total)
2. Client envisions large, robust robot
3. Must use 30-gallon barrel to house components.
4. Only needs to navigate within one building

Key Requirements cont.

Requirement breakdown:

1. Robot will be able to calculate and navigate a path between two points on a single floor
    a. Robot will be able accurately calculate odometry data
        i. Robot will be able to acquire and use wheel encoder data
        ii. Robot will be able to acquire and use inertial measurement unit data
    b. Robot will be able to localize itself within a 2D map
        i. User will be able to send robot approximate location and heading
        ii. Robot will be able to match laser scan data with map data
    c. Robot will be able to send velocity data to control two motors independently

Risks

Likelihood:
1 - Unlikely → 5 - Likely

Risk:	Overheating	Combustion	Loosening/ Detaching Components	Battery Leakage
Likelihood	3	1	1	1
Concern Level	Mid	High	Low	Low
Mitigation Strategy	1) Install heat-resistant shelving in interior 2) Cut holes to facilitate airflow for cooling 3) Heat sinks	1) Use rechargeable batteries 2) Heat Sinks & Good Ventilation	1) Order custom mount for motors 2) Perform exhaustive stress tests on assembled product	1) Proper heat dissipation 2) Purchase Lithium-ion 3) Keep records of last charge, replacements

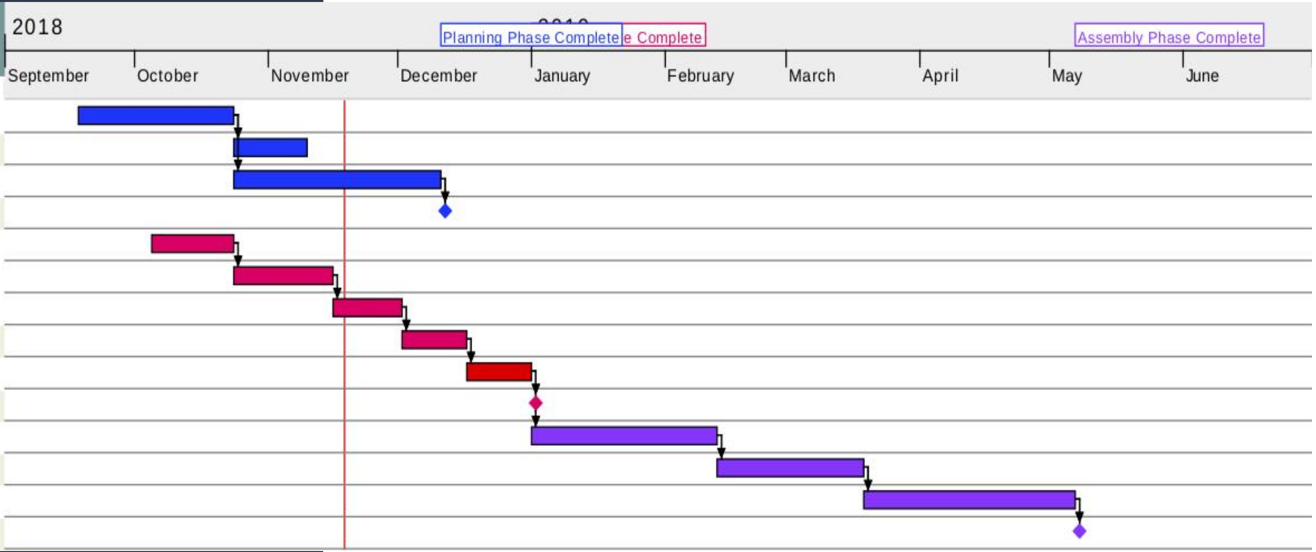
Risks cont.

Likelihood:
1 - Unlikely → 5 - Likely

Risk:	Localization Errors during Navigation	Speed Calculation error	Loss of control (manual or automatic)	Collision with Passerby or Obstacles	Falls/ Failure to Avoid Drop-offs
Likelihood	3	2	2	4	2
Concern Level	Low	Low	High	Mid	High
Mitigation Strategy	1) User ability to correct robot location in map 2) Ability to halt self & emit light or sound warning	1) Controlled - environment testing of robot movement at variable speeds before deployment in public space	1) Physical emergency stop button (cuts power supply) - Large and easily reachable	1) Sensors placed to minimize blind spots 2) Proximity warning lights & sounds 3) Physically stable system	1) Test to ensure sensors notice drop-offs in manageable amount of time 2) Program stop points / warnings into map data

Project Schedule

Name	Begin date	End date
Team Startup	9/18/18	10/23/18
Tech Feasibility Document	10/24/18	11/9/18
Requirements Document	10/24/18	12/10/18
Planning Phase Complete	12/11/18	12/11/18
Parts Order P1	10/5/18	10/23/18
Hardware/Software Testing P1	10/24/18	11/15/18
Parts Order P2	11/16/18	12/1/18
Hardware/Software Testing P2	12/2/18	12/16/18
Assembly Design	12/17/18	12/31/18
Testing Phase Complete	1/1/19	1/1/19
Assembly	1/1/19	2/12/19
Hardware & Software Integration	2/13/19	3/18/19
Stretch Goal Navigation	3/19/19	5/6/19
Assembly Phase Complete	5/7/19	5/7/19



Legend:
Blue - Planning Phase
Red - Testing Phase
Purple - Assembly Phase

Conclusion

- Why:
  - Tours take up faculty time
  - Process can be automated to save time and impress visitors
- Who:
  - Client is a CS Professor with Physics and Engineering Background
- What:
  - Goal is to design robot that can navigate the Engineering building with ease
  - Design has to be safe, autonomous, expandable, and usable
- How:
  - Discuss system requirements with client
  - 30 Gallon Robot:
    - Microcontrollers for processing
    - Motors and Wheels For Movement
  - Design must mitigate multiple risks (Environment, System, etc.)
  - Next: Technical Prototype Demo