Autnomous Detection and Repair of Fishnet Holes Using Vision-based Grasping Algorithm

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MARINE & MARITIME INTELLIGENT ROBOTICS

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Motivation

- Food production is a global challenge; oceans provide a sustainable alternative solution such as fish farms (aquaculture) that mitigate the impact on the biological cycle.
- Fish farms deploy huge nets in challenging conditions.
- There is a need for regular inspection and repair to avoid fish escape, predator infiltration, or unwanted impact on wild fish.
- Net maintenance with human intervention is challenging given the circumstances of the harsh and confined environment.
- It makes sense to look for more autonomous methods.
- There can be a possibility to introduce vision-based ROVs or AUVs that can detect and consequently intervene to fix the holes in nets.

Background

- Research at IRS, UJI presents a promising hole detection and robot alignment algorithm. [1]
- A cooperative strategy involving a surface vehicle, AUV, and a GCS is proposed.
- Deep Learning methods used for hole detection and depth (distance b/w robot-net) estimation.
- Linear control (visual servoing) used for hole-robot alignment as the final step before intervention.
- There is an opportunity to refine the control alogorithm.
- DVL or Sonar could be introduced for non-linear control.
- The intervention needs a dedicated end-effector.
- A grasping algorithm needs to be designed that covers detection, pose estimation, plans and controls the BlueROV to patch the hole.

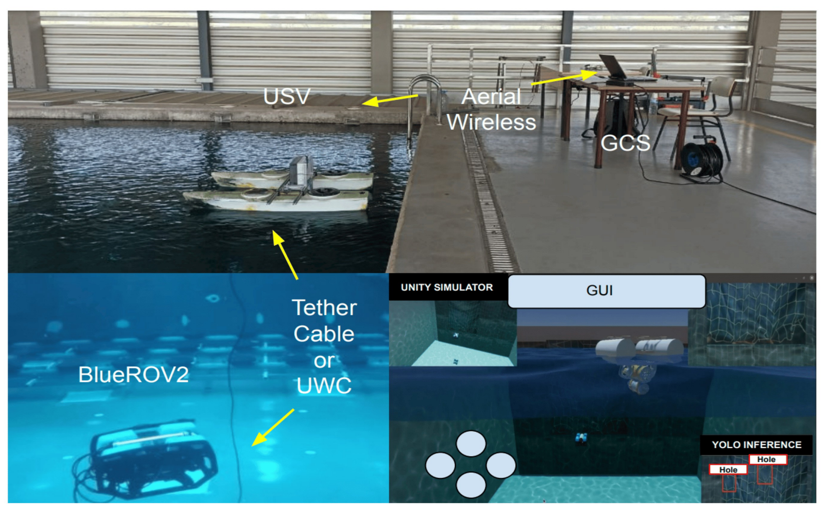

Figure 1. Complete Cooperative System as proposed in [1]

State-of-the-art

- Stonefish: Advanced marine robotics simulation library with realistic physics and rendering capabilities. [2]
- In our context a scene with moving net can be developed on this simulator.
- UJI's TWINBOT project [3] is a great foundation for understanding underwater intervention algorithms.
- They propose utilizing a group of cooperating I-AUVs with decentralized Task-Priority kinematic control to transport a long pipe underwater, optimizing manipulator stress and communication bandwidth.

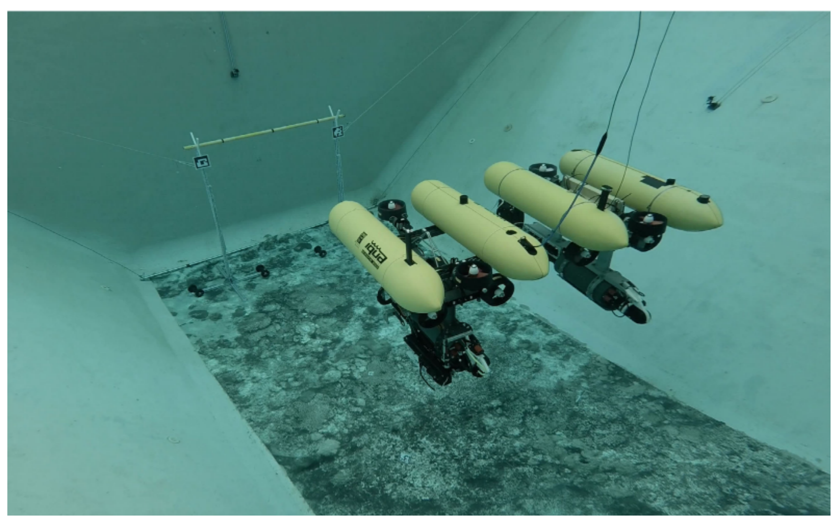

Figure 2. Water Tank Setup in TWINBOT.

- In [4], authors propose a two step grasping algorithm comprising of object reconstruction which then aids the grasping algorithm itself in the second step.
- A laser-line projector along with a camera is mounted on a 4-DOF robotic arm to carry out multi-view target reconstruction.
- A grasping algorithm detects relevant points from the generated point cloud to determine the arm configuration

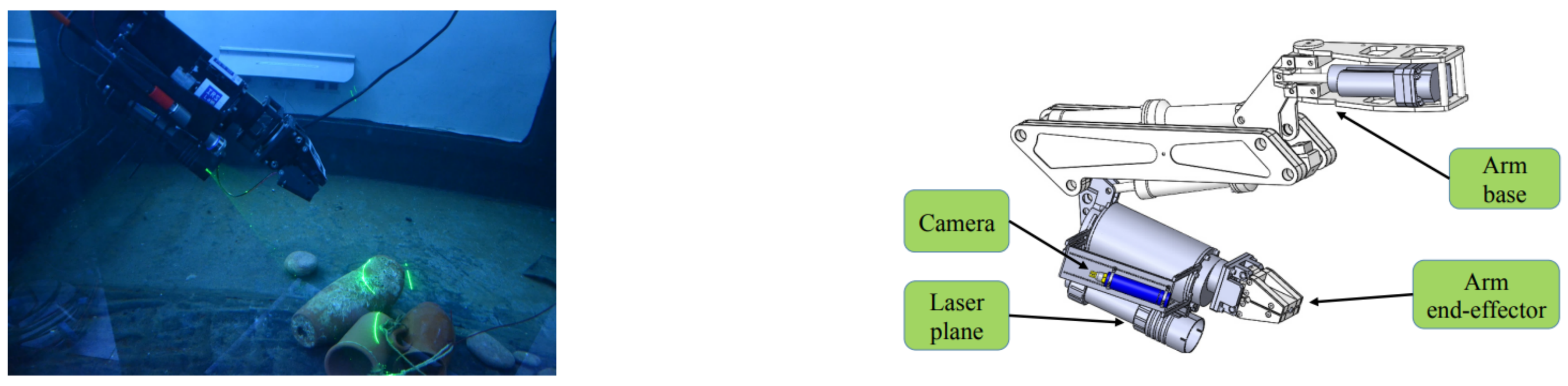

Figure 3. Multi view laser approach for reconstruction. (left) Robotic Arm and End-Effector Configuration. (right)

- [5] and [6] present promising options to be used as an end-effecter in a proposed autonomous hole repair algorithm.

Figure 4. Potential End-Effector Candidates. Deep Trekker [5] (left) Knotdee [6] (right)

Expected Thesis Contributions

- Establish a fully functional StoneFish simulation with a moving net cage for testing underwater intervention scenarios.
- Implement and validate the hole detection algorithm, improving inspection accuracy and efficiency.
- Design a specialized tool based on chosen alternatives for the Reach Bravo arm to patch net holes effectively.
- Conduct thorough testing of the patching tool within the StoneFish simulator to ensure reliability and performance.
- Develop and successfully implement a visual servoing algorithm to control the Reach Bravo arm during patching tasks.
- Achieve successful autonomous operation of inspection and patching algorithms, proving independent system effectiveness.

The completion of this thesis will significantly enhance underwater net inspection and repair technologies, improving efficiency and reliability in marine aquaculture maintenance.

References

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