ARTIFICIAL INTELLIGENCE FRAMEWORK TO ACCURATELY PERFORM UNDERWATER HUMAN ROBOT INTERACTION THROUGH HAND GESTURES

Improving the performance of underwater HRI methods through the implementation of new AI architectures and methods to facilitate the exploration of semi-autonomous underwater applications.

CONTEXT AND MOTIVATION:

- Vehicle-diver communication is complicated due to the attenuation of RF signals underwater.
- Optical alternatives for HRI become an interesting option due to the environmental limitations.
- Semi-autonomous tasks need quick and reliable human-robot interaction capabilities.
- Some AUV applications require on-the-field instructions for success.
- Underwater visual HRI is not on par with the state-of-the-art methods used out of the water.

STATE OF THE ART:

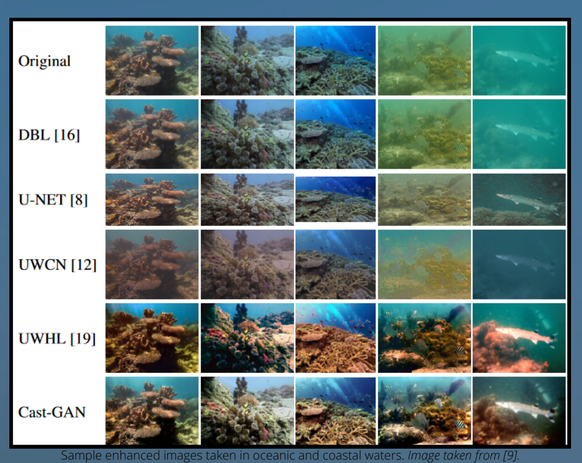
Multiple novel methods have been proposed to perform hand gesture recognition out of the water on recent years:

- HRI Framework with Robust Background Invariant Hand Detection [1].
- Spatial Attention AI Framework for Recognizing Static and Dynamic Gestures [2].

There have also been implementations of similar systems for underwater applications:

- the Implementation of a Gesture-Based Language for Underwater HRI [3].
- Identification of Diver Hand Signals through Diver Segmentation [4] [5].
- Dynamic Reconfiguration of Mission Parameters in Underwater Human-Robot Collaboration [6].

Recent improvements in underwater image color correction [7] [8][9] that could be coupled to increase the performance of the methods.



Sample enhanced images taken in oceanic and coastal waters. *Image taken from [9].*

PROPOSAL:

The result of this research will be an accurate, efficient and intuitive human-robot interaction framework for adaptive underwater missions that does not require the installation of specialized visual systems. The framework will be able to perform accurately solely on RGB monocular cameras.

The research of this topic is proposed to be done in 3 phases:

Phase I:

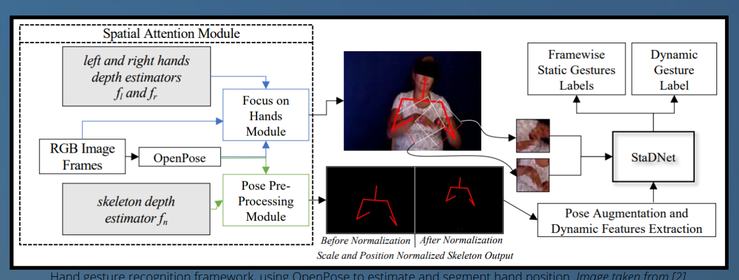
1. Construction of a performance baseline, based on the work seen in [4][5] and [6].
2. Implementation of the framework proposed in [1] and [2].
3. Implementation and evaluation of the improvements on the framework and AI.

Phase II:

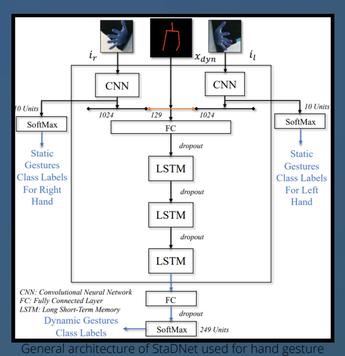
1. Build simulation environment for preliminar tests.
2. Run simulated experiments to evaluate the performance of proposed method.

Phase III:

1. Perform real-world experiments with an ROV/AUV in an unenclosed underwater environment.



Hand gesture recognition framework, using OpenPose to estimate and segment hand position. *Image taken from [2].*



General architecture of StaDNet used for hand gesture recognition. *Image taken from [2].*

References:

1. Mazhar O, Navarro B, Ramdani S, Passama R, Cherubini A. **A Real-time Human-Robot Interaction Framework with Robust Background Invariant Hand Gesture Detection**. Robotics and Computer-Integrated Manufacturing, Elsevier, 2019, 60, pp.34-48. 10.1016/j.rcim.2019.05.008.hal-01823338v2
2. Mazhar O, Ramdani S, Cherubini A. **A Deep Learning Framework for Recognizing both Static and Dynamic Gestures**. Sensors, MDPI, 2021, 21 (6), pp.#2227. 10.3390/s21062227.hal-03173140
3. Chiarella D, Bibuli M, Bruzzone G, Caccia M, Ranieri A, Zereik E, Marconi L, Cutugno P. **A Novel Gesture-Based Language for Underwater Human–Robot Interaction**. Journal of Marine Science and Engineering 6, no. 3: 91. 2018 https://doi.org/10.3390/jmse6030091
4. Codd-Downey R, Jenkin M. **Finding divers with SCUBANet**. 2019 International Conference on Robotics and Automation (ICRA), 2019, pp. 5746-5751, doi: 10.1109/ICRA.2019.8793655.
5. Codd-Downey R, Jenkin M. **Human Robot Interaction Using Diver Hand Signals**. 2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI), 2019, pp. 550-551, doi: 10.1109/HRI.2019.8673133.
6. Islam M, Ho M, Sattar J. **Dynamic Reconfiguration of Mission Parameters in Underwater Human-Robot Collaboration**. 2018 IEEE International Conference on Robotics and Automation (ICRA), 2018, pp. 6212-6219, doi: 10.1109/ICRA.2018.8461197.
7. Akkaynak D, Treibitz T. **Sea-Thru: A Method for Removing Water From Underwater Images**. 2019 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), 2019, pp. 1682-1691, doi: 10.1109/CVPR.2019.00178.
8. Yang M, Hu K, Du Y, Wei Z, Sheng Z, Hu J. **Underwater image enhancement based on conditional generative adversarial network**. Signal Processing: Image Communication, Volume 81, 2020, 115723, ISSN 0923-5965, https://doi.org/10.1016/j.image.2019.115723.
9. Li C, Cavallaro A. **Cast-Gan: Learning To Remove Colour Cast From Underwater Images**. 2020 IEEE International Conference on Image Processing (ICIP), 2020, pp. 1083-1087, doi: 10.1109/ICIP40778.2020.9191157.

2022 MIR SYMPOSIUM

Luis Alejandro Grajeda Blandón

MIR MARINE & MARITIME INTELLIGENT ROBOTICS

Co-funded by the Erasmus+ Programme of the European Union