Performance and security improvements in AUV surveys using RF modules

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Abstract *– Autonomous Platforms Department of Marine Technology Unit (UTM-CSIC) owns two portable AUV with water quality and imaging configurations that at the moment only have been used in shadow waters for safety reasons. To be able to operate these vehicles further off shore or out of line of sight and improve overall safety this department is developing a RF system to localize this vehicles where GPRS coverage is not available. RF system is been developed taking into account and exploring future usage of this kind of communication during campaigns in case of emergency or even to reconfigure deployments on board.*

Keywords *– AUV, RF communications, development, UTM, CSIC*

I. INTRODUCTION

Autonomous Platforms Department of Marine Technology Unit (UTM-CSIC) currently owns two portable AUV with quality water sensors and side-scan sonar configurations respectively and is the newest established department in this service unit. This group is responsible of their maintenance and operation in scientific surveys where they are required but also are able to design software, hardware and structural improvements using these vehicles also as testing and developing platforms. Current development is focused on adding newer sensors according to users needs and interests or to improve vehicles operability and safety during campaigns.

Until now, these vehicles have only been used in coastal surveys because of possible safety issues that can occur during operations where current security systems are not really reliable at open sea. Part of actual localization system is based on GPRS and their tracking is limited only to areas with cell phone coverage, usually only tens of kilometers from coast. For this reason, and in order to operate such vehicles out of GPRS coverage it would be necessary to add a reliable short-medium range tracking system in open water.

New tracking system based on RF is been developed to receive vehicle position in real-time and to be easily expandable allowing future bi-directional communication and monitoring during surveys and other features.

II. SPECIFICATIONS

Coastal AUV surveying area rarely is bigger than 1 km^2 because of platform autonomy and survey normal path (usually a grid) as well. Then, in order to assure full coverage in offshore any communication system should have at least a minimum range of 2 km but with a 5 km as a desirable coverage safety range.

Dimensions of the transmitter installed inside the AUV, its weight and power supply are also limitations to take into account in the system and technology choice. Taking into account all this characteristics two different kinds of modules have been considered:

Xbee-PRO 868MHz OEM RF Modules: their main advantages are their reduced dimensions, low power consumption and cost (about 300€ entire system). It's wide used in low-cost wireless applications based on Arduino boards [1].

FreeWave Industrial Radio Modules (869MHz): much more expensive option (about 3.000€ entire system) but commercially tested and used in similar platforms. Its power consumption is also higher than Xbee modules and its mechanical integration is more complex but it still can be fitted into our vehicles (Iver2 with optional compartment for development).

III. EARLY DEVELOPMENT STAGES

These kinds of devices are not really developed for marine applications and usually data sheet theoretical coverage ranges differ from real performance because of usage scenario itself: communication is not between two fixed points, antennas couldn’t be as far from surface that they should and sea water is heavy attenuator of RF communications. Then, testing this kind of devices in a more realistic environment is necessary to determine a real operational coverage range.

Tests were performed in a flat area with identical proceed and consisted in a simple device confined in a box

in movement sending NMEA strings with its position every 8 seconds to a computer placed in a fixed station. Simulated AUV position could be monitored in real-time using a software in Python at the same time that all information received were stored and range test were repeated several times for both technologies. To make more accurate the comparison between the obtained results most of the components where the same in the two different kind of tests and was easy to swap between RF technologies. For example, GPS source was the same in all tests and antennas used had the same characteristics (2dB omnidirectional).

Comparing both technologies the poor Xbee system performance when antennas haven't direct view between them has to be mentioned as well its weakness against ground bounce loss. Otherwise, Freewave communications easily reach 1 km. distance without any significant signal loss or errors in NMEA sentences. In Fig.1 the maps obtained during coverage tests in the surroundings of the Olympic channel in Castelldefels are shown.

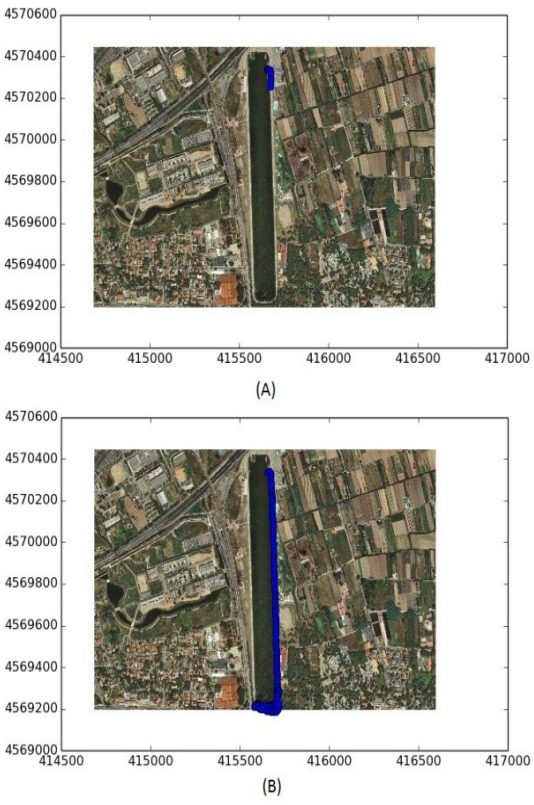

Fig. 1. Comparison between Xbee (A) and FreeWave (B) coverage range performance.

After those first tests similar experiments have been repeated in Barcelona seaside in a bigger flat area than in Castelldefels. In that case GPS signal could be received between points separed more than 2km. This distance had been reached without viewing increased the number of packets lost or with errors (about 1%) and only had real coverage problems closer to areas with buildings.

Observing the clear differences in performances between Xbee and FreeWave the department focused to install FreeWave RF system in one of our vehicles.

IV. CURRENT DEVELOPMENT

Once Xbee option had been rejected for our purpose, Freewave became the technology chosen to introduce in our vehicles. In that way, we could repeat coverage tests in more real conditions and environment.

Fig. 2. External view of Freewave system installed in AUV.

For this purpose only some minor modifications have had to be done and mostly of them related to new wiring. Emiter can we powered directly from Auv power system and module can be connected to secondary CPU that our vehicles have for developing purposes throw serial ports. Main advantage of having this second CPU is that all testing functionalities can be controlled by this extra CPU without interference the usual performance of the vehicle.

Finally an antenna used during previous tests has been covered with resin to be able to support pressure and at the same time to be waterproof.

As Fig. 3 shows the longitude of this antenna is about 25 cm. to minimize coverage loss in wave conditions without to interfere with other communications used by the vehicle.

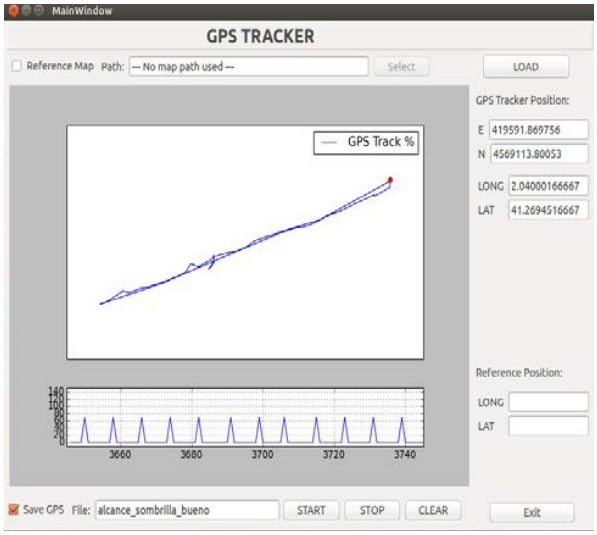

Fig.3 RF communication GUI screenshot

At the same time a better version of user interface has been developed to control RF communication and plot in a map the data received related to AUV position as we can seen in Fig.3. This will be an essential part during real surveys to have a visual reference of vehicles position all the time.

Unfortunately, in recent deployments the system coverage range doesn't exceeds 1,5km. that provably is the result of new wiring and the incrementation on number of connectors and cables length.

For this reason actually we are working in more directive configuration antennas and testing all AUV internal connectivities to try to improve this results in next months.

REFERENCES

[1] Digi International Inc. (2009) "XBEE-PRO® 868 Range Validation" (White Paper).