ELECTRONIC DESIGN IN A LOW COST AUTONOMOUS VEHICLE FOR COASTAL SEA MONITORING

M. Martínez Ledesma, B. Garau Pujol, D. Roig Broman,
A. Alvarez Diaz, J. Tintoré Subirana

Instituto Mediterráneo de Estudios Avanzados (CSIC – UIB)
C/Miquel Marques 21, 07190 Esporlas, Islas Baleares, Spain
+34 971 611 838, miguel.martinez@uib.es

1. Introduction

Several platforms are implemented in order to obtain physical, chemical and biological variables of coastal marine environment but with limitations. Traditional methods such as oceanographic ships do not provide the necessary spatio-temporal measurement resolution because of its high operation cost, moorings do not provide enough spatial data resolution, and new years technologies like Autonomous Underwater Vehicles (AUVs) and Autonomous Surface Vehicles (ASVs) have a very high economic cost.

In order to solve limitations of those technologies Autonomous Hybrid Vehicle (AHV) technology has been developed, hybrid between AUVs and ASVs [1]. This technology aim for make a cost effective ocean observing platform that moves at sea surface to designed positions previously established by a plan, and makes dives to capture the vertical profile of the water columns capturing the desired variables. AHV surface movement behaviour allows satellite based positioning, avoiding use of expensive inertial navigation systems and allowing simpler electronic and movement control algorithms.

The objective of this project is to develop a AHV technology based autonomous vehicle for coastal marine environments. The fact that the marine environment is an extremely dangerous and complex system implies that the design of this platform has to be as robust and simple as possible, in order to keep it save in all kind of situations.

2. Results and Discussion

AHV3-Cormoran prototype is a 1440 mm length, 160 mm diameter, 530 mm total height, and 25,4 Kgr weight platform that can rise a maximum depth of 25 meter at 0,5 meters per second sinking speed and 1,5 meter per second lineal speed with a turning radius of 6 meters. This platform uses propeller and rudders behaviour to move on surface, and a piston to sink (static immersion). In order to add more security a double hull is implemented to avoid great damages if external hull has escapes.

A first version of the prototype's electronic was made using RF radio link control in order to manoeuvre the platform in a real marine environment, take constants for a future control, and test movement and pressure security. To make it there was developed a microcontroller board connected to a low power RF radio modem, two servos to control the yaw and pitch rudders, a commercial motor controller board to control the propulsion rudder, and another motor to control the piston position.

Once when experimental tests [2] were done with the vehicle described on radio link mode with positive results, a second electronic design was developed in order to add navigation control algorithms and sensors.

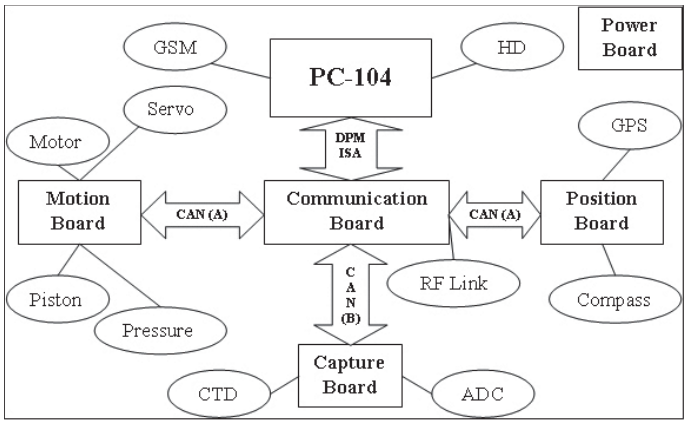

Figure 1. Schematic of Electronic developed in AHV3-Cormoran.

This new design was developed making a functional division that gives an easy adapt to future prototypes, constant increase of capacities, and robust and easy to develop system (Figure 1).

In this design the different types of sensors (position of the platform and scientific sensors) and actuators are separated in three boards. These boards are Motion Board to control actuators of motor propulsion commercial board, servo controlled rudders for yaw and pitch, and piston control (including pressure sensing), Position Board to capture GPS and three axis electronic compass, and Capture Board to capture CT (Conductivity and Temperature) sensor and AD converter of seven channel and eight bit resolution.

Because of low space and power limiting values intrinsic to the design, we decided to use a PC format PC-104 model Geode GX1 266MHz processor, with 128 MB RAM. Done by the fact that all the electronic has to be inserted inside a hermetic hull, it was needed to use all the electronic capable to resist high temperatures. In order to minimize this effect the chassis where the electronic is container is mechanically connected to the external aluminium tube 5mm thick 85 cm length in contact with water.

In order to connect the before mentioned boards, there was developed another board called Communication Board that is connected to those boards using two 500Kbps CAN buses (one of them designed to be used with the sensors and the actuators, and another to the scientific sensors and future boards). This board is connected too to a low power RF modem (at 19200 bps rate with a maximum range of 150 m), and to the PC-104 using double port memory mapped into the PC ISA bus.

The fact of use a double port memory over ISA bus adds communication transparency to the PC code accessing the data as RAM memory. In order to avoid collision of data in the memory seven hardware semaphores are used, one for each memory blocks, related to every device (sensor or actuator).

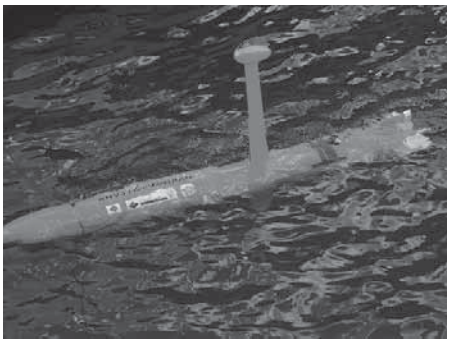

Figure 2. AHV3-Cormoran test at sea

All the electronic is powered using a 5 Volts 15 Watt maximum DC/DC converter. The actual two NiCad battery packs installed in the vehicle give energy of 10A hour at 12V DC. This means that the vehicle has about 2 hours navigation autonomy, 15 hours immersion and measuring autonomy, or a combination of them.

In the software point of view, a driver has been developed to access all the capacities inside the ISA double port memory, a test program (to test all the capacities separately), and the main control software that can access a GSM/GPRS modem connected directly to the PC-104 in order to control the platform remotely and send the data obtained. It has been developed for a 2.4 kernel of Linux O.S. and capable for 2.6 using Posix standard.

Security algorithms have been developed in all the boards and PC main control algorithm. Piston and pressure security is implemented inside the Motion Board using pulse control timing to avoid maximum motor piston pressure (when reached the piston motor is pushed at full speed to expulse all the water inside it in order to emerge to surface).

Finally, the data obtained from the platform is sent as fast as possible in order to add operational oceanography capacities. GSM/GPRS and radio link technologies is been used because of their viability in coastal environments avoiding expensive satellite communication systems.

3. Conclusion

Experimental tests (Figure 2) have been conducted with the platform described using control program connected to radio link modem and GSM/GPRS modem with positive results. Future tests will be done in order to improve control algorithms and to prove the platform in all kind of environments.

Doing by the fact that the electronic design has been done modular, new improved mechanical designs can be developed with few changes in the electronic part. Because of the extension capacities added like second CAN bus, double port memory separated blocks, and analog sensing, future sensors and boards can be inserted easily in order to improve the platform.

4. References

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OBTAINING TURNING CIRCLES OF AN AUTONOMOUS HIGH SPEED CRAFT MODEL WITH A WEB-WI-FI PLATFORM

F. J. Velasco (1), E. Revestido (1), E. López (2), E. Moyano (3) and L. A. Esquibel (4)

1 Dept. Electronics Technology and Systems Engineering and Automatics, E.T.S. de Náutica - C/ Gamazo 1- 39004 Santander (Cantabria) SPAIN, 942 201368
velascof@unican.es, revestidoe@unican.es
2 Dept. Sciences and Navigation Technics, Engines and Naval Architecture, E.T.S. de Náutica y Máquinas Navales – C/ Ma Diaz de Haro 68 – 48920 Portugalete (Vizcaya), SPAIN, eloy.lopez@ehu.es
3 Dept. Applied Mathematics and Computing Sciences, E.T.S. de Ingenieros Industriales y Telecomunicaciones - Avda. de los Castros,s/n
-39005 Santander (Cantabria), SPAIN, moyanoe@unican.es;
4 Dept. Electronics Technology and Systems Engineering and Automatics, Univ. León
E. de Ingenierías –Campus de Vegazana, s/n – 24071 León, SPAIN

Key Words: - In-scale manoeuvering, DataSocket, web server, laboratory marine remote (lmr).

1. Introduction

This paper describes the undertaking of several tests and manoeuvres, using a marine vehicle experimentation platform, to verify the stability and steerability of these vehicles with autonomous in-scale physical models. The model (Figure 1) has an Industrial PC which communicates by means of a wireless network with the laptop on land, which can be connected to another or other PCs through Internet using 3G UMTS technology.

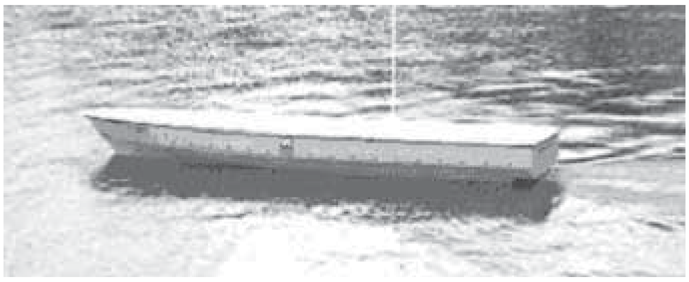

Figure 1. High speed craft model.