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Low-Tech Autonomous Boat for Lake Bathymetry Mapping

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Context and Objectives

For many years, the EDYTEM laboratory has been conducting lake sediment coring missions across the globe. In many cases, the bathymetry of the lakes is unknown. Currently, it is measured using a depth sounder mounted on a secondary boat, which requires both operator time and equipment.

During a standard coring mission, there is an unavoidable setup and preparation period for the equipment. The proposed drone allows bathymetric measurements to be carried out during this downtime, making the overall process more efficient. It helps in quickly locating the deepest point of the lake and provides a better understanding of the lakebed topography.

Descriptions

- Boat: 3D resin-printed, low-tech
- 55 × 28 × 16 cm, 2.7 kg, 2 h autonomy (3 km).
- Sonar: Deeper Pro+2 (https://deepersonar.com): 100 m max depth, triple-beam, precision 0.3m.
- Control: Autonomous (predefined GPS route on microSD) or manual via remote.
- Workflow:
  1. Define route in GPS Visualizer and save on microSD
  2. Run mission & record depth data
  3. View first results on Android app « Fish DEEPER »
  4. Post-process bathymetry with QGIS

Operating Principle

The boat operates by reading GPS waypoints stored on the microSD card, which are created using GPS Visualizer (online).

It then controls the motors based on data from the compass and the averaged readings from the three GPS modules.

Depth data management is handled separately, using a commercially available DEEPER PRO+2 sonar and an Android phone installed on the boat.

A Python program compiles the depth data from the Android device along with the recorded route stored on the microSD card.
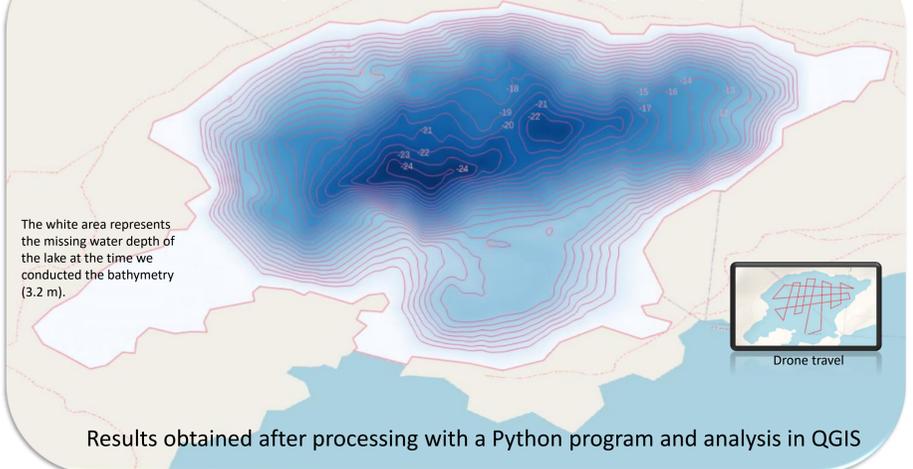
Schematic diagrams

DEEPER PRO+2
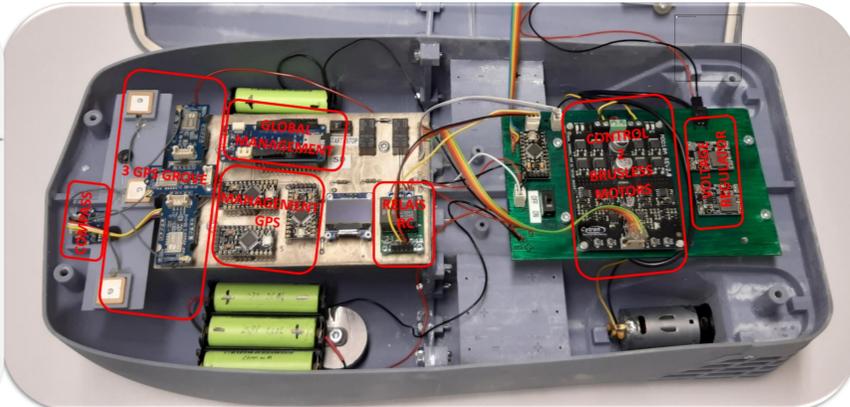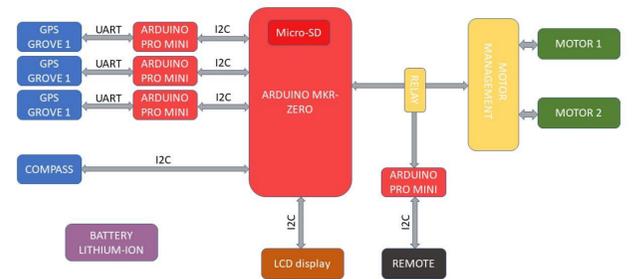
Boat Build

Boat Parts / Hull : 3D resin printing, Anycubic Photon Max 3, ELEGOO ABS-Like resin, about 50 hours of printing, assembly with screws and/or glue.

Electronics : Board 1: voltage regulation and motor control. Board 2: compass, three GPS modules, GPS signal management via Arduino Pro-Mini boards, a relay for manual control, and an Arduino MKR Zero board for running the main program and recording data on a microSD card.

Programming : Three programs uploaded via the Arduino IDE, for remote-control communication management, for GPS signal management and for overall management.

Assembly takes about one week and costs around €700.

First Results
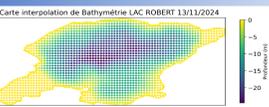
The first tests of the bathymetric drone were carried out on several small lakes. The system demonstrated good navigation stability and autonomy consistent with expectations (≈2 h for a coverage of about 3 km). Depth data collected with the Deeper Pro sonar allowed the generation of a preliminary bathymetric map, viewable directly on a smartphone and exportable for further analysis in QGIS.

The initial surveys showed satisfactory spatial continuity of the measurements and confirmed the drone's ability to identify the deepest areas of the lake. However, these results still need to be compared with a reference bathymetry obtained using a high-precision sonar in order to assess measurement accuracy and reproducibility.

These first results are therefore encouraging and suggest that the system will soon become an operational tool for lake coring campaigns, reducing field preparation time while improving knowledge of lakebed topography.

LAC ROBERT, massif de Belledonne, Isère, France

The white area represents the missing water depth of the lake at the time we conducted the bathymetry (3.2 m).

Drone travel

Results obtained after processing with a Python program and analysis in QGIS

Open Source

Once validated, all files for duplication will be uploaded to a data repository. These files will be available for download for non-commercial use only. The package will include: CAD files (Inventor), STL files for 3D printing, a list of commercially available components, Arduino control programs, the manufacturing procedure, and the user manual. In the meantime, you can contact me by email:
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Conclusion

The drone is designed using Low-Tech principles to allow easy replication. The boat is 3D printable, and the components are standard and widely available. It weighs 2.7 kg, measures 55 x 28 x 16 cm, and has an autonomy of around 2 hours depending on weather conditions, which corresponds to roughly 3 km of coverage. The maximum depth it can measure is 100 meters. This system is well-suited for small to medium-sized lakes.