



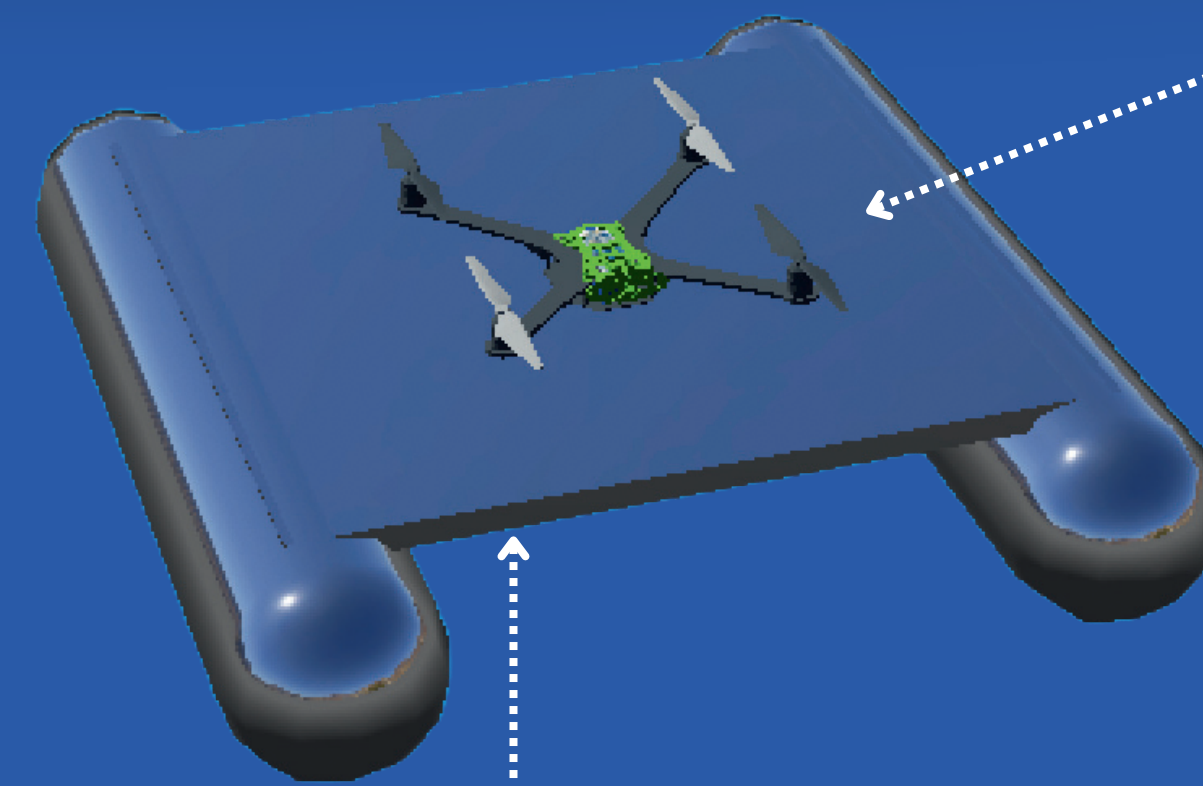
Students: Samuel Darmon,  
Romain Defferrard

Company: EPFL IIE DISAL, Lucas Wälti  
EPFL supervisor : Alcherio Martinioli

### Context

- Robotic platforms offer benefits for automating environmental monitoring, mapping etc.
- These benefit from high-fidelity robotic simulators like Webots (realistic modelling of environmental phenomena, helps researchers design and test systems)
- Current a gap in documentation for simulation of marine environments and robots.
- Project consisted in:
  - a. Researching current lack of documentation
  - b. Proposing relevant environmental scenarios and robotic solutions
  - c. Evaluating current limits of simulation

### Boat & Drone

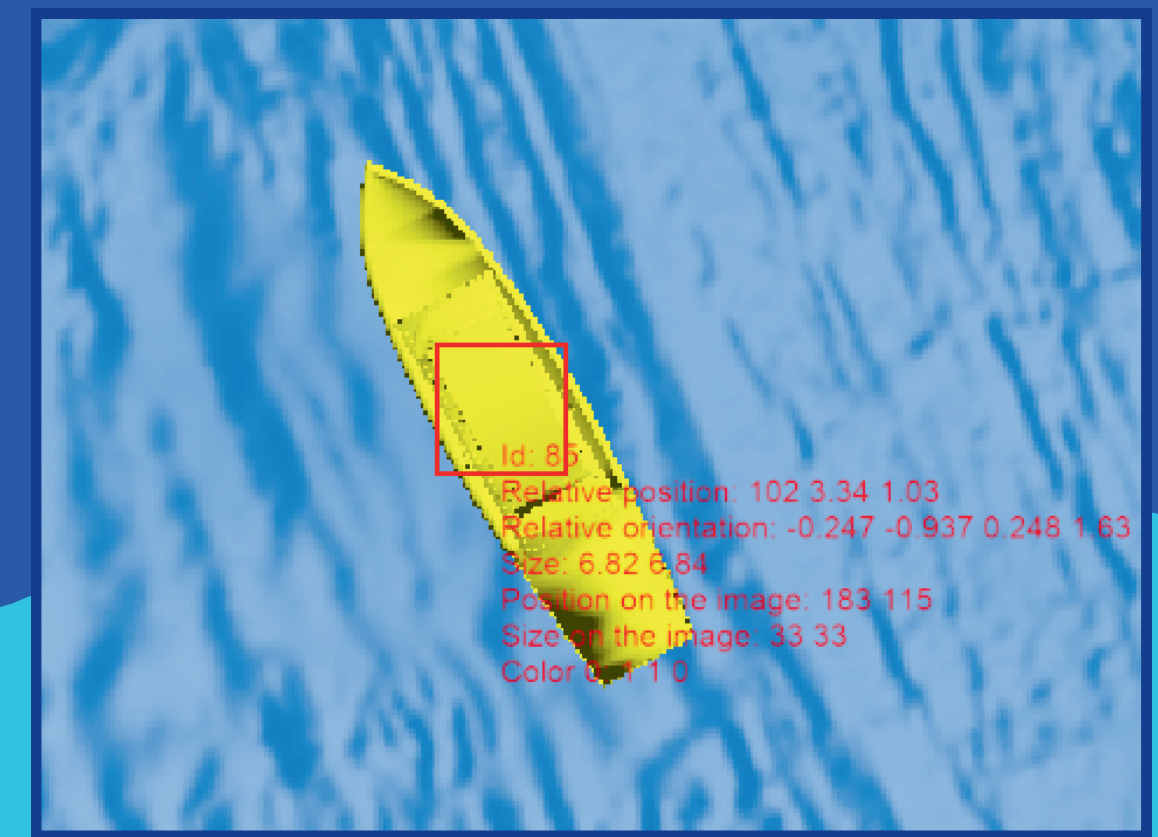


#### Boat (Mothership)

- Dual-hulled for stability and manoeuvrability
- 1 propeller per hull for precise speed control and handling without traditional rudders.
- Landing and charging platform
- GPS and IMU for navigation
- Receiver/emitter for communication.

#### Drone (VOXL m500)

- Follows waypoints, monitors and captures images
- Receiver/emitter for communication, synchronisation and data exchange.
- Battery life simulation, influencing mission planning and realism of field simulation



## 1: Illegal vessel detection

#### Environmental Relevance

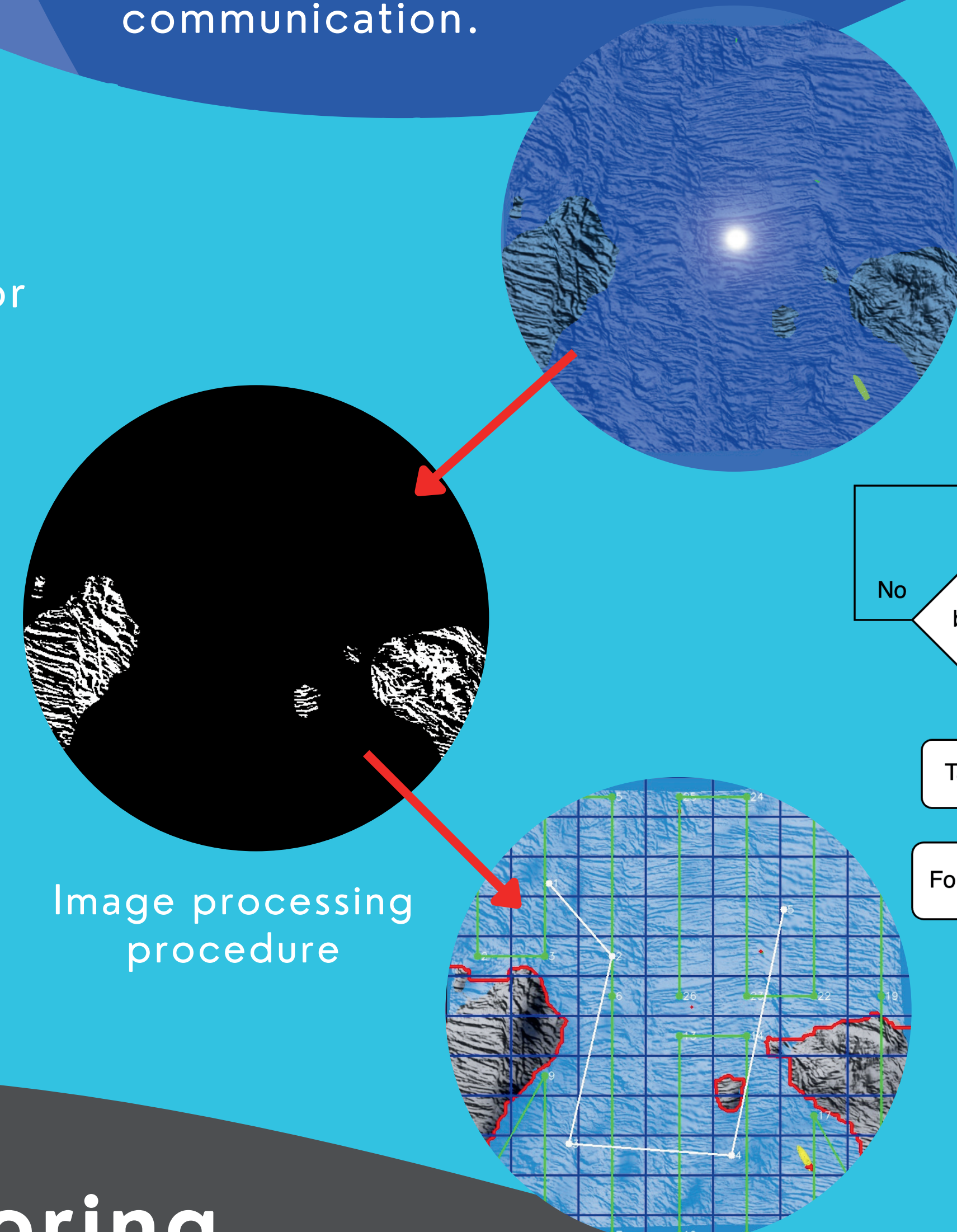
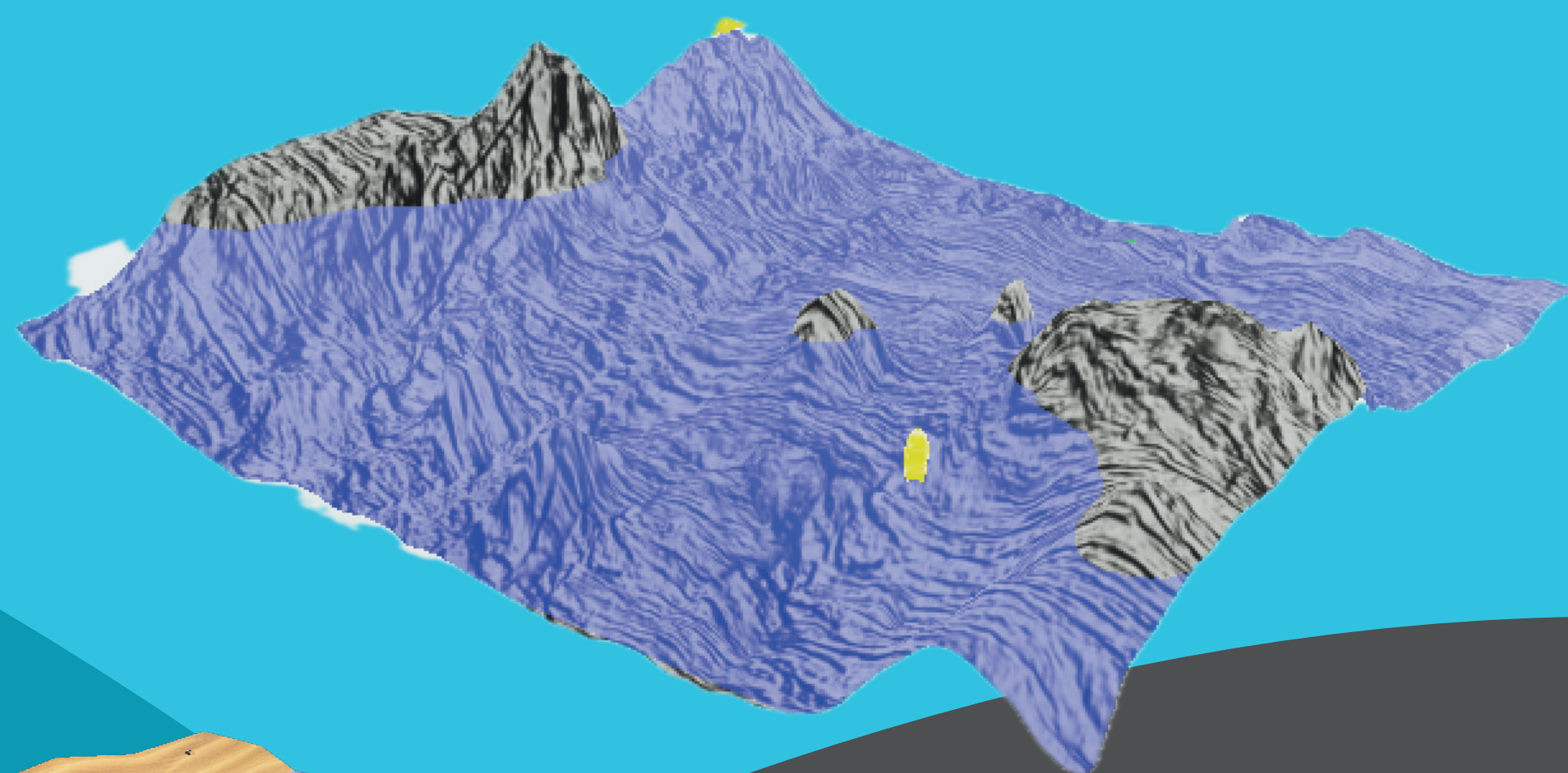
- Automated drone-mothership system prevents illegal fishing and safeguards marine ecosystems.
- Gathers valuable data for better management and conservation strategies.

#### Simulated World

- Topographic underwater terrain covered with water
- Four boats (fishing / leisure) all with different paths controlled by supervisor

#### Operational workflow

- Base-station computes drone & mothership waypoints (OpenCV)
- Drone overflies map avoiding obstacles, landing on mothership when necessary to charge
- Boat detection, compares detected locations with known Automatic Identification System (AIS) data. Coastguard alerted if mismatch.



## 3: Litter Detection

#### Environmental Relevance

- Drones can cover large and difficult to access areas
- More frequent monitoring than satellite imagery
- Possible GIS (Geographic Information System) integration to analyse the sources and impacts of litter
- Reduced need for manual inspection and ground patrols, offering a cost-effective monitoring and rapid response capabilities after environmental events such as storms

#### Simulated world

- Simplified coastal area with dynamic motion of waves and litter

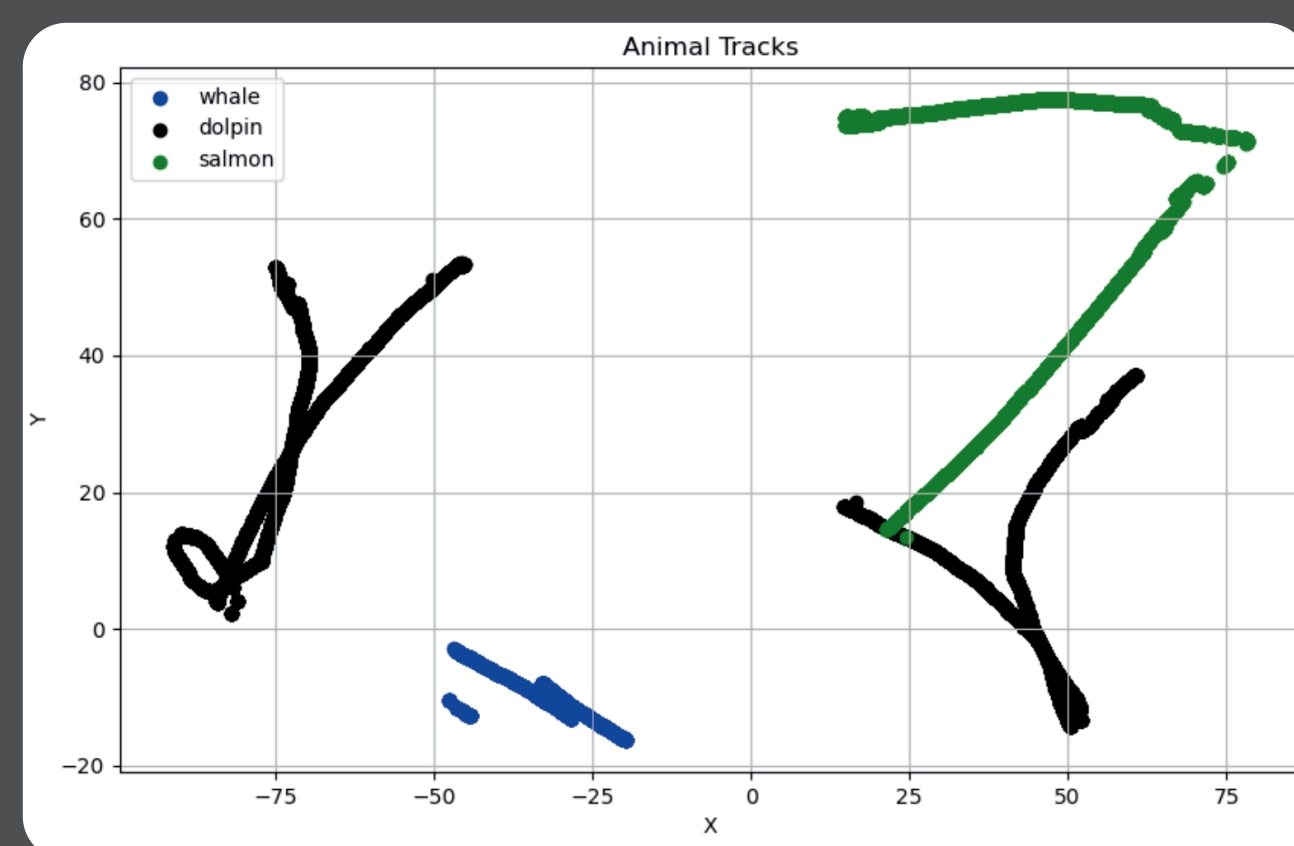
#### Operational workflow

- Drone takes off from the beach, follows the coastline and takes pictures at fixed intervals securing an overlap between images
- Litter detection from the blue band of images to isolate and identify litter from contouring technique
- Get their position on the image and triangulate into world coordinate, updating in real time the littered area.

## 2: Wildlife Monitoring

#### Environmental Relevance

- Enhance understanding of wildlife behavior & population dynamics
- Develop conservation strategies & infer habitat health

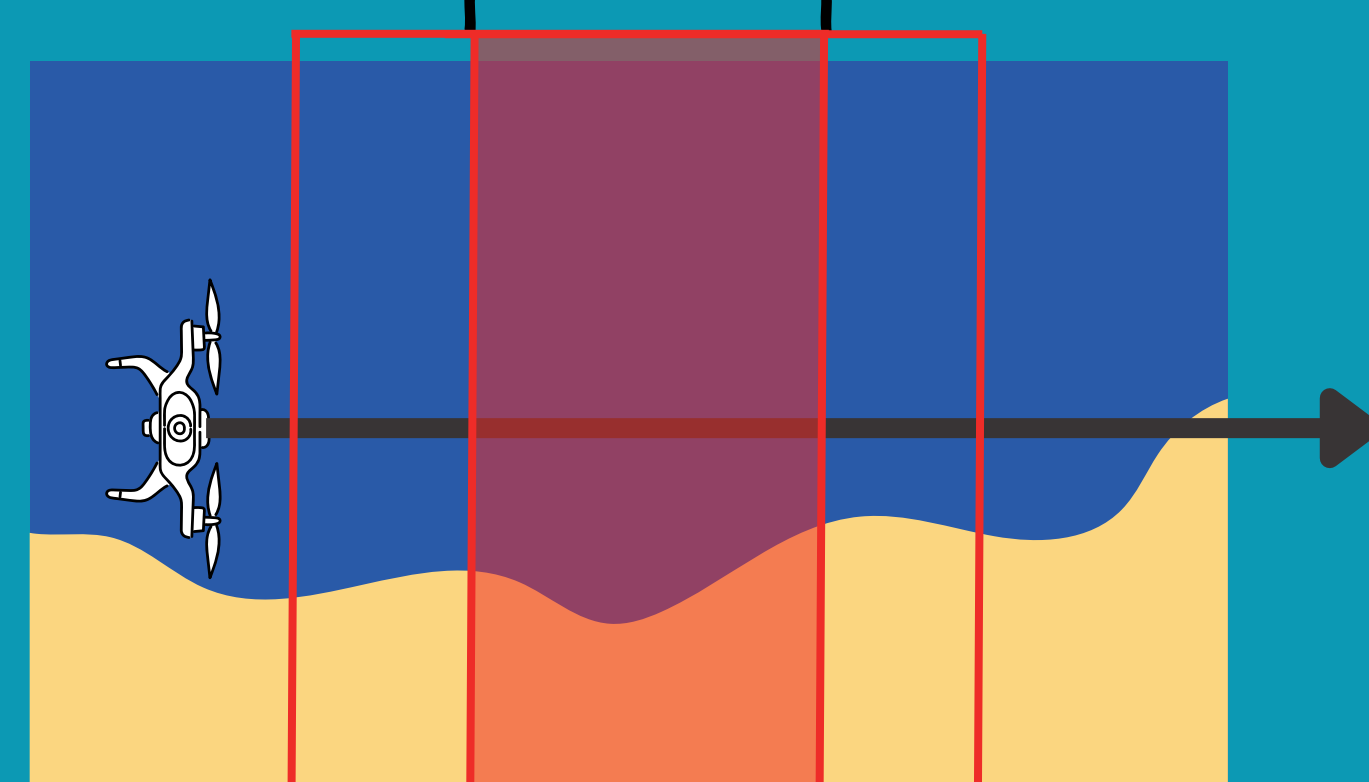


Tracks of detected animals computed by base station



#### 80% Overlap

Overlap exemple between two consecutive images



#### Simulated world

- Four marine animals species: whales, dolphins, salmon and hammerhead sharks following 3-axis random paths
- Flocking algorithm based on cohesion, separation, alignment, global direction, speed limitation and obstacle avoidance

#### Operational workflow

- Drone flies over the area following the path computed by the base station
- Species detection & recognition to initiate tracking
- Tracks file transmitted to a base station which produces a real time plot of animal positions
- If the drone loses track of the animals, it returns to the next waypoint until it has scanned the entire grid

#### Problems encountered & further development possibilities

- Webots color recognition does not support vision through fluid elements use of supervisor knowing true positions and species to simulate computer vision algorithm
- Species recognition is simulated but not individual recognition could be implemented

## Outlook

- Drone simulation is helpful for prototyping systems and testing code in challenging environments
- Steps should be taken to improve realism & add real-world constraints
- Excellent educational opportunity for students