Midway Design Review

IntelliSAR December 13, 2019



Department of Electrical and Computer Engineering

Advisor: Professor Tessier

IntelliSAR



Department of Electrical and Computer Engineering

Advisor: Professor Tessier

Background and Motivation

- Safety and information of the environment are very important aspects of rescue missions
- Not fully understanding the environment and situation can lead to unnecessary risks and dangers

Examples:



Cave rescue Explorers trapped or lost



Urban search and rescue Victims trapped in collapsed buildings

Goal

- Provide ability to remotely examine the situation and environment
- Reduce possible risks or dangers
- Improve efficiency of rescue teams in unknown environments

Our Product



Requirements Analysis

- Be able to be remotely controlled via Wi-Fi
- Be able to work in dim lighting conditions with night vision
- Be able to provide real time GPS location
 - Gathered sensor data can be viewed remotely
 - Can traverse uneven/sloped ground
- Be able to detect obstacles and navigate accordingly
 - Be able to detect and classify objects

Requirements Analysis: Specifications

Specification	Value	Specification Temperature Measurement Range		
Weight	6 lb			
Dimensions	300*220*150 mm	Speed Range		
Battery	Board 12Ah, Motors 2.2Ah	Obstacle Detection Range		
Battery Life	Board 6.5 hours, Motors 1 hour	1		
Control Distance	150 feet indoor, 300 feet outdoor	Video Stream w/ Object Detection Frame Rate		
Camera	Night Vision 5MP	Object Detection Range		

Specification	Value
emperature Measurement ange	$0 \sim 50 \ ^{\circ}\text{C} \pm 2 \ ^{\circ}\text{C}$
beed Range	0.7 ~ 6.5 km/h
bstacle Detection Range	0 ~ 150 cm
deo Stream w/ Object etection Frame Rate	H.264 640x480 @ 4FPS
bject Detection Range	6 meters (best case scenario)

Block Diagram



Battery Life Analysis

- Current peripherals consumes 800 mA in total
- Raspberry Pi 4 requires 5V, 3A* to operate stably
- Very few battery banks in market provide 5V, 3A output

Main Board Power Consumption								
Components	Q′ty	Current Voltag		Power				
		(A)	(V)	(W)				
Raspberry Pi	1	1.1	5	5.5				
Camera	1	0.16	5	0.8				
Temp Sensors	1	0.015	5	0.1				
UltraSonic	3	0.015	5	0.2				
GPS	1	0.015	5	0.1				
Camera Motors	2	0.3	5	3				
Sum	9	1.9	5	9.7				

Battery Life Analysis			Driving Board Power Consumption						
Components	Q′ty	Capacity (Ah)	Current (A)	Battery Life(h)	Components	Q'ty	Current (A)	Voltage (V)	Power (W)
RPi's Battery	1	12.6	1.9	6.5	Drive Board	1	0.1	12	1.2
					Wheel Motors	6	0.35	12	12.6
Motors'	1	2.2	2.2	1.0					
Battery					Sum	7	2.2	12	13.8

*https://www.raspberrypi.org/products/raspberry-pi-4-model-b/specifications/

Latency Analysis

- Mobile Hotspot on an Android Phone (frequency 2.4 GHz)
- Outdoor, open terrain with interference signals (Stadium)
- Packet Delay = (t4-t1)/2
- Controllable distance < 100 meters

Controllable Distance



MDR Deliverables

- Functional robot able to be remote controlled
- Azure setup for our system
- Train model to be able to detect/classify certain objects

Responsibilities

- Yong Li
 - Hardware selection, robot functionality, sensor connectivity, web application, data collection and analysis
- Arthur Zhu
 - Networking, data collection and analysis, demo videos
- Derek Sun
 - Object detection, web application

MDR Deliverables: Robot

- Flask web application running off Raspberry Pi
 - Robot controller
 - Camera rotation controller
 - Night vision video feed w/ object detection
 - Environmental sensor data
- Robot is able to maneuver up sloped ground of up to 30°
- Semi-autonomous navigation enabled



Semi-Autonomous Navigation Flowchart

MDR Deliverables: Object Detection

- Implemented with Python, Tensorflow + TFLite, and OpenCV Training
 - Transfer learning with SSD MobileNetV2 model as basis
 - Open Images Dataset v5 by Google
 - Labeled "Person" images : 6250 total \rightarrow 5000 train, 1250 test

Evaluation

- Tensorboard visualization tool
- Measure detection accuracy and detect overfitting/underfitting



Demo

Proposed CDR Deliverables

- Enable GPS tracking
- Improve accuracy and speed of object detection
- Improve semi-autonomous navigation

Responsibilities

- Yong Li
 - GPS research, design, and development
- Arthur Zhu
 - GPS selection and testing, robustness enhancement, object detection
- Derek Sun
 - Object detection, semi-autonomous navigation

Schedule



Questions?