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Development of High-Fidelity recording systems used to Capture Coral Soundscape

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Background

Traditional coral reef surveys are invasive, time-consuming, and expensive. Bioacoustics offers a non-invasive , continuous and scalable alternative. By simply listening, we can assess ecosystems health and biodiversity.

Alpheus Snapping shrimp dominate tropical reef soundscapes, producing high-frequency 'snaps' through rapid claw closure. These sounds are so powerful they can interfere with sonar yet also serve as indicators of reef health – thriving reefs sound louder and more active.

Developing high-fidelity hydrophone systems and adaptive filtering methods allows us to capture and interpret these complex soundscapes. This technology could revolutionise marine monitoring, supporting global conservation efforts while advancing underwater engineering, sonar design, and biometric research.

Aims and Objectives

This project investigates snapping shrimp bioacoustics to improve hydrophone technology and enhance non-invasive reef monitoring. By developing cavitation-optimised hydrophones with improved high-frequency response and resistance to biofouling, we aim to capture clearer acoustic data from marine ecosystems.

Understanding shrimp-generated cavitation bubbles can inspire advances in medical ultrasound, material science, and underwater communication systems. This research also supports climate monitoring by tracking biodiversity shifts through sound, while helping quantify how natural biological noise impacts human use of underwater acoustics.

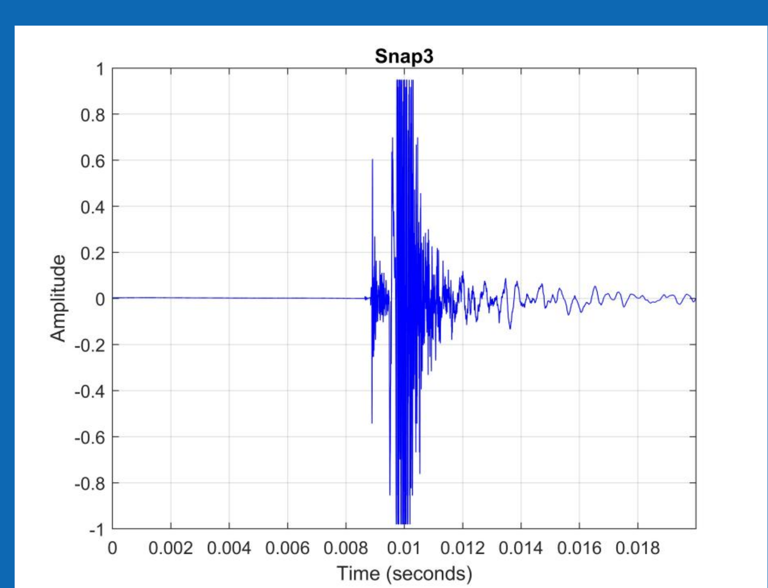
Research Methodology

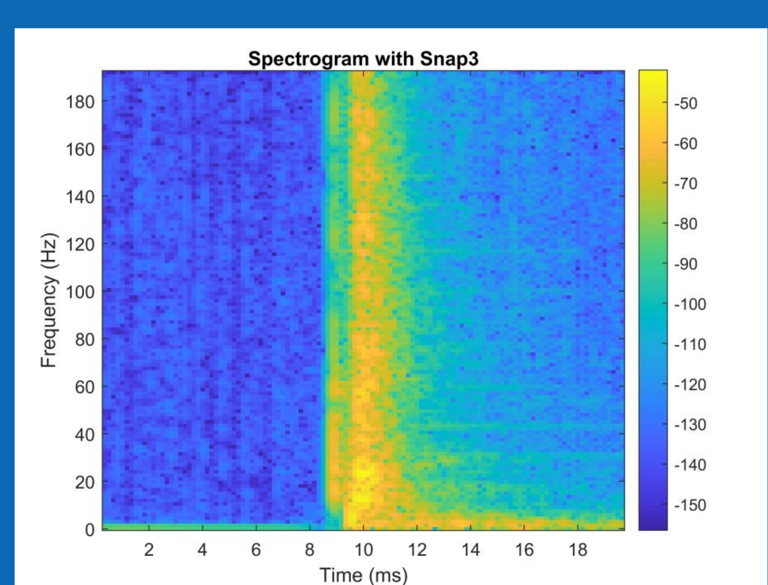
To investigate the acoustic behaviour of Alpheus snapping shrimp, I conducted both field and laboratory experiments in collaborative with researchers from Swire Institution of Marine Science (SWIMS) at the University of Hong Kong. Using a shrimp trap I designed, we collected six Alpheus specimens from local muddy shores in Hong Kong. These samples were then relocated to a 3D printed housing I designed and built to allow long term monitoring.

The setup was based on a recirculating seawater system using water sources from nearby coastline. To maintain stable environmental conditions, one third of the seawater was replaced every three days, which prevented salinity fluctuations from evaporation. The shrimp were fed every three days to keep them active and to encourage natural snapping behaviour.

I recorded their snapping sounds using the hydrophone, which detects underwater pressure variations through manipulation of the piezoelectric effect – when acoustic pressure waves strike the sensor they deform the piezoelectric crystal, generating an electrical voltage proportional to the sound intensity and recorded as audio files ready for analysis.

Recordings were taken at high sampling rate of 380kHz to accurately capture the rapid, high-frequency snaps produced by the shrimp. The data was later converted into spectrograms using Fourier Transform analysis, allowing visualisation of the frequency components and distinguish shrimp generated sounds from background noise. This laboratory-based monitoring system provided a controlled environment to develop and test high-fidelity coral soundscape recording methods before scaling to field applications.





Results

High-fidelity recordings captured distinct Alpheus snapping sounds between 2–200 kHz. Signal filtering effectively removed low-frequency background noise, revealing clear, high-intensity snaps on spectrograms. Variations in amplitude and frequency between individuals suggest potential behavioural or physiological differences. These results confirm the hydrophone system's capability to isolate shrimp-generated sounds and demonstrate its potential for future use in reef health assessment and marine soundscape monitoring.

Conclusion

This project demonstrated the successful development of a high-fidelity recording system capable of capturing and analysing snapping shrimp soundscapes. By isolating and processing these high-frequency acoustic signals, we showed how sound can be used as a non-invasive indicator of marine ecosystem health. The findings highlight the potential of acoustic monitoring as a faster, cheaper, and more ethical alternative to traditional coral reef surveys, with applications extending to conservation, underwater engineering, and climate monitoring.