Acoustic Landmarks for Navigation in Water: Integrating Sound into Underwater Spatial Orientation

Bachelor- or Masterthesis

Motivation

- Water is a challenging navigation environment due to limited visibility and dynamic conditions
- Sound propagates efficiently underwater and may serve as a reliable non-visual landmark
- Potential applications: diver safety, navigation aids, cognitive mapping studies



Colourbox

Possible Extensions

- Multi-sensory integration: visual + acoustic + haptic landmarks
- Cross-environment studies: caves, reefs, wrecks, open water
- Machine learning to classify salient acoustic landmarks automatically
- Adaptive navigation systems tailored to user experience or sensory abilities

Research Questions

- Which underwater sounds are salient or useful for navigation in water?
- How do acoustic cues complement or conflict with visual landmarks?
- Can an integrated taxonomy of acoustic and visual landmarks be developed?
- How effectively can divers use acoustic cues for wayfinding tasks in water?

Methodology

- Data Collection
  - Identify and record acoustic landmarks
    - Natural (fauna, currents, waterfalls)
    - Artificial (boat engines, sonar signals, diver equipment)
  - Conduct surveys or experiments with divers:
    - Ask participants to identify salient sounds
    - Optional: navigation task using only acoustic cues
  - Record environmental context:Visibility, depth, currents, season
- Modeling Approaches
  - Annotate sounds by type, location, and perceptual salience
  - Integrate acoustic features with existing underwater landmark taxonomy
- Evaluation
  - Experimental navigation tasks
  - Metrics: Accuracy, task completion time, errors
  - Qualitative:Diver confidence, subjective usefulness, preference

Tools

- GIS: QGIS / ArcGIS
- Audio analysis software (Python Librosa, MATLAB, Audacity)
- Statistical software: R or Python (Pandas, SciPy)
- Optional: VR or AR simulations for controlled experiments

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