An Autonomous Surface Vehicle for Water Quality Measurements in a Lake Using MQTT protocol

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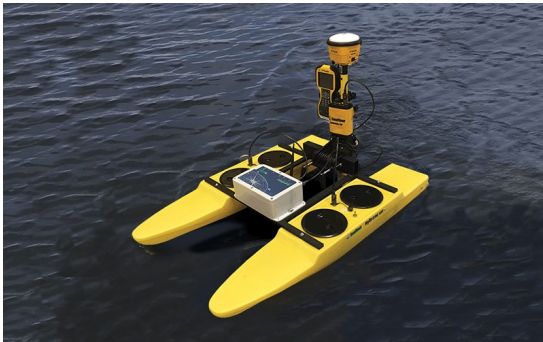
IEEE Chilecon 2021
December, 2021
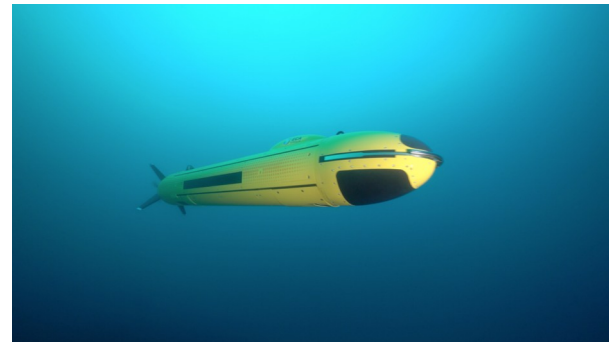
Introduction

- ## Global motivation

2/3 parts of the world is covered with water

This would required the development of tools for monitoring over and under the surface

Autonomous vehicles are being used for this type of tasks (ASV and AUV)
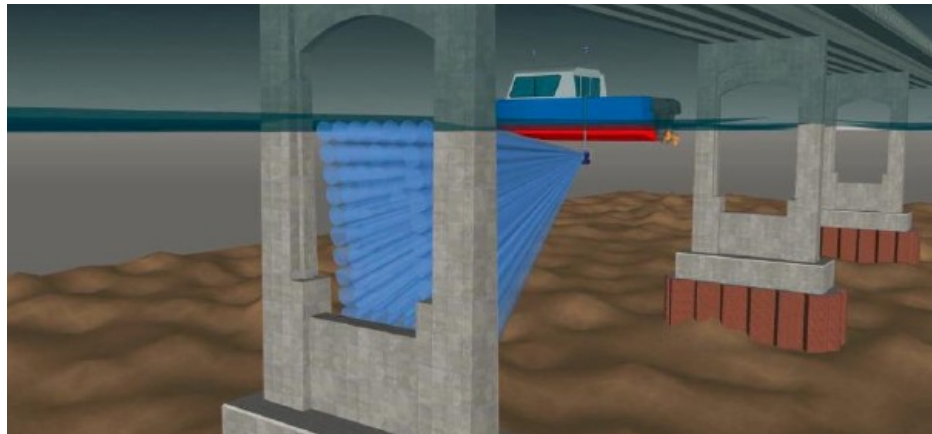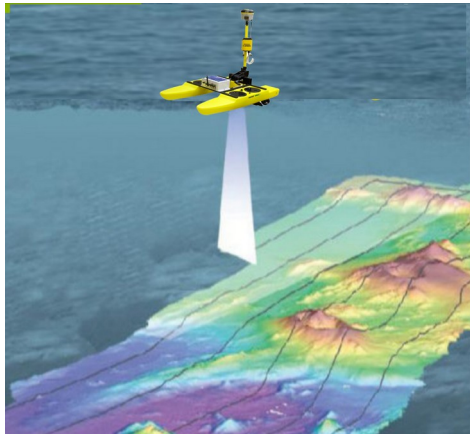

Hydrone ASV

A18 AUV

Introduction

- Global motivation

ASV (Autonomous Surface Vehicles) and AUV (Autonomous Underwater Vehicles)

Application examples: Environmental Monitoring, Surveillance, Inspection, Bathymetry, Communication Relay
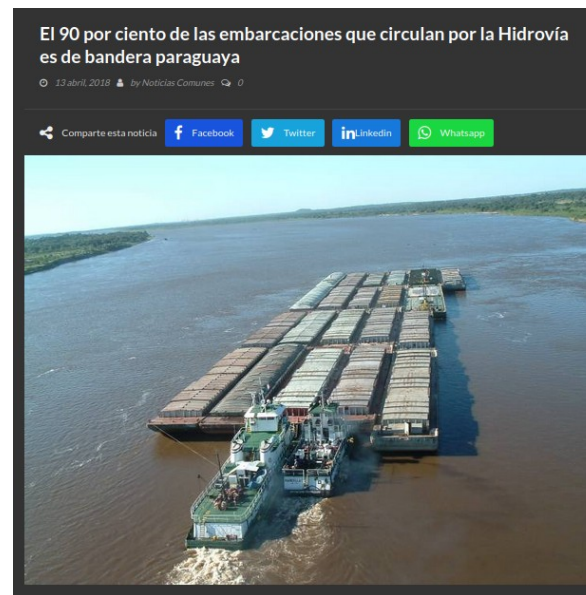
Introduction

- Local motivation

Many rivers cross Paraguay and two hydroelectrics dams required the monitoring of these resources

Rivers are important for international trade (hydroways)

El 90 por ciento de las embarcaciones que circulan por la Hidrovía es de bandera paraguaya

13 abril, 2018   by Noticias Comunes   0

Dams are indispensable for energy generation at hydroelectric plants

Contribution: Implementation of an ASV with an onboard sensor unit that submerges for taking water quality measurements and can be remotely operate it using MQTT
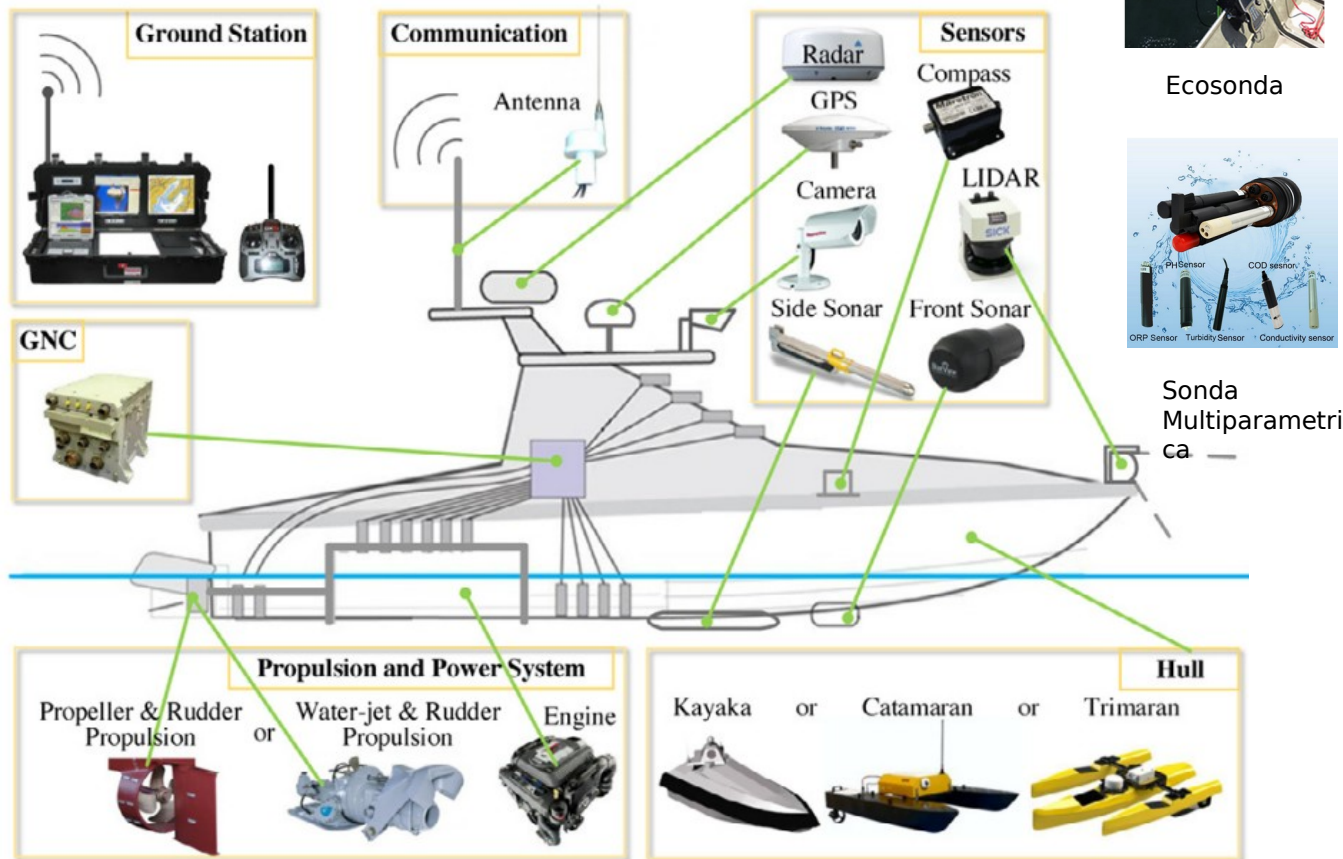
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Introduction

- ASV General Architecture*

General systems are required for operation

GNC (Guidance, Navigation and Control) is the main system

Ecosonda

Sonda Multiparametrica

*Liu, Z., Zhang, Y., Yu, X., & Yuan, C. (2016). **Unmanned surface vehicles: An overview of developments and challenges**. Annual Reviews in Control, 41, 71-93.

Implementation

- ## System diagram

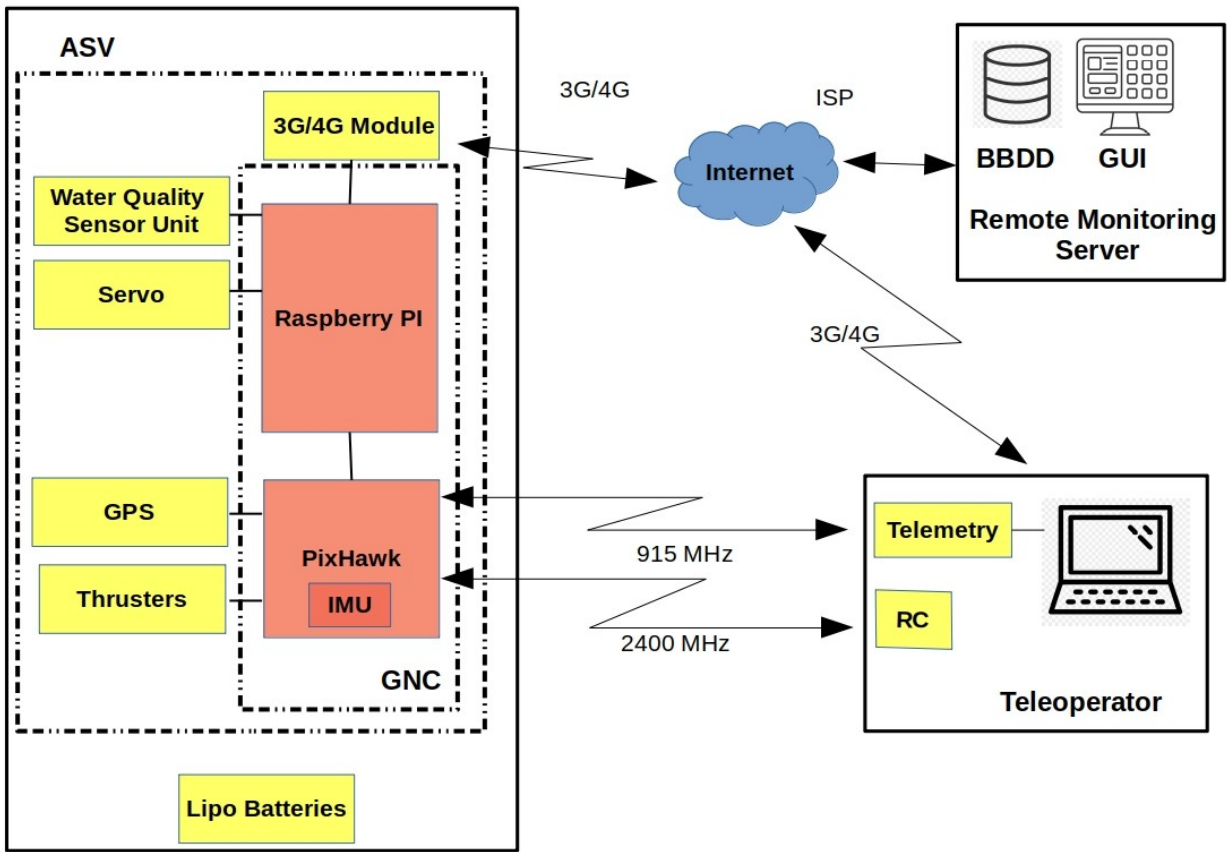GNC, Communications, Sensing Unit and Power were mounted on the ASV

A server was installed for data storage, visualization and path generation


Pixhawk   Raspberry Pi

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Implementation

- Hardware and software used

Task	Component
Guidance	Raspberry Pi
Navigation and Control	Pixhawk 4
Power	2x 16Ah Batteries
Remote Control	FrSky Taranis X9D plys
Telemetry	Holybro telemetry
3G/4G	Quectel EC25
Thruster	2xBlue Robotics T200
Sensor unit	Libelium Smart Water

List of hardware

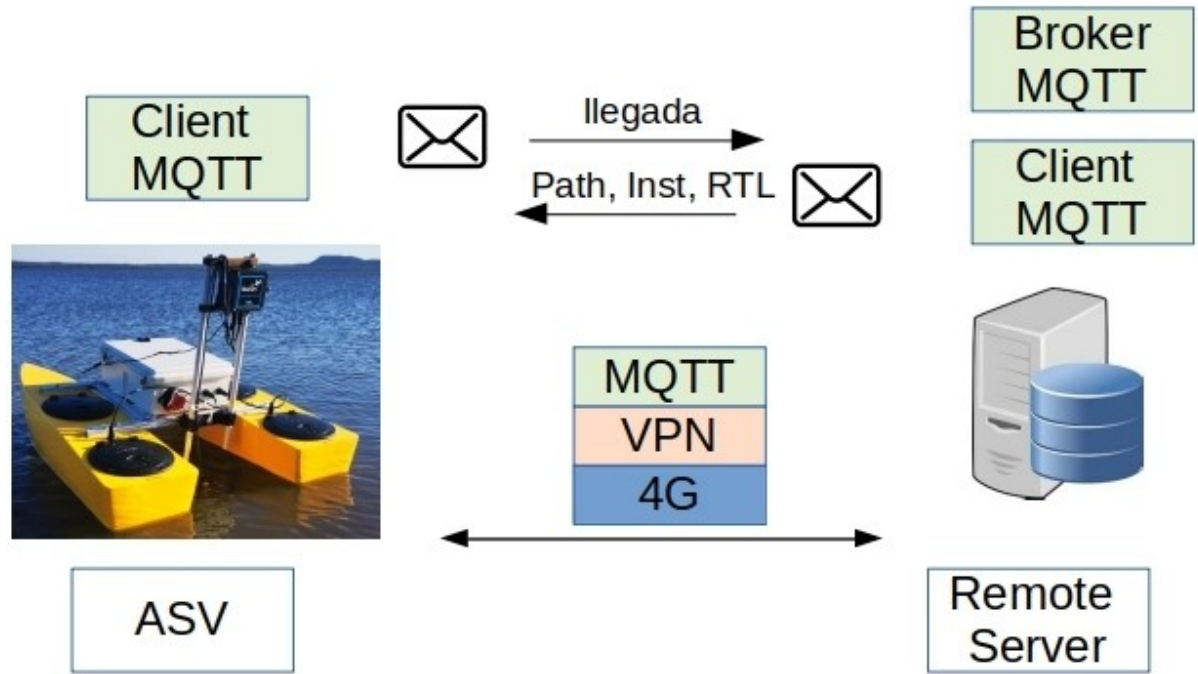| Name	Location
Python 3.7	ASV and Server
Dronekit 2.9.2	ASV
Paho 1.5.1	ASV
Mosquitto 2.0.11	Server
PostgreSQL 10.4	Server

List of software

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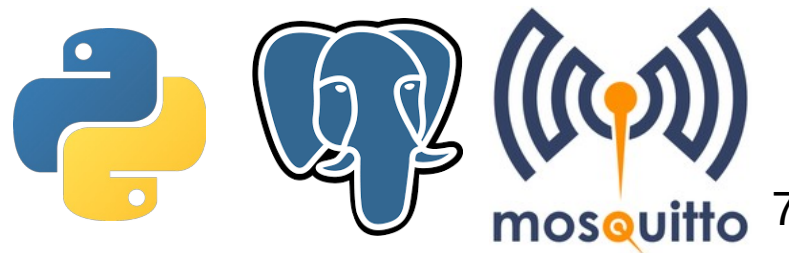
Implementation

- MQTT diagram

Lightweight publish/subscribe protocol

Clients publish or subscribe to messages under "topics"
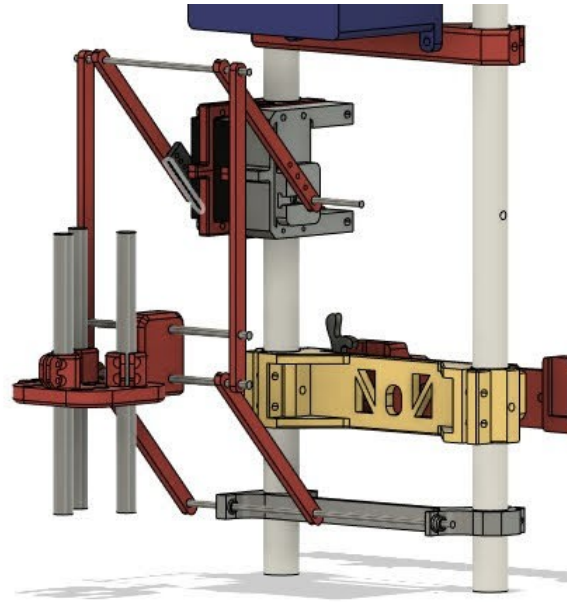
Broker manages the network and messages

Implementation

- ## Sensing Unit
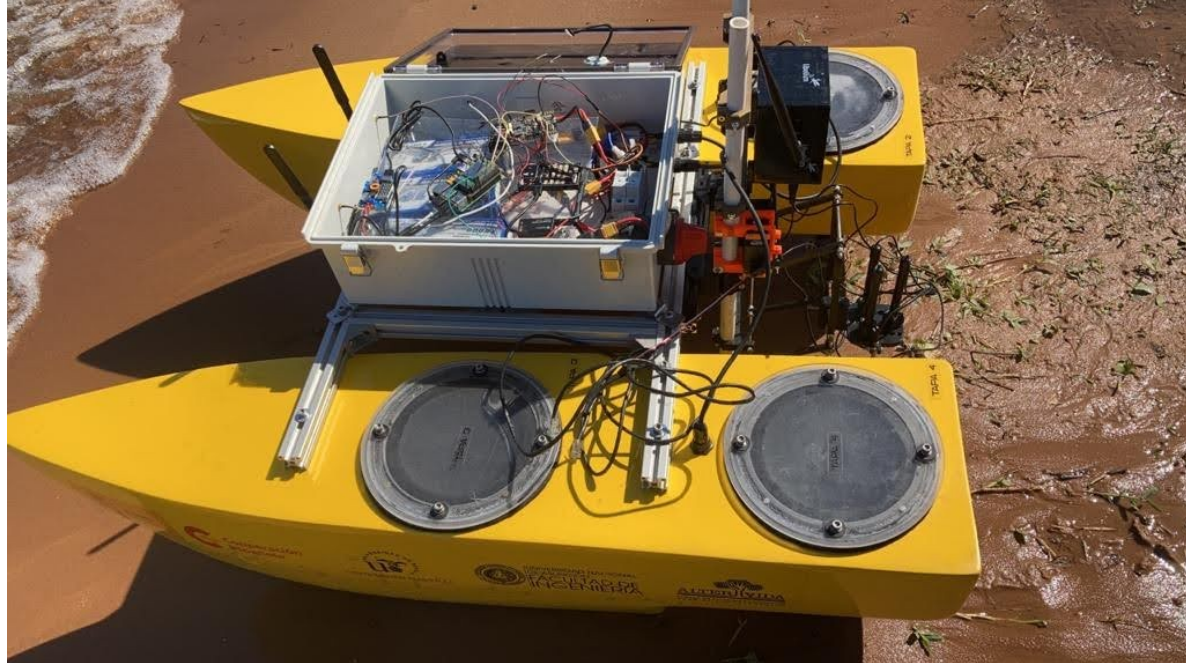
Composed of a Smart Water from Libelium

It measures pH, temperature, dissolved oxygen, conductivity

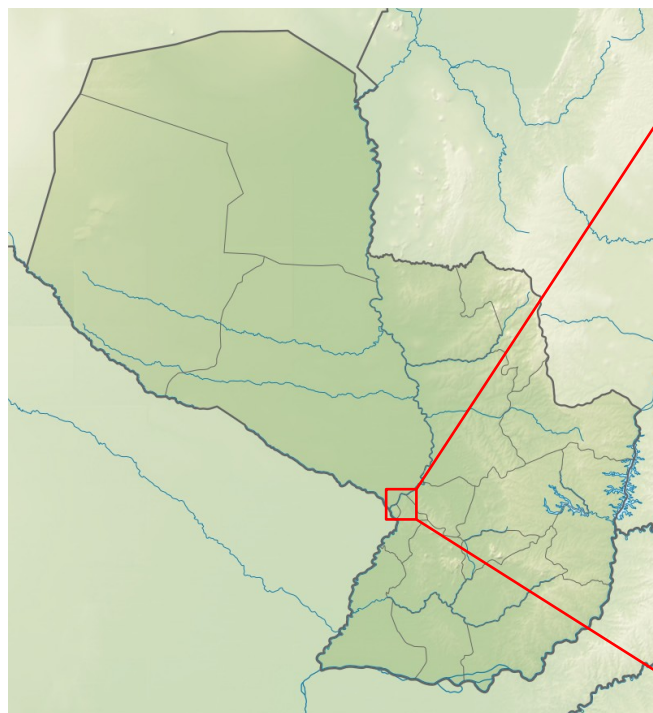An arm was designed for support of sensors, and move with a servo

libelium

Implementation

- Final Mounting

Field Tests and Results

- Tests were carried out at Ypakarai Lake
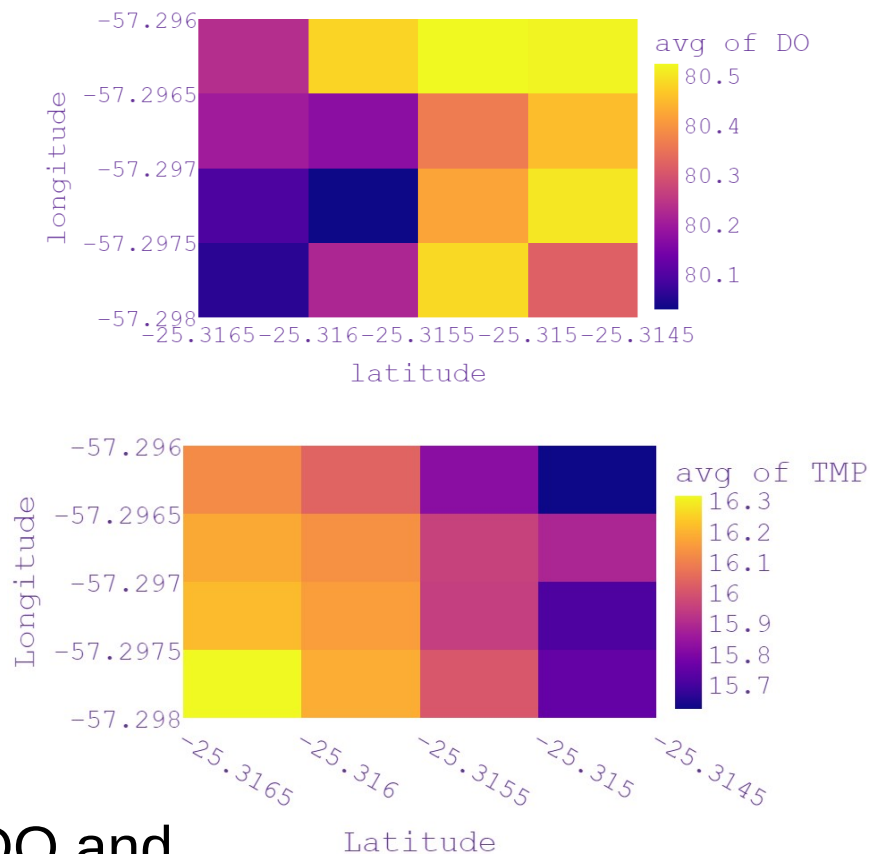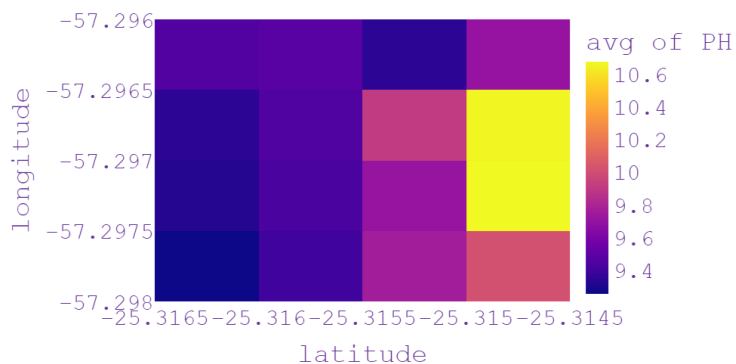
Field Tests and Results

- ## Route planning

A square-wave for sweeping an area was implemented in Python code at the server

Then the route is sent to the ASV using MQTT protocol

Field Tests and Results

- Measurements of Dissolved Oxygen, pH, and Temperature

pH sensor requires further analysis, while DO and temperature showed coherent results

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Conclusions and Future Work

- A small ASV was built and mounted for taking water quality measurements.

- The sensing system included a mechanism for submerge the sensors.

- MQTT is used for exchange of data about route and measurements

- As future work, it is proposed to build more ASV with different sensors.

- Additionally, it is expected to use artificial intelligence to calculate the routes in the server and pass to the ASV.

Acknowledgment

- AECID (Spanish Agency of International Cooperation for Development) for its financial support of the project

- Stic Amsud program for their support to project ROEM (Advanced Control of Robots for Environmental Monitoring)

Thank you for your Attention