# IMPAQT Miniaturized Underwater Acoustic Telemetry Platform: Transmitter Node System Design

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#### Presenter





# Hamed Jafarzadeh

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- Computer and Electronics Engineer
  - 6 Conference papers
  - 6 Industrial projects
  - 5 National Patents
  - 1 US Patent approved
- research topics :
- Miniaturized sensors and devices development
- Biomedical devices development
- Robotics and mobile robots
- Internet of Things

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According to the latest United Nations world population estimation, by the year 2050, the population of the earth will reach approximately **10 billion people** [1].

Increase in population result in higher demand for (sea)food.



★ Key point :

Aquaculture industry is important, and it will be even more important in future

Data sources: Our World in Data based on HYDE, UN, and UN Population Division [2019 Revision] This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing.

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## Introduction



In 2012, aquaculture production volumes **exceeded** capture fisheries production [2].



#### Seafood production: wild fish catch vs aquaculture, World

Our World in Data

Aquaculture is the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Capture fishery production is the volume of wild fish catches landed for all commercial, industrial, recreational and subsistence purposes.



**★** Key point :

Aquaculture is the future of seafood

#### Introduction



In order to maximize the benefits from aquaculture environments, it is necessary to take **data-driven actions**.

Part of **IMPAQT** Project is aiming at providing information about aquaculture sites to the farmers .



— Semantic aquaculture data interoperability and harmonization

★ Key point :

It is important to monitor aquaculture environment and take scientific and data-driven actions

IMPAQT is a European project aimed at promoting and supporting the eco-intensification of aquaculture production systems inland (including fresh water), coastal zone, and offshore.

#### Background



There are various research efforts on providing information to farmers as a part of precision fish farming concept [4].

**Precision Fish Farming** intending to use scientific methods to manage the fish production by enabling farmers to monitor, control and document the biological process in fish farms.

As part of AquaExcel project, **AE-FishBIT** has been developed for monitoring physical activities and respiratory frequency of the farmed fish. Despite its novel features, AE-FishBIT is not able to transmit the data, and the fish is required to be captured to download the sensors data.

There are also devices for tracking the movement of the fish in dams, fisheries, and cages. Salmon Acoustic Telemetry System (JSATS) tags are developed to identify and track the movement of juvenile salmon in dams and rivers. JSATS tags are extremely compact. Although



(A) JSATS Tags

(B) AE-FishBIT tags

Overview



As part of the IMPAQT project, a novel underwater acoustic telemetry platform has been proposed and is under development, to provide a method to collect and transmit sensors data underwater. The proposed platform architecture consists of several ultrasonic transmitter sensor nodes and a gateway buoy as a data aggregator interface. The Transmitter nodes can be attached to seaweeds, cage nets or they can also left floated in the water.



**Transmitter Tag** 



Each transmitter tag is running on a **battery**, it collect raw information and perform **edge data processing** to compress the collected data, hence increasing the battery life. Then at a predefined interval, based on user requirements, the processed data is transmitted using piezo transducer. Each tag has **its own sensors** and can integrate with other sensors using **external sensor interface**.



IMPAQT Acoustic transmitter design block diagram

**Transmitter Tag** 





IMPAQT Acoustic transmitter design block diagram

- The transmitter tags are using **PZT Type VI piezo** materials to transmit the collected information
- PZT Type VI consume more energy comparing to other types, but they also provide better source level and frequency response compared to others





**Transmitter Tag** 

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IMPAQT Acoustic transmitter design block diagram

Component	Sleep current (µA)	Typical supply current (μΑ)	Max supply current (μA)
BQ24040	1	1	6
LTC2935	0.5	0.5	0.5
TPS6104	1	25	25
NCP170AMX300	0.5	0.9	0.9
TFBS4650	0.01	75	2000
ADG1436	1	170	280
STM32L062x	0.23	312	780
MS5837-30BA	0.1	20	1250
LIS3DH	2	2	11
Piezo	0	1000	1000

Each transmitter tag is running on a 260mA battery, we are estimating that based on the tag's configuration, each device can run up to **three months** on batteries.

**Transmitter Tag** 

- Each tag incorporates an **accelerometer**, **pressure** and **temperature** sensor
- In order to facilitate the integration with other sensors, an IR transceiver is used that can communicate with external sensors using IrDA protocol



IMPAQT Acoustic transmitter design block diagram





Results



······ Gateway buoy board

Air piezo transducer IrDA link St LowPower microcontroller -Nalog switch -Voltage booster

IMPAQT Acoustic telemetry evaluation boards



BII-7003 Hydrophone from Benthowave

- Our Project is a work in progress
- We developed two evaluation boards for the telemetry system
- We achieved 200 bps using air transducer using BPSK modulation
- We achieved 400 bps using air transducers using OOK modulation
- We are evaluating and benchmarking underwater communication using commercial hydrophones at the moment

# Thank you



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