UgCS
INTEGRATED SYSTEMS

INTEGRATED SYSTEM FOR BATHYMETRY WITH ECHO SOUNDER

SYSTEM DESCRIPTION

UgCS Integrated Systems is a product of SPH ENGINEERING
SMART PLANES & HELICOPTERS

integrated.ugcs.com

INTEGRATED SYSTEM FOR BATHYMETRY

Bathymetry is the measurement of the depth of water in oceans, rivers, or lakes. The standard measurement tool for bathymetry is echo sounding, and the survey process involves the use of a ship, boat or unmanned surface vehicle (USV) as a platform for the sensor.

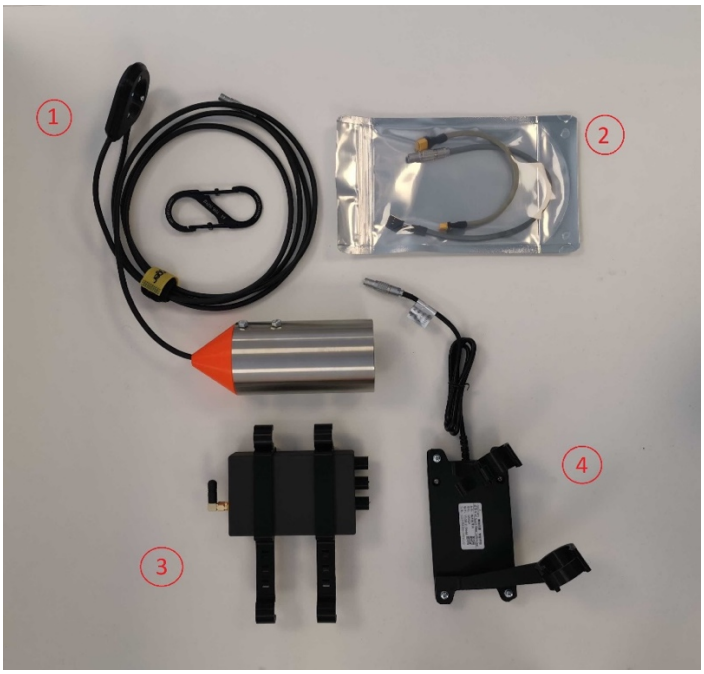
Sometimes, the use of a boat can be complicated, especially in the case of small or hard to reach rivers and lakes. The use of USV is not feasible in every situation either. Firstly, it is necessary to have a good point of entry to the water for deployment/recovery. Secondly, it may be impossible to use USV in shallow lakes with lots of seaweed. Last but not least, in many cases, USV should be big enough to resist the waves and a big car may be necessary to transport it.

An alternative is to fly a drone (UAV) to carry the echo sounder. A drone is compact and easy to transport and deploy. Drones also have a high precision of following planned survey lines and can be used in any place where there is at least a small area for take-off and landing near the surveyed water surface.

The integrated drone system for bathymetry includes:

- A commercially available drone like DJI M300 RTK, M210 or M600 Pro (as well as drones based on the Pixhawk autopilot)
- Echo sounder sensor on a rope (cable)
- Radar altimeter to measure the precise altitude of the drone over the water surface
- On-board computer to control the mission and store geotagged measurements
- Software to control the mission

Below is the photo of full set for DJI drones.



1 – echo sounder with stainless steel protection housing, cable, hook and carabiner to attach sensor to the drone

2 – cables set

3 – UgCS SkyHub onboard computer

4 – radar altimeter with mountings for the drone.

THE SENSOR

There are 3 options of the single-beam echo sounders (please see the table below). All sensors manufactured by Korean company EofE Ultrasonics Ltd. (https://www.echologger.com/), specialized in survey-grade sonar products.

All echo sounders equipped with integrated tilt sensors allowing to reject data when sensor attitude is not close to vertical, and temperature sensor.

Nominal accuracy of all echo sounder models is 0.2% of the depth, resolution is <1mm.

Sensor	ECT 400S	ECT D052S	ECT D032S
Type	Single frequency	Dual frequency	Dual frequency
Acoustic frequency	450 kHz	50/200 kHz	30/200 kHz
Measurement range*	0.15 … 100m	1.0 … 200m (50 kHz) 0.5 … 200m (200 kHz)	1.0 … 200m (30 kHz) 0.5 … 200m (200 kHz)
Beam width Conical (-3dB)	5°	27° / 7° (50 kHz/200 kHz)	26° / 5° (30 kHz/200 kHz)
Weight of the echo sounder (in the air)	275g	460g	460g
Weight of all components in the air (echo sounder, SkyHub, altimeter, housing, cables, mountings)	1.6 kg (light housing) 2.6 kg (heavy housing)	2.7 kg	4.2 kg
Suitable DJI drones (or Pixhawk drones of comparable size)	M210 (light housing) M300 RTK M600 Pro	M300 RTK M600 Pro	M600 Pro

(*) Measurement range is from the bottom of transducer. The practical minimum depth is around 15cm deeper because the sensor should be submerged during measurement.

The sensors use the RS232 interface to provide robust data transmission via long cable.

ALTIMETER

For precise depth measurements (and for the safety of the drone) it is vital to control precise altitude over the water's surface.

We use a high-frequency radar altimeter and a special terrain (surface) following algorithm to keep the altitude of the drone constant during automatic survey missions.

ON-BOARD COMPUTER

The heart of the integrated system is UgCS SkyHub – a small and powerful onboard computer with special software.

The first function of this onboard computer is to maintain a constant altitude of the drone over the water surface using data from the radar altimeter. Standard DJI drones do not have such function and rely on a barometric altimeter for altitude control. Unfortunately, it is not a precise sensor and altitude drift per single flight can be up to several meters. With a radar altimeter, on the other hand, the drift of flight altitude is about 5 cm.

The second function of the onboard computer is to store echo sounder measurements in geotagged form. To geotag data, the UAV's GPS receiver is used. If the drone is equipped with an RTK/PPK receiver, data points will have coordinates with precision down to centimeters.

Measurements are stored in three formats:

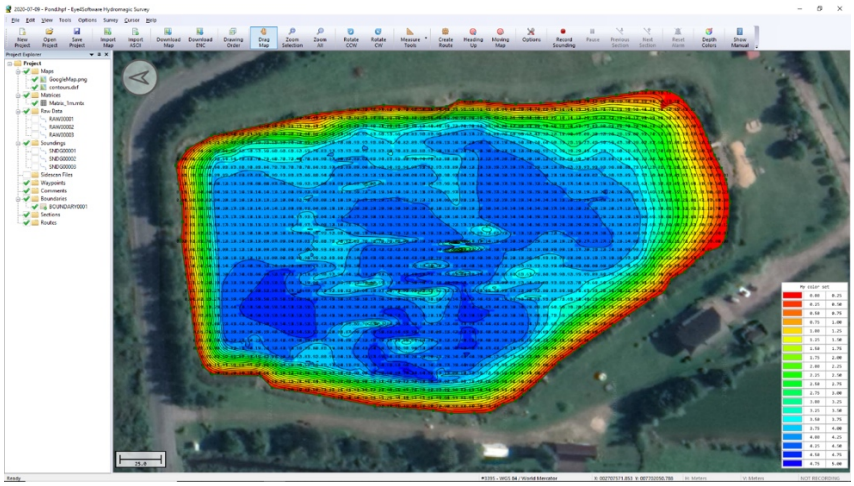
- simple textual CSV format with coordinates, depth and additional information allowing the import to a variety of software capable to process XYZ data (Surfer, Oasis Montaj, Excel),

- NMEA 0183 compatible with popular hydrographic software (HydroMagic, Reefmaster),

- SEG-Y with full echo sounder data.

In addition to depth measurements, water temperature and tilt angles of the sensor are logged.

Sample of a colored depth map, data processed in the HydroMagic software:

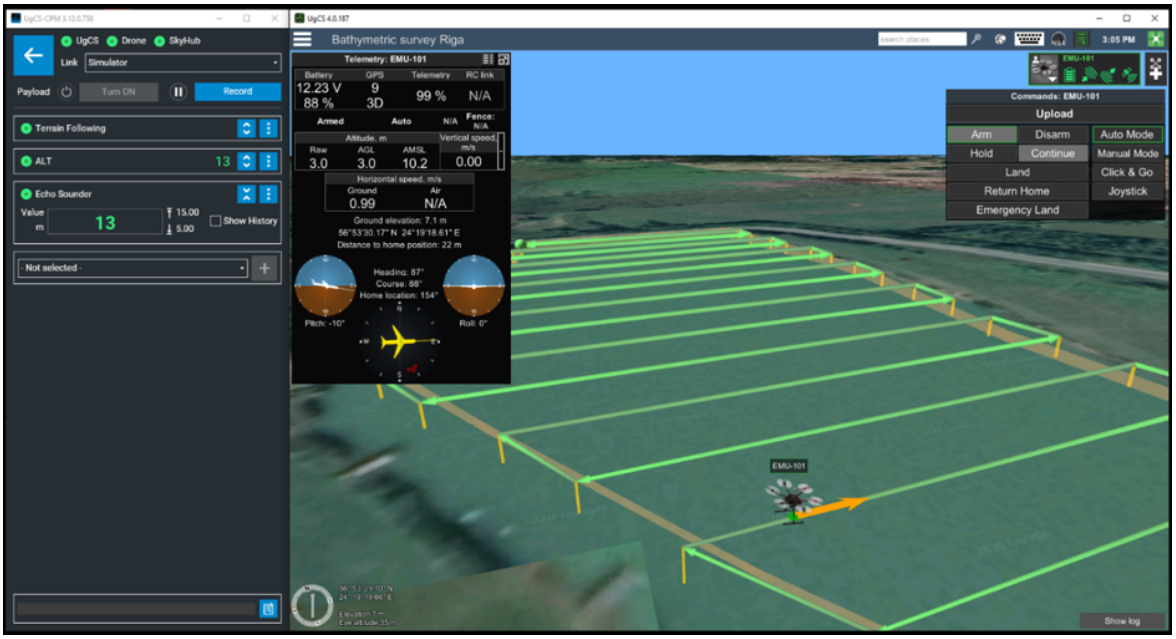


Data logging begins automatically when the echo sounder is submerged and stops when the sensor is in the air again.

The onboard software also sends current depth measurements to the ground station allowing the operator to make sure that everything is functioning as it should and to make manual measurements (when the drone is not on an automatic mission).

GROUND CONTROL SOFTWARE

The ground control software is UgCS with the additional companion application that controls the echo sounder. During the flight operator on the ground can see current depth measured by echo sounder.



USAGE SCENARIOS

The integrated system supports 3 modes of operations:

- continuous measurements along survey lines;
- measurements in specified waypoints;
- manual measurement.

In the first case, the drone operator should plan missions with a survey grid (or separate lines) over water. When sensors are submerged underwater, data logging will start automatically.

The drone will tow the submerged sensor on low speed (0.5 – 0.7 m/s) and perform constant depth measurements.

In some cases, continuous measurements cannot be done, for example, if there is a lot of seaweed in the water.

In such a case, the operator should plan a grid over water and set waypoints where it is necessary to make a “shot”. The drone will fly between waypoints, descend to required altitude to submerge the sensor, make measurements, ascend to a safe altitude and move to the next waypoint.

Video of the lake survey near Riga - https://youtu.be/Xq3CfSbj65o

Video of surveys in Israel - https://youtu.be/LN1ybqPMJ3A

Data sets - https://files.ugcs.com/s/t67bWmaEjG6nDD6