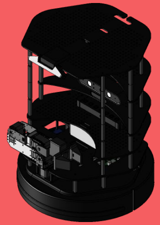
SAR

Team E2 - Keshav Sangam, Jai Madisetty, Raymond Xiao

Motivation

A building is on fire, and the firefighters need to find where humans are. How is it possible to find humans without going in yourself?



Use Case

Enter SAR: Search and () Robot. An autonomous way of traversing a building and finding rooms where humans are likely to be.

Use Case Requirements

Completely autonomous robot navigating an unexplored environment

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Environment modifications don’t affect robot performance

Able to find human analogues reliably and accurately

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< 5% miss rate on beacon localization

Robot moves quickly and efficiently throughout the environment

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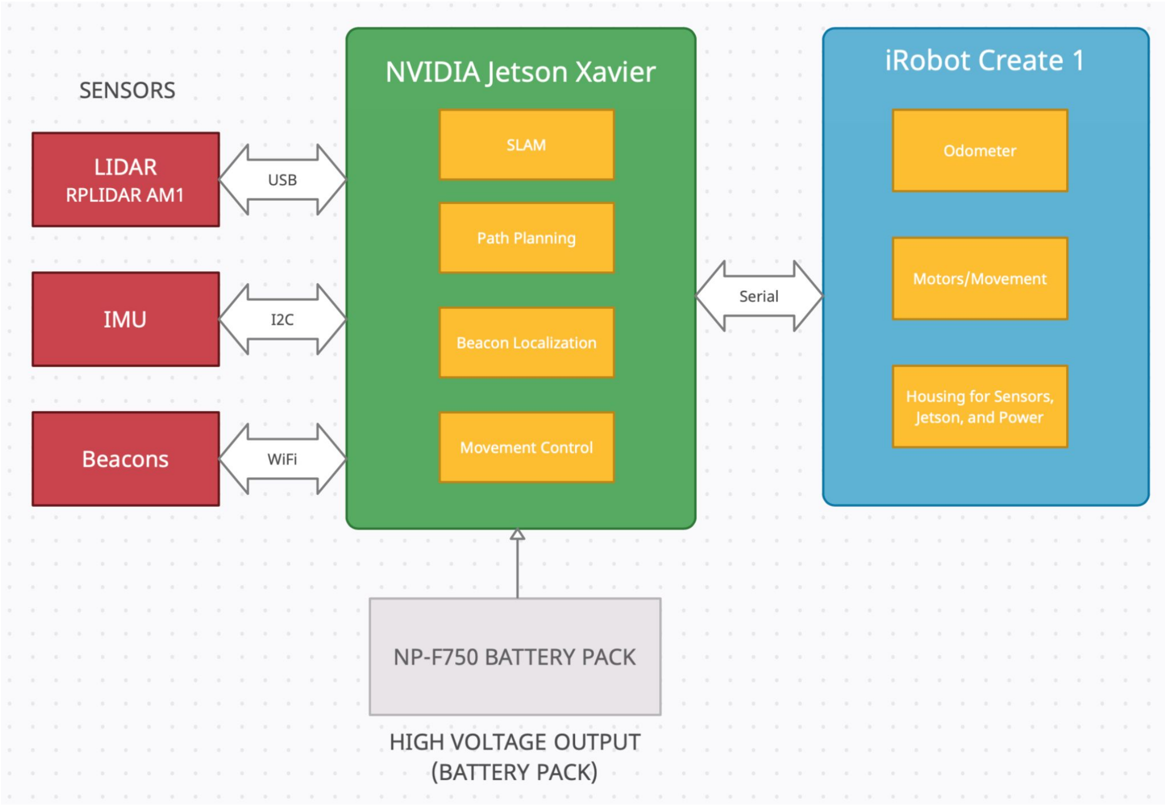
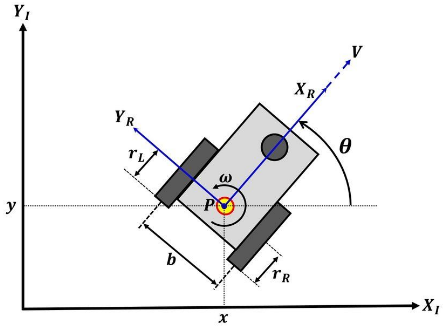
7 minutes to fully navigate demo environment

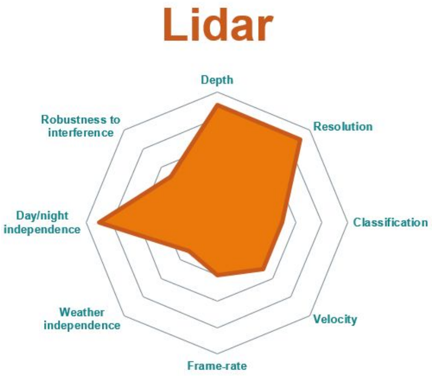
Solution Block Diagram

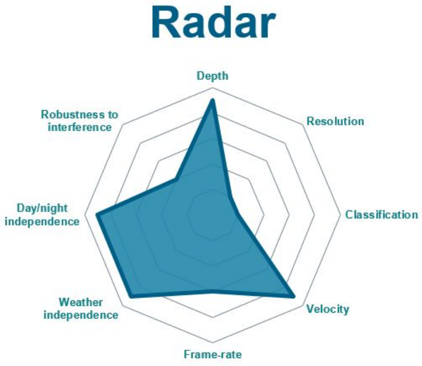


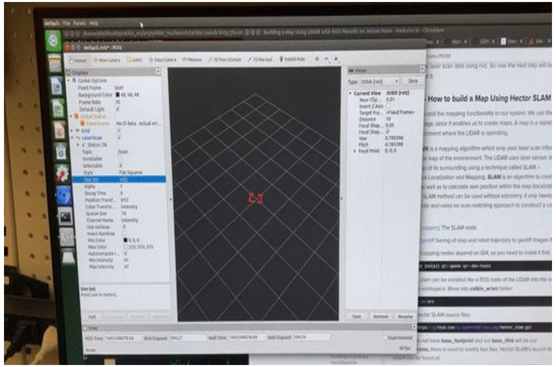
Solution Approach - Sensors

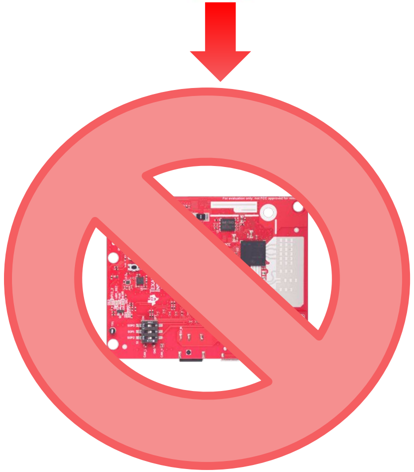
1. LIDAR sensor
   - Slamtec RPLIDAR
2. Potential Extra sensors
   - IMU
3. UWB Beacons
4. Odometer
   - iRobot Create





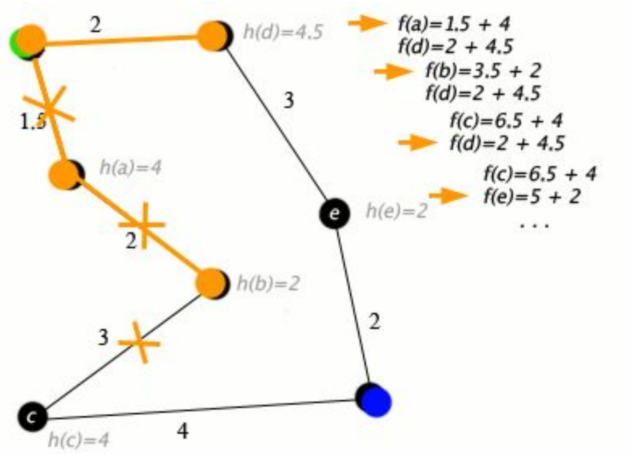






Solution Approach - Software

- Software Platform
  - ROS for SLAM, path planning, and controls
- Path Planning
  - A* algorithm vs. Djikstra
  - Use the UWB nodes as human analogues
- SLAM
  - Hector (no odometry)
  - GMapping (with odometry)



comparison of different technologies for server-based indoor positioning

Technology	Accuracy	Range	Suitable for	Tracking	Transmitter power supply	Battery lifetime
Wi-Fi	< 15 m	< 150 m	area detection		or	medium
BLE	< 8 m	< 75 m	area detection			high
UWB	< 30 cm	< 150 m	area detection		or	low to medium

Implementation Plan

Components	Develop/Purchase/Download
SLAM	Develop: Hector vs. Gmapping vs. Other
Path Planning	Develop: Testing A* vs. Djikstra for multiple node endpoint traversal
Robot Frame	Purchase: iRobot Create 1
LiDAR	Purchase: Slamtec RPLidar A1
Bluetooth Beacon	Purchase: DWM1001-DEV
Battery Packs	Purchase: NP-F750 Battery Pack
Localization	Develop: Integrating bluetooth data with path planning for node traversal

Testing and Verification of Subsystems

Requirements	Testing	Metrics
Autonomously map environment	View SLAM data in a set of environments	Subjective comparison between true environment and mapped
Autonomously navigate through environment	Let the robot explore a set of environments	<2% chance of robot getting stuck
Lightweight and portable	Weigh robot on scale	Weight is less than 15 pounds
Minimize false endpoint detection	Place varying number of beacons in environment	5% error in localizing the true amount of beacons
Battery life	Exhaust robot resources	Able to visit every room on battery power
Ensure odometry	Move the robot through a path that ends in a specified location	<1m offset between true endpoint and localized endpoint

Validation of Use-Case Requirements

Environment modifications don’t affect robot performance

Change environment between runs

< 5% miss rate on beacon localization

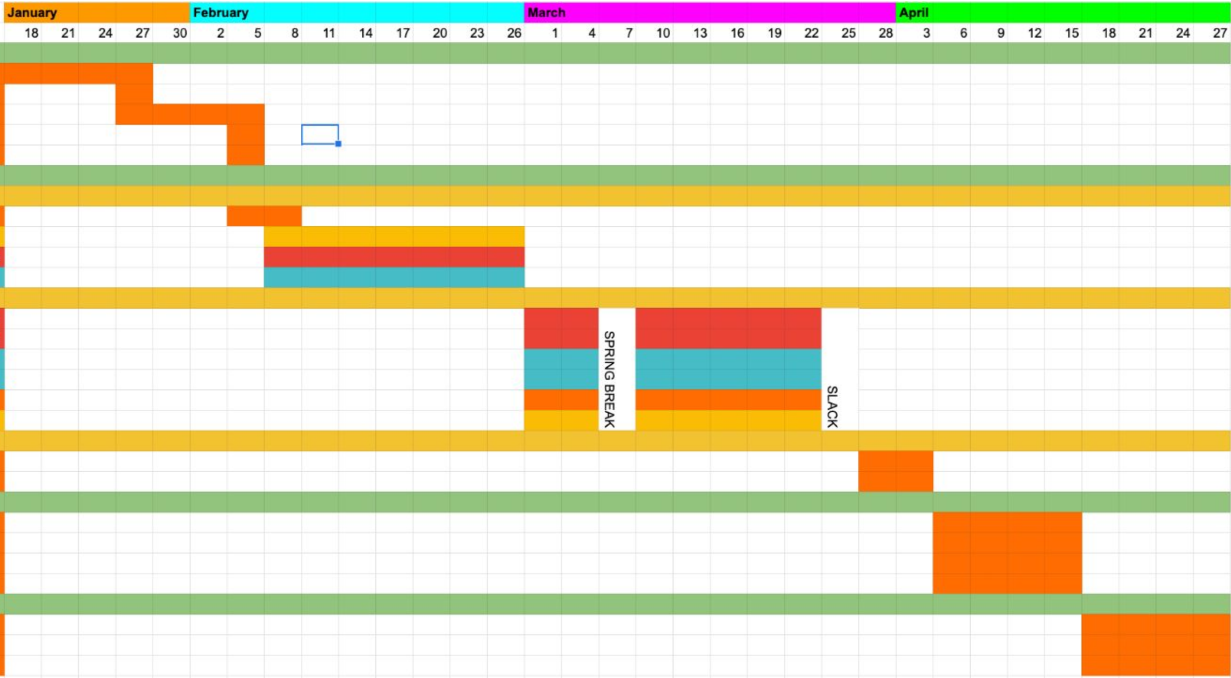
Average localization error over a set of 5 runs

7 minutes to fully navigate demo environment

Time how long it takes for robot to navigate environment

Project Management

	Tasks	Start	End	Team Member
Part 1	**Proposal and Planning**			
	Brainstorm different projects	1/18	1/25	**Everyone**
	Project abstract	1/26	1/26	**Everyone**
	Proposal presentation	2/7	2/9	**Everyone**
	Finalize parts required	2/5		**Everyone**
	Brainstorm algorithms/implementation	2/5		**Everyone**
Part 2	**Implementation and Design**			
	Milestone 1: Proof of concept			
	Order necessary components			**Everyone**
	Planning and movement algorithms			**Jai Madisetty**
	Interfacing with all sensors			**Keshav Sangam**
	Learn to program ROS			**Raymond Xiao**
	Milestone 2: Integration			
	Implement basic SLAM			**Keshav Sangam**
	Receive data from LIDAR			**Keshav Sangam**
	Integrate components with ROS			**Raymond Xiao**
	Interface with Jetson Xavier			**Raymond Xiao**
	Set up testing environment			**Everyone**
	Improve SW algorithms			**Jai Madisetty**
	Milestone 3: Final Design			
	Finalize path planning			**Everyone**
	Systems integration check			**Everyone**
Part 3	**Verification and Optimization**			
	Rigorous testing in different scenarios			**Everyone**
	Tweak design paremeters (accuracy, speed, etc.)			**Everyone**
	Test/improve robot's battery life			**Everyone**
	Test/improve robot's speed			**Everyone**
Part 4	**Finalize and Present**			
	Record video explaining project			**Everyone**
	Edit and finish video			**Everyone**
	Final presentation			**Everyone**



Conclusion

One of the primary applications of robotics is the ability to replace human intervention in dangerous conditions; a firefighting/SAR robot is the epitome of this idea.

Our project is a first step in creating a fully featured robot that can help firefighters and save lives.