Development of a Low-cost Unmanned Surface Vehicle for Digital Survey

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Abstract

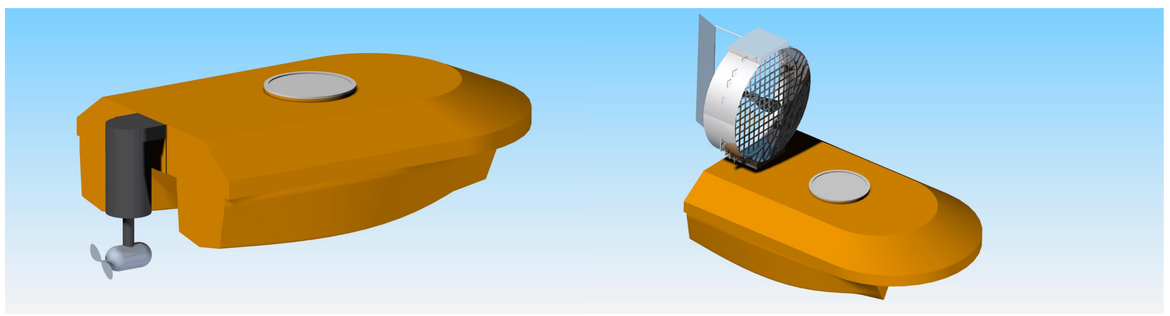
This work presents the development of a **low-cost unmanned surface platform** for **digital survey** also in **shallow water** owing to a low draft design.
An **embedded system** with **ROS** on-board has been deployed on a surface vehicle based on an **open-hardware** solution, which is responsible for the interfacing of an **RTK GPS** with a **bathymetric** ultrasound sensor to **map** the **sea** / **lake** / **river** floor. The boat is remotely controllable or **fully autonomous**.
An **Augmented Reality** (AR) application shows the path and the set of **survey blocks** that are already mapped or not. We also tested a **SfM** approach by processing images acquired from a **low cost camera** to **map riverbanks**.

Hardware Design

First requirement: capability to navigate in presence of **shallow water**, a fundamental aspect when the survey of small river / basin is required.

Second requirement: capability to navigate also in presence of **canopy** or **algae**. We designed two propulsive systems:

- azipod like configuration;
- rotary counter-rotating propellers.



The control of the developed USV is demanded to the Sensor & Control Box unit, which manages the following aspects:

- to interface the ultrasound bathymetric unit;
- to interface the controller of the propulsion unit;
- to interface the GPS RTK rover receiver ;
- to interface an 9axis IMU (MPU9150);
- to transmit/receive telemetry data;
- to transmit analog video/sound data;
- to log survey data.

The HW is based on the 1GHz Cortex-A7 A20-OLinuXino manufactured by Olimex

Software Design

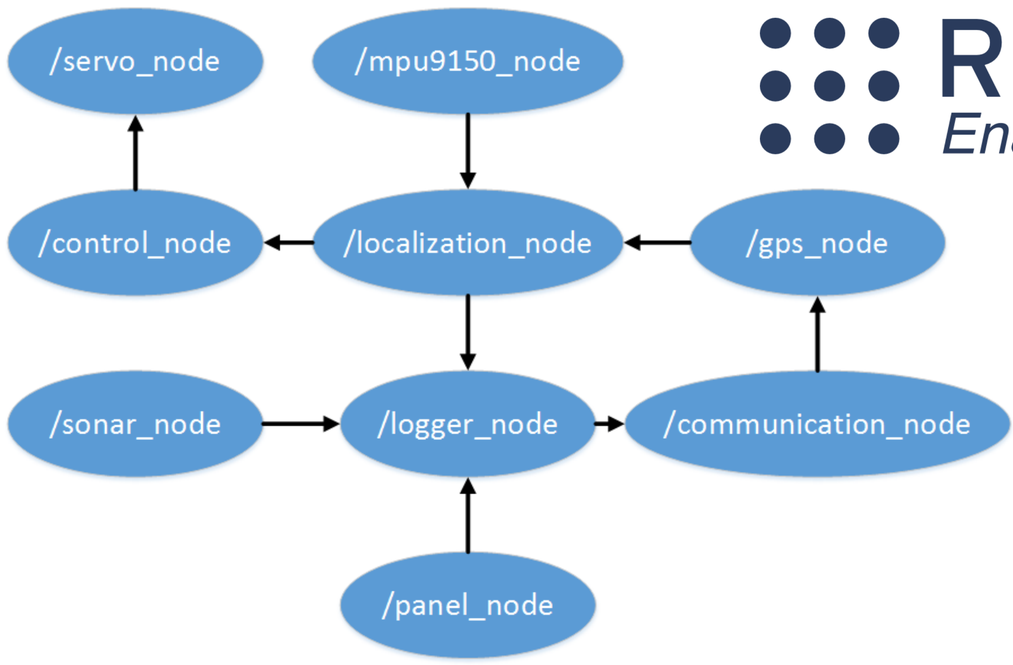
The **software** is based on **ROS** and is formed by several nodes that are responsible for control, navigation, sensors, log, …

The use of **ROS** simplified the workflow owing to the versatility of the **publisher-subscriber** mechanism.

About localization we used a VRS and Rover with Topcon GRS1 Receiver configuration, which is a good compromise between cost and accuracy.

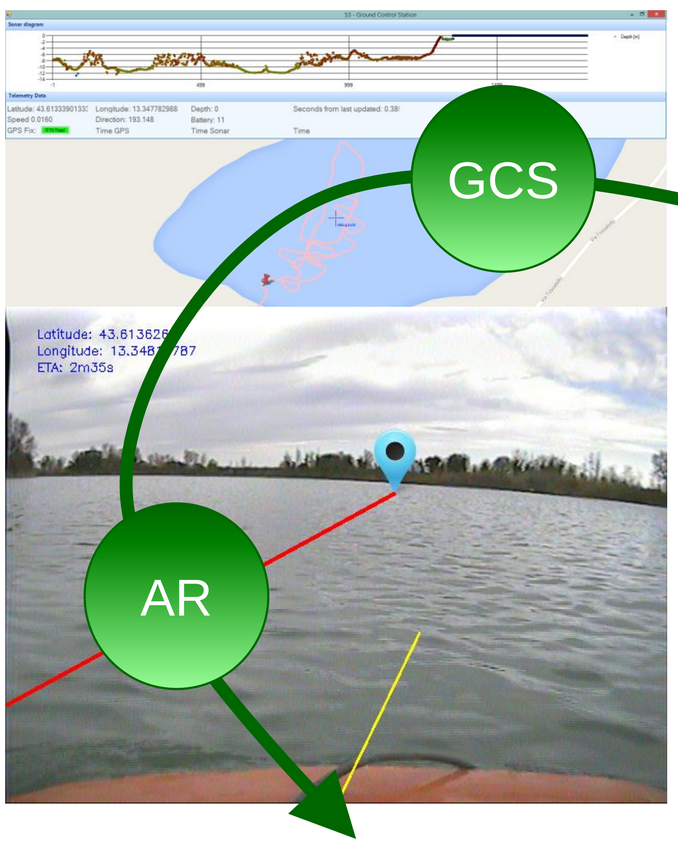
We used a **single RF link** to :

- encode and transmit telemetry data on a custom NMEA-like string;
- transmit the GPGGA NMEA string from the receiver to the ground NTRIP client, interfaced to a NTRIP server;
- receive the RTCM corrections from the ground NTRIP client.

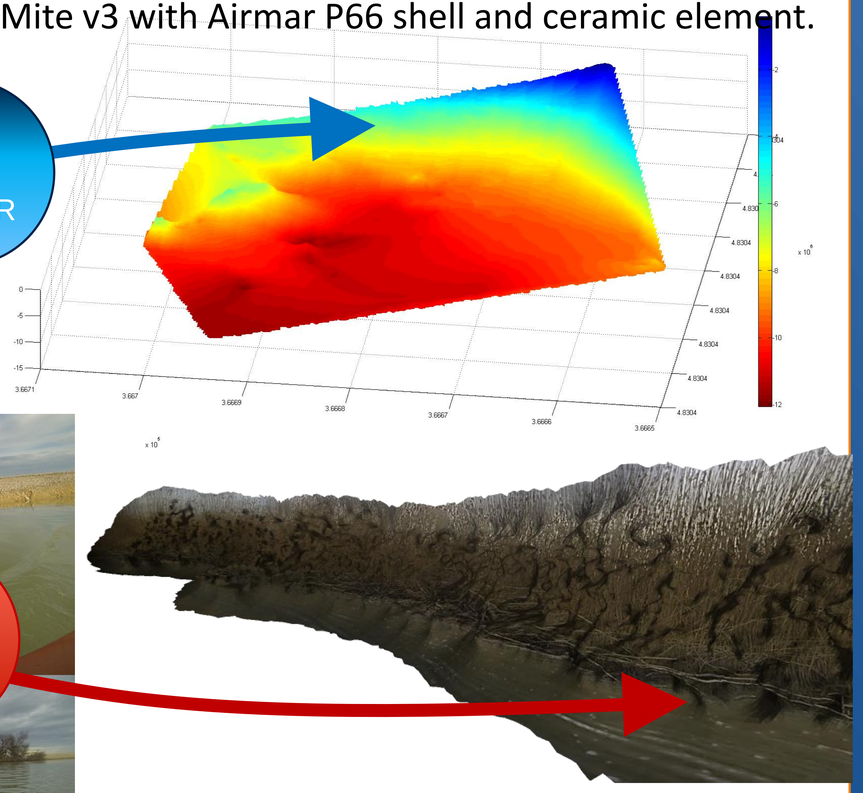


USV@work

Integration of RTK-GPS, echo-sounder for a low-cost sea/lake/river floor mapping.
Telemetry and RTK corrections are transmitted over the same RF link.
Echo Sounder is the Ohmex SonarMite v3 with Airmar P66 shell and ceramic element.



Augmented Reality (AR) app for a Smart control of survey.
The desired waypoint is shown to the user as planned and actual path.



SfM approach to map riverbanks using photogrammetric approach (3D textured DSM)