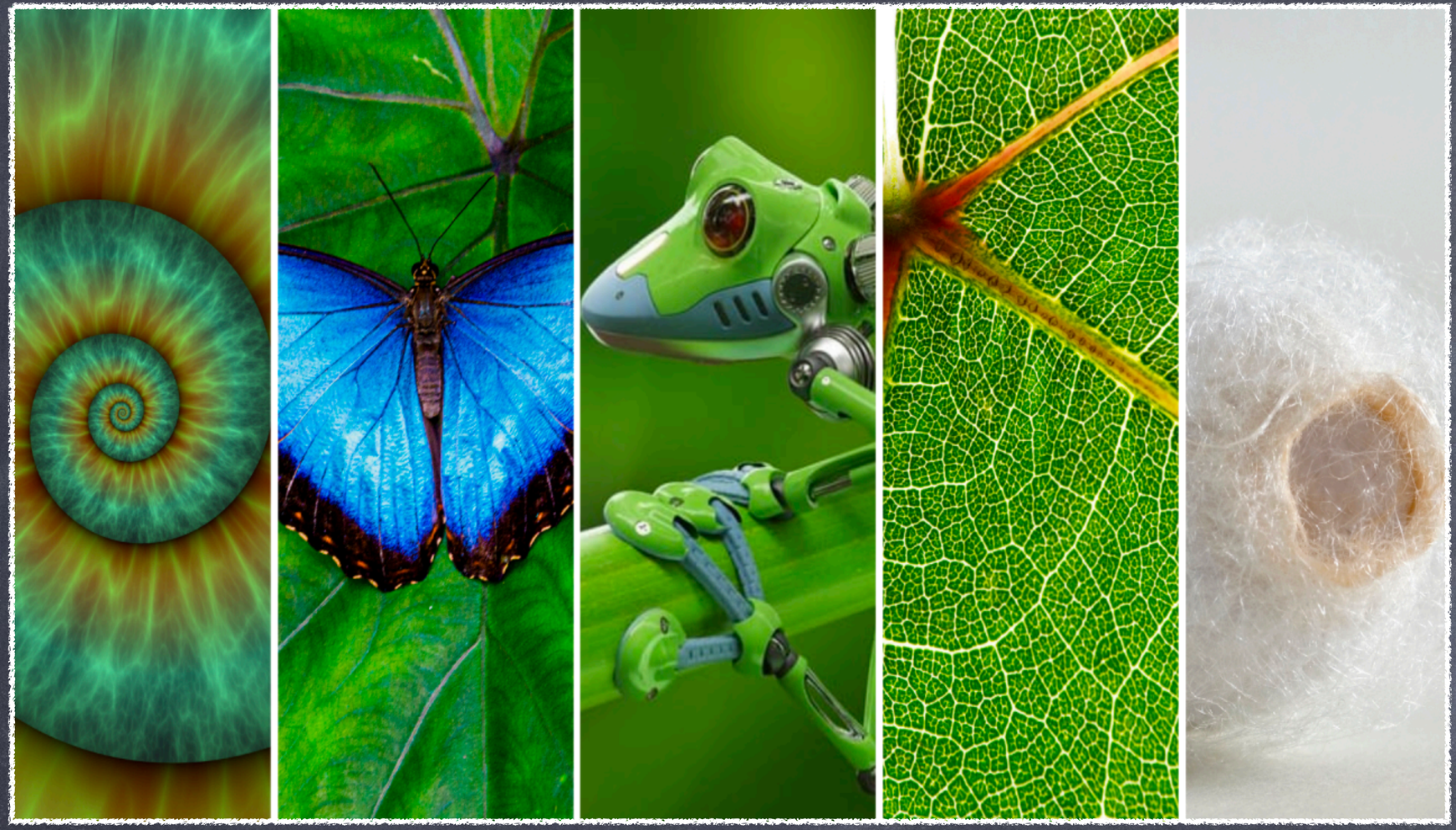

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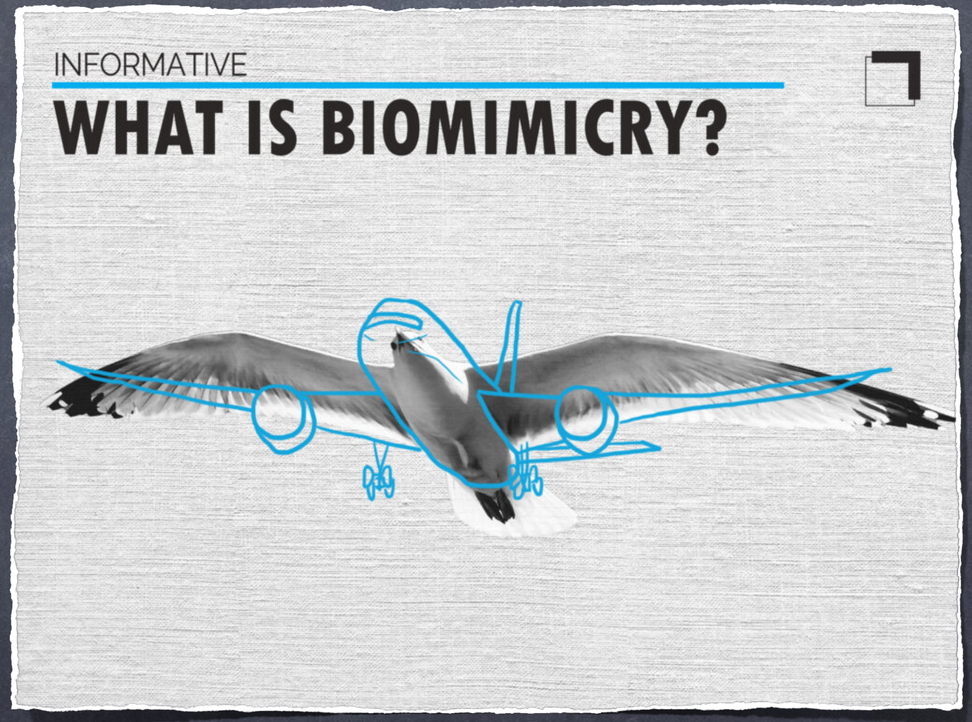
What is biomimicry?

Biomimicry or biomimetics is the examination of nature, its models, systems, processes, and elements to emulate or take inspiration from in order to solve human problems.



The term biomimicry and biomimetics come from the Greek words bios, meaning life, and mimesis, meaning to imitate. Other terms often used are bionics, bio-inspiration, and biognosis.

Types of biomimicry

There are three types of biomimicry -

- one is copying form and shape,
- another is copying a process, like photosynthesis in a leaf, and
- the third is mimicking at an ecosystem level - like building a nature-inspired city."

Dolphin inspired compact sonar

Glimpse

Much of our earth's oceans continue to be unexplored and unmapped. Certain Tsunamis, earthquakes and other catastrophic events are undetected due to the motion, noise, limited bandwidth, and variable delays that severely impact data transmission underwater.

Dolphins on the other hand seem to communicate complex information just fine! The way they achieve that is by distributing their chirps and songs over a wide frequency band. This greatly negates specific disturbances and provides clarity even through echos. As such, dolphins and other marine life forms provide the key to unlocking our oceans.

Biological model

Dolphins chirp and sing across a broad frequency bandwidth. This continuous change of frequencies not only serves to transmit information, but also to compensate for sources of interference that can occur underwater, such as echoes and noise.

Applications

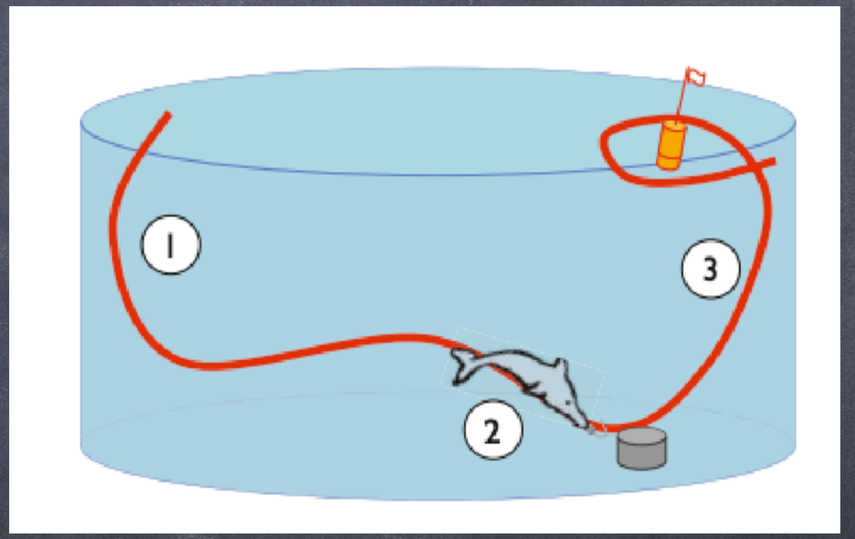
The new sonar processing method could have potential benefits in underwater commercial or military sonars.

For example,

- it could be used to scan the seabed to search for features that can be used to aid navigation.
- The sonar's compactness also makes it suitable to be mounted on underwater robots for ocean exploration.
- Martine communication (underwater communication).

Dolphin's behaviour experiment.

- Localisation of the target(1)
- Target identification(2)
- Turn to the boat(3)



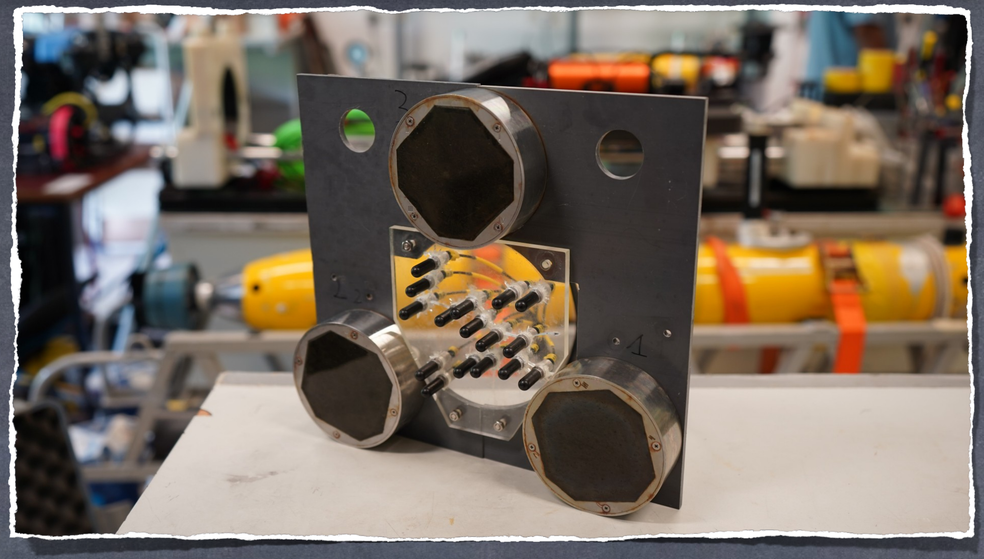
- During phases 1 and 3, the dolphin is respectively searching for the target on the seafloor and the boat at the surface. The signals emitted during these longer range detection phases are typically low frequency.

- When the dolphin finds the target (phase 2), it starts an interrogation strategy

- It is during this phase that the dolphin is trying to perform the object identification and will be wanting to receive a number of returns on the object of interest to improve

Sonar interpretation

- The scientists observed that dolphins were able to acoustically scan objects underwater and pick matching objects visually. This demonstrated that a dolphin's sound echoes emitted off an object contained information of the object's shape.
- They then recorded dolphin echoes emitted when scanning an object underwater.
- Based on their observations, the team built a biomimetic sonar that replicated a dolphin's sonar.

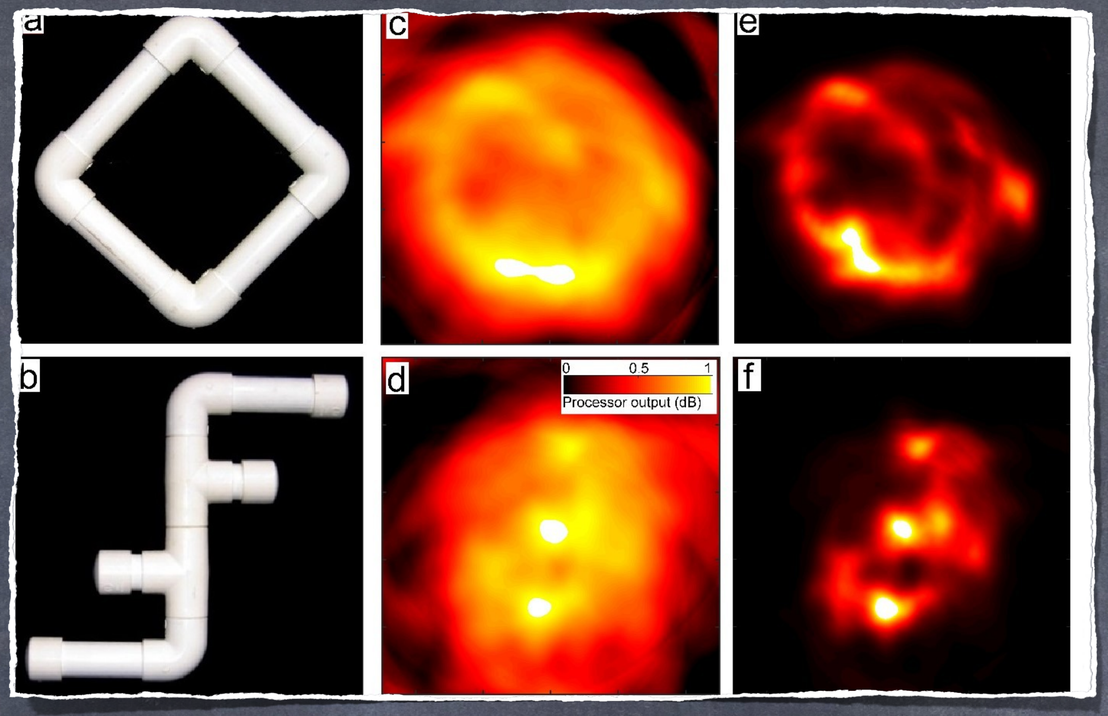


- The sonar, which is about 25 cm in width and around the size of a dolphin's head, is designed to emit sharp, impulsive click sounds similar to a dolphin's echolocation.

- Three transmitters are used to send sounds from different directions. The researchers then processed the sounds from both the dolphin and their sonar to visualise what the echoes revealed about the object shape.

Sonar based software

- To complement the hardware, the team came up with an innovative software that allowed the sonar to improve the visualisation of the echoes.
- Based on the hypothesis that dolphins use prior information to process their echoes, the researchers incorporated the concept of sparsity into the sonar's software. This assumes that out of the space scanned, only a small percentage is occupied by the object.

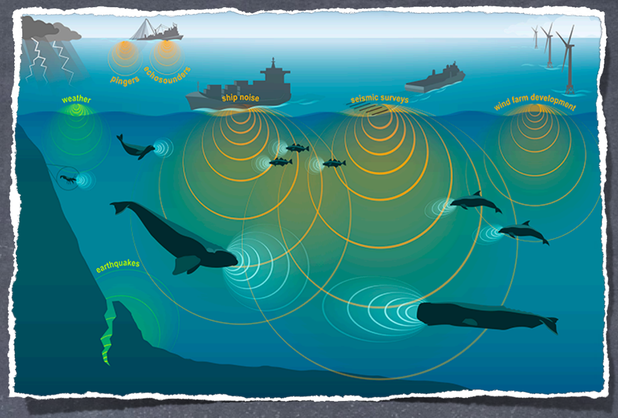


Sparsity-aware processing produces clearer biomimetic-sonar data visualisations (images e and f) than those produced via conventional image processing methods (images c and d). The original objects can be seen in a and b.

The effectiveness of the software was demonstrated when it was able to visualise information from a dolphin's sonar echoes when scanning an object, as well as sonar signals produced by their compact sonar.

A conventional approach of processing both sonar echoes resulted in noisy images. However, the novel processing approach gave better resolution and therefore sharper images. The software is also able to generate visualisations with a mere three clicks from the sonar, thus allowing it to be operationally fast.

Challenges



Reliable wireless communication is crucial for maritime and offshore applications, where malfunctions and delays could put the whole operation at risk. All systems must be able to perform in the most challenging weather and sea conditions.

Transmitting data underwater is challenging due to the motion, noise, limited bandwidth, and variable delays. Even in calm seas, poor transmission quality and below-average transmission speeds can result in the transmission getting altered or lost.


Thank you