Lifeguard Autonomous-Robot

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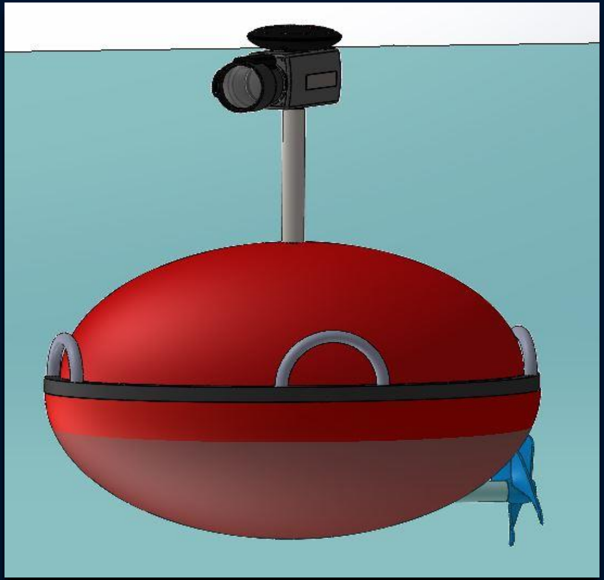
2 late days used

Motivation:

1. Drowning is the 3rd leading cause of unintentional injury death worldwide
2. An estimated 320,000 annual drowning deaths worldwide

Concept:

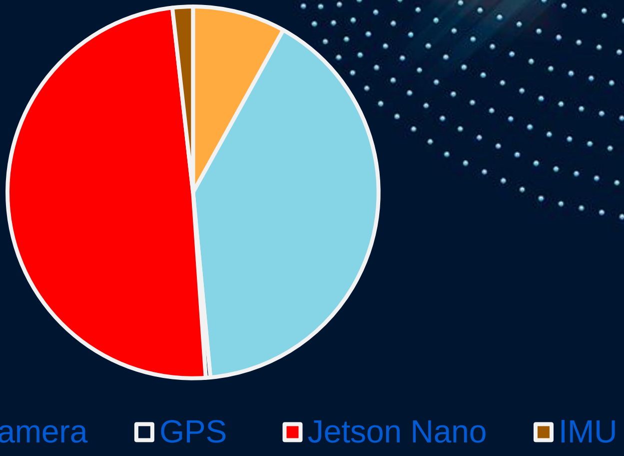
1. Autonomous Robot to rescue people from drowning
2. Rotating(for 360° view) thermal imaging camera to detect people
3. Deep Learning model to distinguish between people swimming and drowning
4. Navigates to the area of interest using model predictive control
5. Pulls the survivor back to the shore so that they can be treated



Power Analysis

Battery Specifications (lithium-polymer battery)

- Power - 1 kW / 3 hp
- Battery Capacity- 1276 Wh
- Battery Weight - 8.7 kg
- Rated voltage- 45.6 V
- Rated current- 25 A
- Max discharging current- 40 A



Performance

1. Stationary(only camera is rotating):

Power Consumed	Runtime
12.414 W	103 Hours

2. Moving:

Power Consumed	Runtime	Speed
71.62 W	16.5 Hours	4.3 Km/hr
506.62 W	2.5 Hours	8.5 Km/hr
1000 W	1 Hours	10.1 Km/hr

Energy Consumption

Device	Energy Consumed
Servo	1.044 Wh
Camera	5 Wh
GPS	50 mWh
NVIDIA Jetson Nano	6.1 Wh
Brushless DC motor	35-1000 Wh
IMU	0.22 Wh

Sensors

Thermal Camera

- Thermal cameras can see in absolute darkness and in challenging conditions where visible cameras and LIDAR can struggle
- Thermal camera scans areas with 37°C temperature and track the movement of areas of interest
- Fixes its target If the movement is similar to that of a person drowning

IMU

- Helps robot to dynamically control its linear velocity, angular velocity and acceleration
- Can be used to fill in gaps between GNSS updates and to safely navigate for short periods when GNSS and/or other sensors are compromised.

GPS

- Great to track robots position as there are no obstructions around
- Helps the robot to get back to the shore/treatment area accurately
- Useful while manually controlling the robot in case of a failure

Wireless sensor system

- In case of a failure, wireless sensor system can be used to manually control the robot

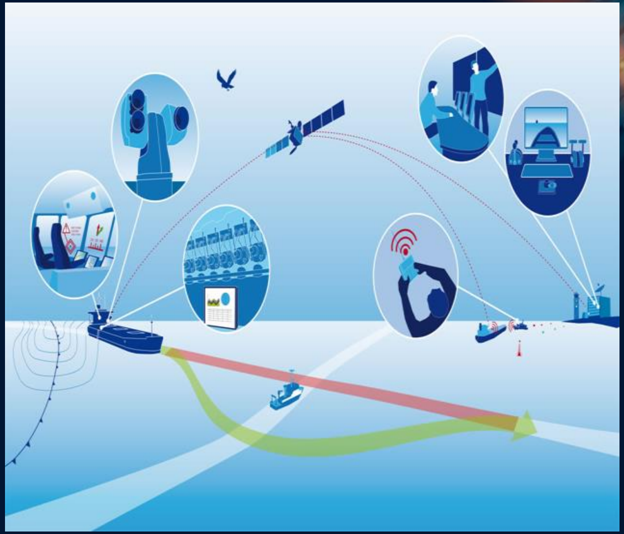
Navigation

Base Correction

- While the robot is stationary, there may be drift due to waves
- Robot uses IMU and GPS to correct its current position and also solves the “wake up problem” after its turned on

Goal generation node

- Starts navigating towards the area of interest using data from thermal imagery
- Uses Model Predictive Control to face dynamically changing environment and to avoid obstacles
- Keeps getting updates from camera regarding the distance of the goal
- Implements extended Kalman filter to fuse the GPS reading and Velocities with 9 axis IMU to improve the accuracy of its current position
- Robot starts its return journey to the shore or the treatment area, as it gets a feedback(Switch on the robot is pressed) by the survivor
- Uses, the location of shore/treatment area stored in the memory to calculate the shortest path from its current location
- In case of a failure, IMU data is used for dead reckoning
- Can also be navigated using remote control in case of a complete failure



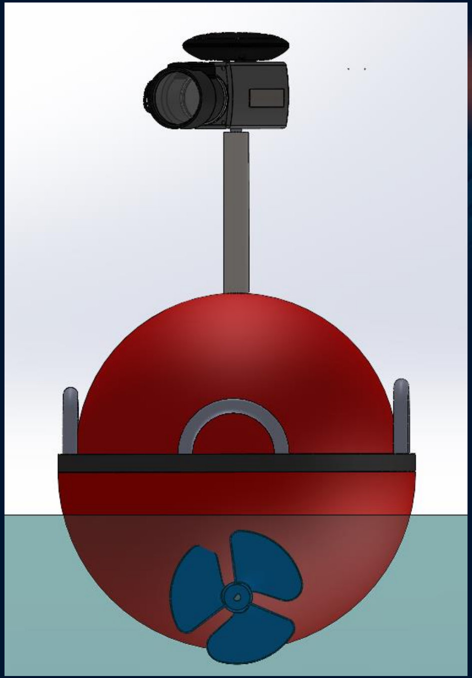
System Dynamics

Software

- Runs on ROS and uses in-built packages like EKF, mpc_local_planner, etc.
- Employs Convolutional Neural Networks to analyze thermal imagery
- Operating System - Linux4Tegra, based on Ubuntu 18.04

Hardware

- Primary computer-NVIDIA Jetson Nano 4GB; powerful computer to run multiple neural networks in parallel
- Propeller- 11" × 5.8" 2-blade composite propeller
- Trim / Tilt Angle- 0°, 7°, 14°, 21° / 70°
- Total weight of the system- 22Kg
- Dimensions- 1.2X0.7X0.7 m
- Safe weight limit – 133Kg



Safety features

- Kill Switch to stop the motor in case of an emergency
- Positive Buoyancy of the battery makes it impossible to sink in the water
- Employs shaft seals to avoid leakages inside the robot