Sustainable Communication Networks
Prof. Dr. Anna Förster

In Cooperation with:
Prof. Dr. Sven Kerzenmacher (Faculty 4) and Prof. Dr. Christian Wild (Faculty 2)

Autonomous underwater sensor system for coral reef eutrophication monitoring: IoT System Design

Prerequisites:	- Basic IoT knowledge (as from the course Internet of Things) - Basic knowledge of various IoT communication technologies - Programming skills (Python, C) - Interest in learning about fuel cells and coral reefs
Level:	This topic is appropriate for Bachelor Thesis or Master Project
Language:	German or English

Introduction

In Sediment Microbial Fuel Cells (SMFCs) naturally occurring electro-active bacteria generate an electric current between an anode (embedded in the sediment/ocean floor with no oxygen present) and a cathode (submerged in the oxygen-rich ocean water). Such devices can be used to generate electricity from the sub-aquatic environment for e.g. autonomous sensor networks, but can also serve as a sensor for e.g. eutrophication (presence of excessive amounts of nutrients e.g. from waste water) that can negatively affect sensitive marine environments such as coral reefs. In this project, a system architecture is targeted to monitor coral reefs with the above used fuel cell. The fuel cell serves both as the energy source and as the sensor itself.

Project description

The targeted system architecture must describe all elements of the system, starting from the sensor node with the attached fuel cell, and ending with delivering the data to the central cloud service. The only sensor on the system for now should be the fuel cell itself, which is the energy source at the same time. The steps to follow include:

1. Familiarise yourself with underwater communication technologies and especially their properties in terms of communication range and bandwidth (references to start with are at the bottom).

2. Perform structured interviews with the cooperation partners (contacts will be provided after the kickoff presentation) to derive all needed system requirements, such as power output of the fuel cell at different eutrophication levels; the position of the coral reefs to be monitored, their depth and their distance from land; the size and the interface of the fuel cell. During these interviews, you will also have the opportunity to see the fuel cell.

3. Evaluate the available underwater communication technologies in respect to the derived system requirements.

February 16, 2022

4. Design at least two different system architectures, compare them in terms of their advantages and disadvantages (cost, maintenance ease, market availability of components, energy requirements, etc.) and make a recommendation. The components need to be listed in details, e.g. with specification sheets. Alternatives for each component should be noted (in case the market availability changes). The designs need to be feasible, e.g. the total costs should be reasonable and all proposed components should be available on the market. Also software components need to be included (required libraries and tools, etc.)

For the kickoff, a literature survey of best practice underwater coral reef monitoring systems should be performed (starting form the references provided below, but also extending the survey with other publications). Also, a list of concrete technical questions for the interviews need to be prepared. For the intermediate presentation, potential designs must be presented with their pros and cons, together with the requirement analysis from the interviews. The final presentation must include all details as described above.

Contact

If you are interested in this work, please contact us via mail: projects@comnets.uni-bremen.de

References

[1] C. Gussen et al., A Survey of Underwater Wireless Communication Technologies. Journal of Communication and Information Systems, Vol. 31, Issue 1, pp. 242–255, 2016

[2] M. Jouhari et al., Underwater Wireless Sensor Networks: A Survey on Enabling Technologies, Localization Protocols, and Internet of Underwater Things. IEEE Access, Vol. 7, pp. 96879–96899, 2019