Keio University

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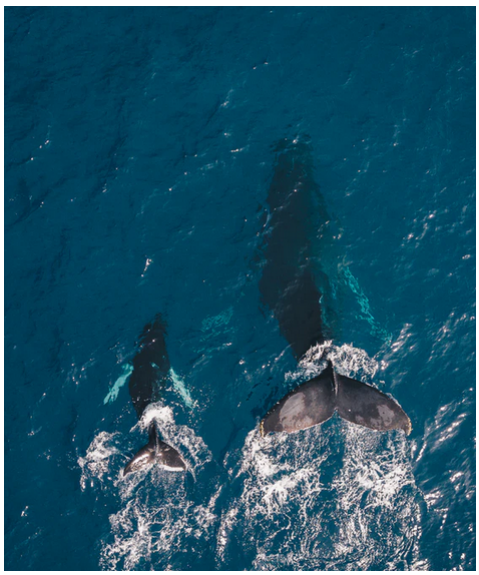
CALAMVS GLADIO FORTIOR

Onoe Hiroaki & Takahashi Hidetoshi's course - 2020

Biomimetic Micro/Nano Engineering
Report 6 : Biologging


[1]

Academic year 2019-2020
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Contents

1 Introduction

Bio-logging is a technique using data loggers attached to the bodies of animals to conduct ecological surveys, to study the behavior of physical quantity. Typically the researchers design small electromechanical systems that with various techniques they attach to animals. Then, they either collect the data in real-time, for intance using a GPS, or in other cases record the data using memory and then collect the biologging equipmentn this was the case for birds during the lecture.

2 Whale rover with camera

The biologging equipment presented in this report is a whale rover with camera for bio-Logging. In the first part, the rover equipment presented is from a paper called "Whale Rover for Bio-Logging" by Kosuke Tsuchiya, Akihito Suzuki, Yuichi Tsumaki and Kyoichi Mori [2]. Although, in the first article, the camera devices is not explained. Therefore in the additional second part, the camera is presented from "Monitoring the behavior and multi-dimensional movements of Weddell seals using an animal-borne video and data recorder" by Randall W. Davis, William Hagey and Markus Horning.

While it was already possible to put a logger on the back of whale to measure depth at which they dive, their velocity, the migration patterns, ect. Now, scientists are trying to capture videos of how whales are hunting their preys. But, because of the lack of visibility in deep waters (very few light reaches deep ocean, almost none), it is not yet possible to take a video of the mouth area. Also, the camera logger must be attached close to the sperm whale's mouth, but this is impossible to achieve with the conventional approach. The solution designed to perform this difficult action is to create a special rover. Initially attached on the back and then moving along the back of the whale to reach the mouth. On top of this, this rover is actuated by the flow of water from the motion of the whale this technique is called "Environment-driven". After this, on top of this rover, a camera will be placed. The all system is displayed on figure 1.

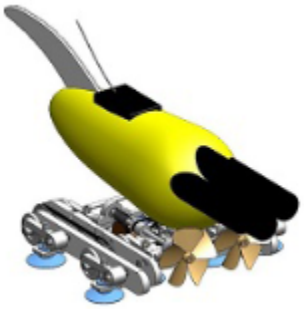

Figure 1: Whale rover with camera [2]

3 Locomotion part : whale rover

3.1 Specifications [2]

- It must not injure the sperm whale or disturb their behavior.To do so, is rover must be as small and as lightweight as possible. This is done in order to let the animal perform a normal daily behavior and record its usual habits.
- The dimensions for the practical rover are 255, 240, and 87 mm respectively. It weighs 1070g. This rover negligible for the whale.
- While a particular protection would be necessary to protect the electronics components if the rover composed by electronic components in this case the rover is only mechanical. No protections are required even at 1000 m under the sea.

3.2 Locomotion technique

The whale's body is big and the surface is therefore uneven. The best approach used up to now is the a walking mechanism, ensuring a good step by step locomotion. Usually, this mechanism is complicated because multiple legs are required. In this case, the total number of legs is 8. The is an inner and outer frame that are synchronised and therefore move alternatively. Two propellers are employed at the front.

As previously said, there are propellers. When there is a water flows reaching the propellers the power is transformed into power to propel the whale rover. Rotation of the propeller shafts to other shafts and gears, finally, a belt-pulley is actuated.

The rover is displayed on figure 2. The propellers are observed and on the bottom the blue legs are seen. Also it can be observed the two parallel moving parts.

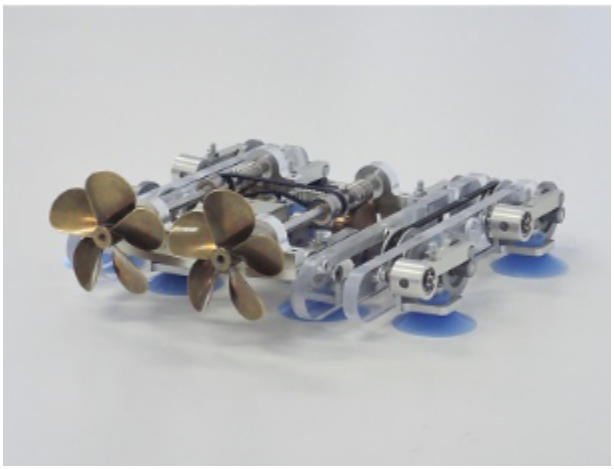

Figure 2: Locomotion mechanism : whale rover [2]

4 Camera for the bio-logging

The biologging is made using a camera. In the first article, only the rover was presented. Then the discussion on the camera part is based on another article. This article is from "Monitoring the behavior and multi-dimensional movements of Weddell seals using an animal-borne video and data recorder" by Randall W. Davis, William Hagey and Markus Horning [3]. The future design the wanted to do by the time is displayed on figure 3.

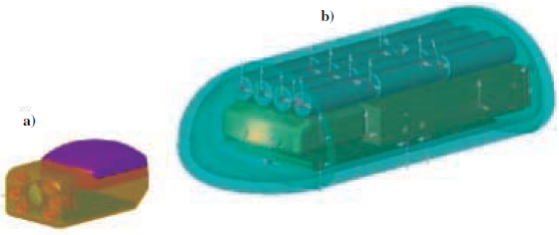

Figure 3: Camera : (a) camera and (b) data recorder [3]

4.1 Specifications

- Be able to sustain the pressure until 1000 m deep

- Be able to see in really dark waters
- Integrated GPS and antenna (3 cm long, 3 cm wide, 1 cm tall)
- Able to record image on a short range (1 m)
- Sustain the flow speed

4.2 Sensors type

Previously designed camera are low-light sensitive with minimum illumination of 0.05 lux and angle of view = 80° horizontal and 60° vertical). They typically emit monochromatic light (invisible light to the animal) allowing the recording of images.

The new system designed, lighter and smaller and is showed on figure 3. It is build by two different elements : the recording element and the camera.

The recording element's sensors are such is needs and is build by:

- A titanium housing for the electronics
- 3-axis gyros
- sensors for pressure, swim speed, compass bearing, ambient temperature, conductivity, ambient dissolved oxygen, light level, bio-luminance, tilt, pitch and roll
- miniature GPS module with active antenna
- camera emitting light using LEDs

5 Conclusion

Biologging of animals was studied through a combined camera-rover system. The first part was dedicated to a locomotion system, the rover. And the second part to the camera and sensors necessary for the recording. It can be imagined that the combined systems can be build and record how whales eat their preys.

References

[1] *Unplash-Whale*. `https://unsplash.com/photos/P0OUHx-5mHo` [Accessed: 13.06.20].

[2] Kosuke Tsuchiya, Akihito Suzuki, Yuichi Tsumaki, and Kyoichi Mori. Whalerover for bio-logging. *Conference on Advanced Intelligent Mechatronics (AIM)*, July 9-12, 2018.

[3] Randall W. Davis, William Hagey, and Markus Horning. Monitoring the behavior and multi-dimensional movements of weddell seals using an animal-borne video and data recorder. *Mem. Natl Inst. Polar Res., Spec. Issue, 58, 148–154*, 2004.