ID31- REVIEW OF LESSONS LEARNED AFTER FIVE YEARS OF SHALLOW WATER AUTONOMOUS UNDERWATER VEHICLES (AUV) OPERATIONS

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Abstract *– The Unidad de Tecnología Marina (UTM) acquired in 2010, due to the wide scientific requirement to obtain high quality images of the seafloor, a couple of AUV´s for shallow waters applications with the aim to support marine research operations in coastal waters. The vehicles has been used as a routine science vehicle but also for technical development. During these years a valuable experience has been gained for future operation on either, coastal and open waters with new and more performant platforms.*

Keywords *- AUV, marine research*

I. INTRODUCTION

The Unidad de Tecnología Marina (UTM. CSIC) after listening to the scientific requirements, decided to set up a department devoted to the newest imaging sea technology concerning the Autonomous Platforms with several objectives. • First the acquisition of two generic well proven AUV´s for shallow waters operations mostly at coastal areas. • Gather technical and operational experience with issues related with the submarine vehicles and to study the feasibility of using them on board the vessels managed by UTM. • Provide support to scientific research using the vehicles as sensor platform, integrating new sensors if needed. During these years these technical objectives are somehow fulfilled, and additionally valuable lessons learned on operations and sensor were accomplished to build a long term strategy for future operations.

II. REVIEW OF OPERATIONAL ISSUES.

The natural operational environment for our vehicles is shallow waters, i.e. ports or coastal areas. These coastal environments involve certain operational risks, therefore we have developed a specific protocol to minimize risks, although risk zero doesn't exist, and by applying these procedures we have been able to recover our vehicles every time we have had a high-risk situation.

This protocol encompasses three phases:

• Information. Study of potential risks and adaptation of the mitigation protocol to the mission

• Planning and execution of the mission applying the risk mitigation protocol

• Analysis of the mission and update of the mitigation protocol if needed.

Fig 1.- Ecomapper grounded after an emergency mission was started. Alfacs, 2012.

Our experience with this simple protocol works correctly, and all the parties involved on our AUV operations have been satisfied with the implementation. However, this is a dynamic process and continuous adjustments are necessary in every new survey to improve it.

In addition to our experience in coastal waters with AUV's, our normal operational environment is on board oceanic and global research vessels. Thus, in recent years, several cruises with Deep Remoted Operated Vehicles (ROV's) and AUV's have been done on board vessels BIO Hesperides and BO Sarmiento de Gamboa and a considerable experience has been gained on the setup and operation of such platforms. So the UTM already has the technical and operational expertise to take the full responsibility for the integration of sensor in whatever operations using Deep sea vehicles.

The main reason that UTM has been unable to operational respond to the scientific demands is the substantial reduction in R&D funding scientific projects and investment in new marine platforms. Therefore, we have opted for small UAVs that are more suitable for low-cost science on coastal waters but this advantage is slight when the number of projects (specially the small / cheap ones) drops by the lack of funding.

An extra effort on outreach and information had to be done to make the platforms and its potentialities known. Thus only few research groups had been actively interested on the use of the vehicles for the active projects and certainly more can be done on this area.

However, there are positive signs: an increasing number of research projects (presented at National and European level) which demands the use of AUV's and / or ROV's and it seems that a confidence build up is starting inside the scientific community. .

III. DEVELOPMENT

Development has been another of our main targets; in this case, focus has been put on the operational aspect of the AUV. Our main concern is related with safety, mission control and sensor integration and these has been the main zones where we start working on hardware and software solutions. Given the costs and time constraints on sensor development, we have focused on hardware development in small sensors integration, adding commercial sensors (Ecopuck, radio-modems) to the original vehicle frame, either, inside or outside the vehicle's setting.

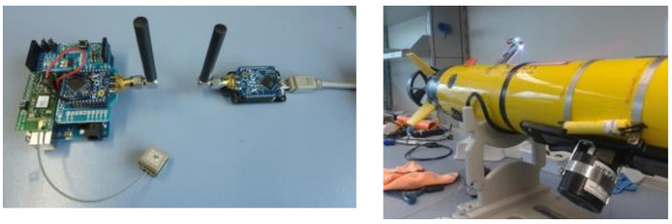

Fig. 2. Xbee (left) and Ecopuck (Right) sets installed on Iver2 vehicles

GPS-trackers have been valuable assets for safe recovery of stranded vehicles when an emergency arise, we have developed different Delrin/ABS containers to install such devices on top of our vehicles, although outside GPRS range these devices doesn't work. For this reason we have started the development of radio-modem, based on XBee®, which, besides knowing the location of the vehicle, will allow us to have fully control of vehicle status and main functions.

Once implemented we will be able to monitor the vehicle status, download data during the mission to make a quasi-real time assessment of a particular process and modify and upload a new mission if necessary. We also have successfully integrated an Ecopuck Triplet on our vehicle, demonstrating the feasibility to integrate small sensors thanks to the vehicle's Open Architecture; the sensor was installed at the bottom of the vehicle and connected to the auxiliary CPU via serial line.

Our vehicles have installed a Nortek 1 Mhz DVL with profiling option and we are investing some effort to gather useful current data with this sensor

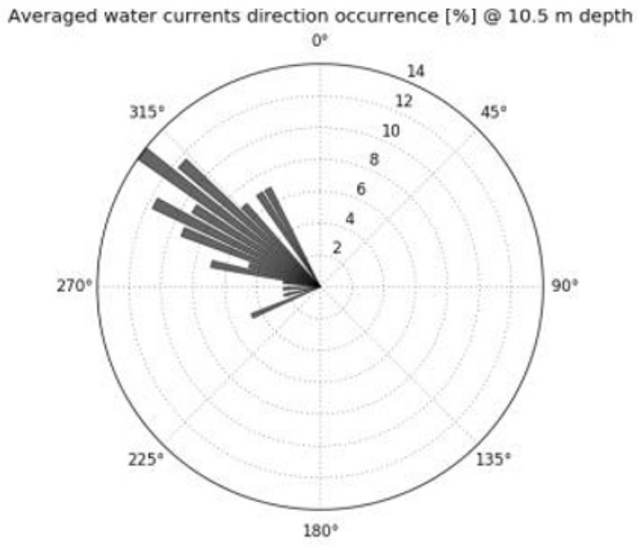

Fig. 3. ADCP Current polar plot of a transect.

For all our developments Python has been the standard programming language, we have used it to program different scripts (automatic report generation, navigation processing, ADCP, data comparison, etc.) for either, real time applications or processing.

IV. CONCLUSIONS

The economic crisis has put serious constraints to the Spanish scientific research in most fields, marine research operations and investments on new technologies have been affected as well, but the relative small operational cost of the vehicles has allowed us to continue operating at small scale and gather experience on a field that should represent an key part of future our marine research operations in all kind of platforms (regional or global) as it is now in other agencies. Despite the work done, additional effort is needed to integrate AUV's and ROV's as regular scientific platforms, integral part of bigger assets which will contribute to enhance our knowledge and supporting of the marine environment research.

REFERENCES

[1] Rodríguez, P., Pujol, N., Piera, J., New lightweight AUV at the Spanish Research Council, 4th. Intenational workshop on Marine Technology MARTECH, 2011.

[2] Pujol, N. and Rodriguez, P., Performance and security improvements in AUV surveys using RF modules, 6th. Intenational workshopon Marine Technology MARTECH, 2015.

[3] Cusí, S., Pujol, N. and Rodríguez, P., A Python tool for AUV-borne ADCP current data processing. 6th. Intenational workshopon Marine Technology MARTECH, 2015.

[4] Cusí, S., Roque, D. and Rodríguez, P., Performance of an Autonomous Underwater Vehicle-borne Acoustic Doppler Current Profiler. Proceedings IEEE Oceans, 2015.

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