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IMPAQT UNDERWATER ACOUSTIC TELEMETRY PLATFORM: RECEIVER DESIGN

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Introduction

By 2050 the world population will reach approximately 10 billion people, and it will be required to be supported by an associated increase in the level of food production [1]. Seafood is one of the main sources of nutrition for the world population and consequently, its production should be increased to support the increase in demand. Integrated multi-trophic aquaculture (IMTA) refers to the co-culture of the aquatic species including the extractive species that use the waste or feed leftovers of other species [2]. IMTA is gaining a reputation as a sustainable aquaculture method that also minimizes environmental impacts and provides economic benefits. To maximize the benefits of IMTA, farmers need to have a good insight on water quality parameters and chemical substances which can be carried out using manual sampling of the water or using off-the-shelf sensors.

As part of the European IMPAQT project [3],we are developing a universal telemetry platform that can be integrated with external sensors to collect the sensory information and transmit them wirelessly underwater to the receiver gateway. At the gateway the data can be saved for manual extraction or on-site data analysis, or can transmit to an inland station using Long Range (LoRa) radios. The proposed telemetry platform enables the farmers to have better and almost real time insight over the IMTA sites as regards various critical parameters.

Platform

Our proposed platform, shown in Figure 1, consists of several miniaturized transmitter nodes and a receiver node that collects the sensory information of attached sensors. The IMPAQT ultrasonic transmitters are designed in a miniaturized form factor that will run on a battery for deployment and they can be connected to external sensors using Serial Peripheral Interface (SPI) protocol or Universal asynchronous receiver-transmitter (UART) protocol to collect their information and transmit them in real-time to the receiver gateway which is discussed in [4].

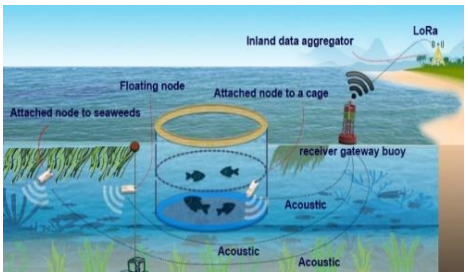


Figure 1. IMPAQT telemetry platform

The receiver gateway is also powered by a battery, and it can be attached to a buoy with the connected hydrophone immersed into the water where it receives information from the sensorised transmitter nodes underwater. The received information can be collected on the SD Card and it can be transferred to an inland receiver station for monitoring/processing.

The receiver board has 3 main component blocks which are shown in Figure 2.

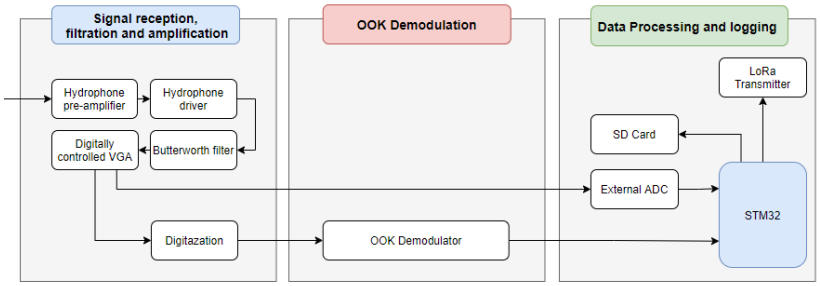


Figure 2 IMPAQT Receiver system design

The signal reception stage receives the hydrophone signal, pre-amplifies the signal, and then drives the hydrophone signal for the filter stage. There is also a variable gain amplifier that is controlled via Inter-Integrated Circuit (I2C) protocol [5] by STM32 microcontroller to amplify the signal to the required level before feeding into the digitalization stage. We chose the On-Off keying (OOK) modulation technique as it is the most favourable to the battery life of the miniaturized transmitters and there is a relevant OOK demodulator on the receiver side to demodulate the received signal.

Results

The transmitter and receiver boards are manufactured, and tests have been carried out successfully. External sensors have been connected to the platform. The sensor data transmitted successfully underwater. We initially managed to achieve 40 bit per second bitrate at 42KHz carrier frequency. The transmission range, battery life, bitrate, and deployment results will be presented in the oral presentation.

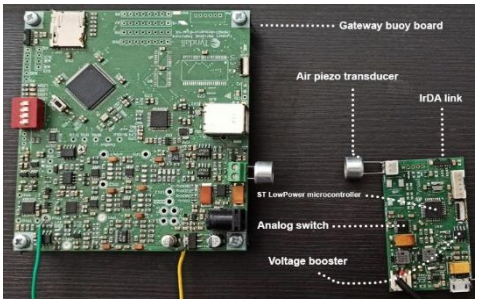


Figure 3 IMPAQT boards

Future Work

Future work involves increasing the carrier frequency to shorten the active transmission period to increase the overall battery life. It would be also interesting to evaluate binary-phase-shift keying modulation and compare the results with OOK demodulation regarding battery life and signal noise ratio between two. In addition, there is an opportunity to perform edge-processing on the receiver board, to inform emergency events, for instance, early detection of excessive number of toxic substances in the sites.

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