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Development of a low-cost multi-sensor platform for recording shallow water depths

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Many sailing and surfing hobbyists are interested in collecting depth values during their trips and sharing those. For enabling hobbyists to collect bathymetric data the creation of a multi-sensor platform is the focus in this paper. It should be able to measure autonomously shallow water depths with its low-cost components. The connection to OpenSeaMap should also be provided.

Accuracy and instrumentation requirements

In order to succeed in building a low-cost measuring platform, the accuracy requirements need to be specified. In addition, it is examined which sensors and requirements from OpenSeaMap have to be met with the measurements and data through crowdsourcing. It is determined that for a working system an echo sounder, a GPS receiver, a motion sensor and a data logger are necessary for enabling the supply and usage of sufficient data to OpenSeaMap (see figure 1).

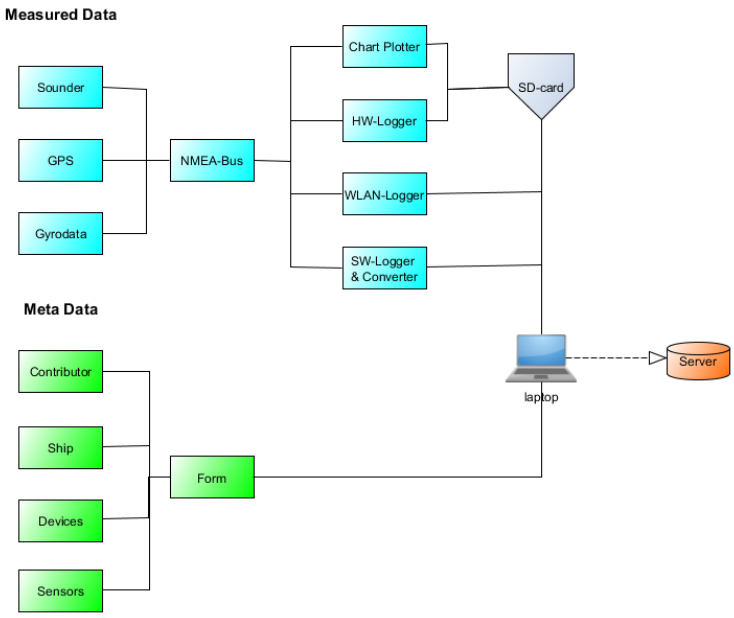

Figure 1: Overview of all devices and information needed for OpenSeaMap

After the data has been recorded and compressed by a logger, the data is loaded onto the OpenSeaMap server via the web client. Thereon the processing of the data by OpenSeaMap begins. If the data is sufficient, OpenSeaMap correct the wave, the tide, according to the sound velocity in water, the ship's motion and the quality of the data. The last step is the calculation of depths and depth contours.

Market analysis

A market analysis deals with possible sensors that are available in the low-cost area at the time of the analysis and gives an indication of the devices used in the following steps.

The main devices are the platform of the measuring device, a standard body-board, the OpenSeaMap data logger with an integrated motion sensor, a fish

finder of the company Lucky and a GPS antenna of the company U-blox.

Assembly of sensors

The next section is the practical work. The combination of the sensors and devices, as well as the accessories, are very experimental. Problems are described and how they can be handled and remedied, so that the wiring of the sensors and interfaces is successful. Before connecting the GPS and the chosen fish finder some settings must be made and the fish finder signal must be received, decoded and transmitted in the NMEA-0183 format to the logger. This signal is converted into depth values by the use of an Arduino (microcontroller) and transferred in the NMEA format. After preparing the instruments, they can be assembled.

The connection to the data logger is done via a patch cable. The different cable colors indicate the device. But before the devices can be easily connected with each other, it is still necessary to check weather the connections really fit. Therefore two interface standard converter are also used.

As next step, the instruments were integrated into a water-tight box so that nothing can move and nothing can get wet. In addition, a 12 volt battery and a simple on / off switch were installed. The various current voltages could be achieved by step-down converters. Figure 2 shows this assembly in detail.

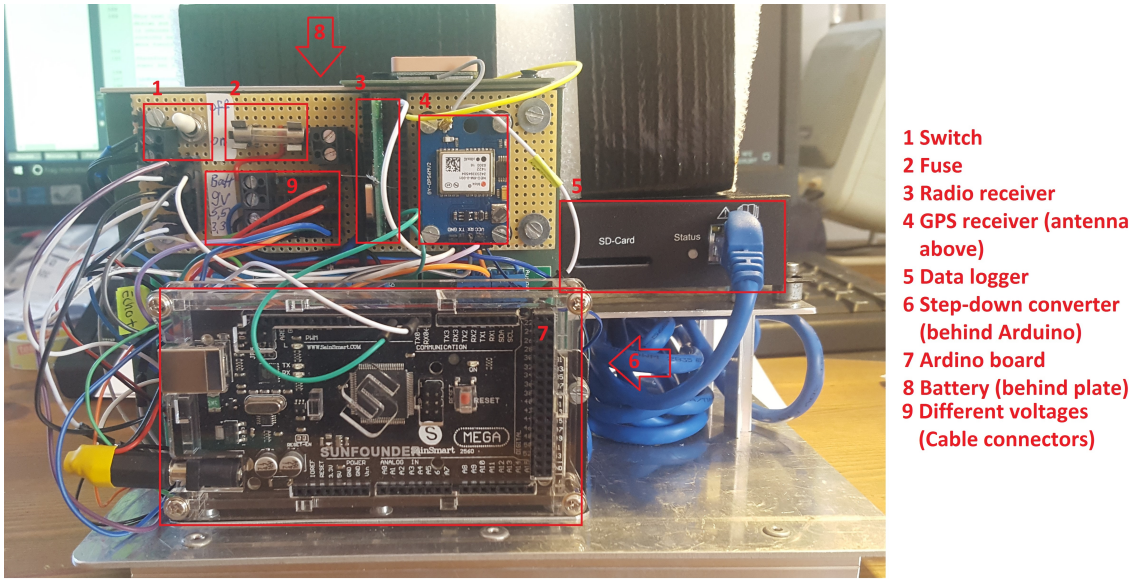

Figure 2: Complete construction (inner workings

The plastic box is attached to the bodyboard with the help of a belt and matching slots in the board. In addition, angles are attached to prevent slipping of the box in case of possible waves or other turbulences.

The next step is to place the fish finder on the bodyboard, so that it cannot fall off, float or move on its own. The board and the fish finder have to do the same movements, because the motion sensor should be able to records the correct data for the fish finder. In addition, it should be noted that the fish finder is in contact with water. This means the waterline of the bodyboard should match that of the fish finder. For this, the fish finder is first mounted on a fibre glass compound and epoxy resin plate with the help of a suitable cutout and a fishing line. The plate itself is mounted on a small metal plate. By a slot in the bodyboard and another equal sized metal plate the fish finder could be attached to the stern side of the board.

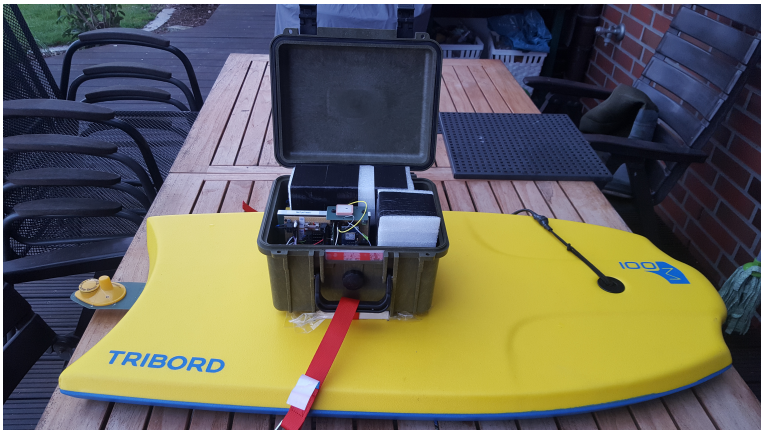

Figure 3: Complete construction

Now, all the sensors are mounted to the bodyboard and the ship alignment and a test run can take place.

For this test, an area of a 2,0 meter deep pond is chosen. Therefore the power battery was switched on and the bodyboard with the sensors is dragged over the water surface for two and a half hour. The measured data can be uploaded to the OpenSeaMap server. After the account creation the form for describing the vessel and its sensors must be filled out. Then the data can be easily uploaded. The test revealed that the measuring platform itself works and also gives correct data and is therefore a good feasibility study.

Unfortunately, it also turned out that not all results are correct. In some places it is noticeable that the fish finder measures the depth irregularly. In some places, depths are logged directly two times consecutively and at other time sections the depths are completely missed out. This can be because the signal is not received accurately enough by the receiver and thereby the decoding is prevented, or the sensor itself could not measure the travel time of the echo.

In the course of the work it came out, that the fish finder with its inaccurate way of measurement remains a problem. If the possibility exists to be able to invest more money, a better and more accurate echo sounder should be used and tested.


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