Integrating open hardware and software: An ocean drifter prototype

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Drifters have been traditionally used on the study of marine currents in order to better understand local and global circulation patterns. This work describes our work in the design and test of an ocean drifter prototype for measuring environmental parameters. Currently, our drifter prototype is able to transmit its location at regular intervals to a mobile device located at the coastline. The drifter data processing unit was build using an open hardware microcontroller-based board along with off-the-shelf low-cost hardware modules for GPS data acquisition and transmission. A mobile version of Quantum GIS open source software was extended for real time visualization of the drifter location and data logging on a mobile phone.

Besides the use of open hardware and software, the modular design of our drifter allows the addition of sensors using simple serial communication interfaces. Moreover, several drifter can form a mesh network to extend the communication range. The development of the prototype was divided into two phases. The first phase consisted in the design and implementation of the drifter core features using open hardware and software tools. In a second phase, several sensors will be integrated and visualization extended to environmental data. This work focuses on the first phase of development.

Our system has two components: the data processing unit and the visualization software. The data processing unit was built using the following devices: Arduino Duemilanove board with the microcontroller Atmega328, the UC430 GPS receiver with a position accuracy of 2.5 m., and the 900 Mhz. Xtend long distance radio module. Both GPS and radio devices use serial data communication which makes data exchange with the arduino board straightforward. The GPS device has ultra small form, low power consumption and an embedded antenna. In our prototype, an external GPS active antenna was used to improved satellite signal detection. The Xtend radio module uses the 802.15.4 communication standard protocol, it has 1 Watt power output and a range of 11 km (outdoor, line-of-sight). The Xtend device can work in different configurations: point to point, point to multipoint and mesh network.

The visualization software was designed to run on mobile platforms instead of a rugged and more expensive computer. A mobile version of Quantum GIS was exploited for map and drifter location rendering. To collect the drifter generated data a Xtend radio module was connected to a phone running the android operating system. This operating system does not support usb-serial data communication, therefore we recompiled the android kernel to enable FTDI support. The FTDI kernel module allows any process to use the usb port as a serial interface. Since the Xtend module comes with a FTDI chip, no additional board is needed to add radio transmission capabilities to the phone. A plugin for Quantum GIS was developed, this allows to send and receive data from the drifter while looking at the map.

The proposed system works as follows: (1) The software sends a command to start/stop the drifter data transmission, set the intervals for data transmission, request historical data, and turn on/off the GPS module. (2) The data processing unit collects GPS data at intervals from 1 second to 1 hour, we set it to 10 seconds for our experiments. A copy of the data is stored in the Arduino board non-volatile memory. (3) The data processing unit sends the drifter location through the Xtend module. (4) At the coastline, visualization software reads data from the radio plugin asynchronously. Then, it plots the drifter location in a map and sends a copy to the cloud using a web service, if an internet link is available.

The prototype was tested near San Pedro, a small town at the Ecuadorian coastal region. The data processing unit was placed into an underwater capsule and released at different locations. The capsule

showed a good hydrodynamic performance, however additional work is needed to guarantee the continued use of this structure. Our experiments showed that the drifter location can be accurately retrieved within a range of 4 kilometers from the mobile station. For longer distances, the data packets loss occurs. The main reason is the absorption of signal power in aquatic environments.

In this work, we demonstrate how open source tools can be integrated and combined to build a data collection system to support marinel studies. The applications of the proposed device are not only limited to the study of marine circulation patterns as assessed in the present study. The proposed modular design allows geo-referenced data gathering and transmission for inland applications with minimal changes in the prototype components. A possible application is hydrometeorological/environmental monitoring in remote areas or rivers.