
Autonomous Underwater Vehicles

UMI LAFMIA 3175 CNRS - CINVESTAV



September 13th, 2011

THE TEAM

M Sc



Elba Antonio Yañez

Ph D



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Ph D



Eduardo Campos



Octavio García



Rogelio Lozano



Jorge Torres



BACK-GROUND

- Know-how of more than ten years in the field of autonomous flying vehicles
- LAFMIA offered the possibility of tackling new challenging and pertinent projects
- AUV's is a recent research area in complete expansion around the world. Opportunity to innovate in the field of AUV
- New training profiles for our master and Ph D students



GOAL OF THE PROJECT

What is an AUV?

It's a vehicle able to execute tasks, loaded previously, in an autonomous way i.e. without human intervention

Objective:

Design and Control of underwater vehicles to handle some risky or difficult tasks for the humans



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MSc I. Torres, first operational prototype



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- 3) 2010- : Path-tracking, matching of a reference, obstacle avoidance, wall following, etc. M Sc **E. Antonio**, Ph D of **I. Torres** and **E. Campos**

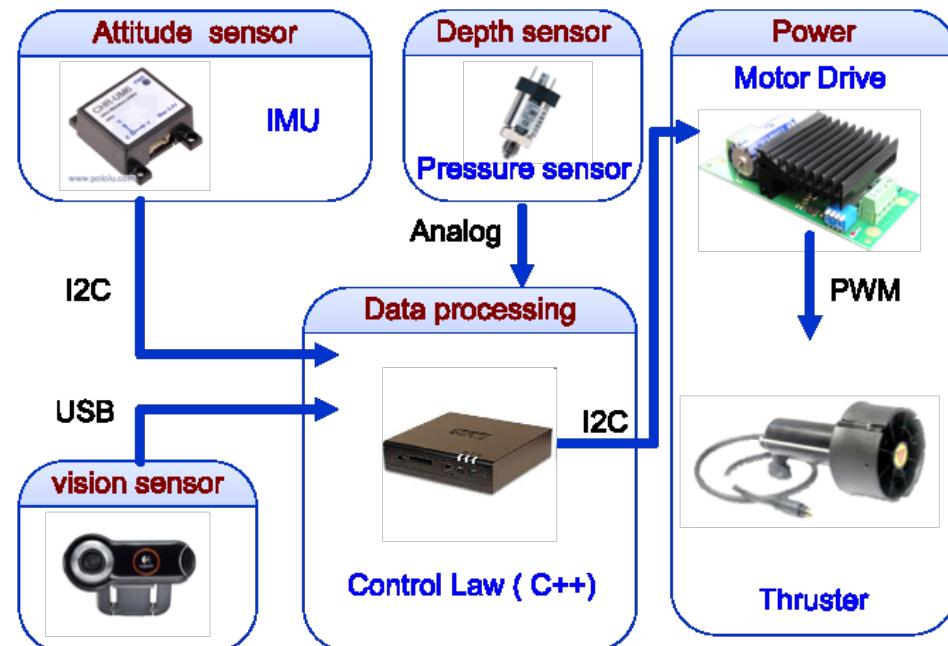


MODELING, SIMULATION AND CONTROL

$$M\ddot{\nu} + C(\nu)\dot{\nu} + D(\nu)\nu + g(\eta) = \tau + w$$

Where:

- M** is an inertia matrix including hydrodynamic added mass.
- C** is an nonlinear matrix including Coriolis, centrifugal and added mass terms.
- D** is an matrix of dissipative Terms.
- g** is an vector of restoring force and moments.



Partnership with France

1 Prof. Luc Jaulin, ENSTA-Bretagne, since March 2010

- AUV: SARDINE
- Vision Algorithms
- Interval Analysis

2 Dr. Vicent Creuze, LIRMM Montpellier, since November 2010

- AUV: TRITON-PR
- Adaptive Control
- Co-supervision, E. Campos (PCP)



Prototypes

First : A toy

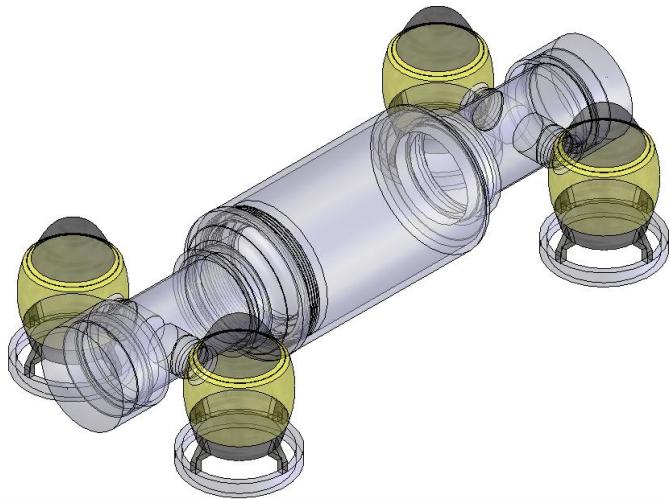


Lowest Cost and Weight

Two toys joined each other
and controlled by radio



Second : 4 Tilting-Thrusters

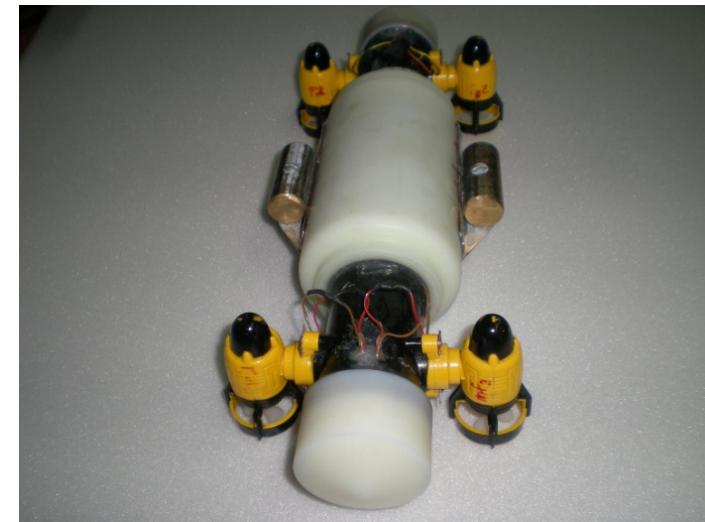


Advantages:

- 1.Light : less than **2 Kg.**
- 2.Micro Size: 70 mm x 3200 mm
- 3.4 Thrusters to control **6 DOF**
- 4.Attitude PID Control

Disadvantages:

- 1.Weak radio frequency communication
- 2.Not able to dive deep, bcs size
- 3.Difficult to install cameras
- 4.Limited for complex tasks (main program in Microcontroller)



Third : 5 fix thrusters



Advantages:

- 1.Light : less than 10 Kg.
- 2.Small Size: 70 mm x 3200 mm
- 3.5 Thrusters to control 6 DOF
- 4.Attitude & Altitude Nested PID Control
- 5.Adaptive Control
- 6.Vision System
- 7.Low Cost: less than 2500 Euros

Disadvantages:

- 1.Communication by cable
- 2.Limited for complex tasks (main program in Microcontroller)



Fourth : 3 fix thrusters



Advantages:

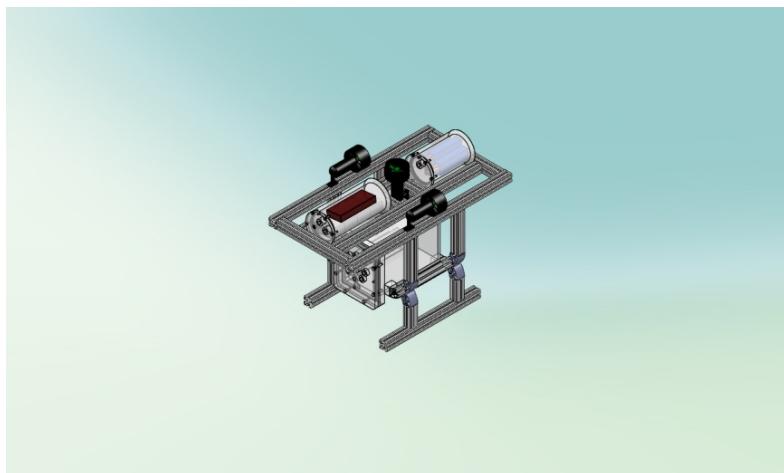
- 1.Light : less than 10 Kg.
- 2.Small Size: 70 mm x 3200 mm
- 3.Attitude and Altitude Nested PID Control
- 4.Adaptive Control
- 5.Vision System
- 6.Embedded Control
- 7.Storage in HDD
- 8.ROV and AUV Control

Disadvantages:

- 1.Using Cables for Communication
- 2.Low capacity for task due to the batteries.
- 3.Noise in measurements introduced by thrusters.



Fifth : Modular Model



Advantages:

1. Modular
2. Vision System
3. Embedded Control (Able to use any kind of control law)
4. Storage in HDD
5. ROV and AUV Mode
6. Reconfigurable

Disadvantages:

1. Heavy in air 45 Kg.
2. Difficult to handle
3. Autonomy limited by power supply



Sixth : Last Generation

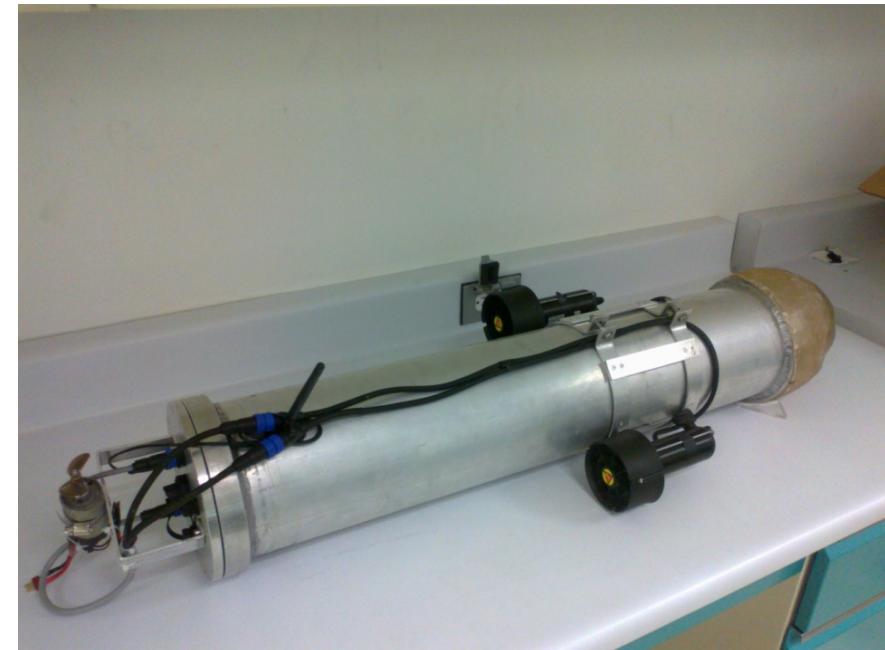


Advantages:

- 1.Light : less than 30 Kg.
- 2.Vision and Sonar System.
- 3.Embedded Control (Able to use any kind of control law).
- 4.Saving data and Video in HDD.
- 5.ROV and AUV Mode.
- 6.Reconfigurable.
- 7.Designed to support depth up to 100 m.
- 8.Salty Water Resistant.

Disadvantages:

- 1.Depends on the application



French-Mexican exchanges

- 1 Luc Jaulin, March 2010 visited UMI LAFMIA
- 2 Ivan Torres, 2-months stays at ENSIETA, 2009, 2010, 2011
- 3 Vicente Creuze visited UMI LAFMIA, November 2010
- 4 D. Mallouf, 1-month stay on February-March 2011
- 5 E. Campos, 1.5 months stay, 2011 at ENSIETA and SAUC-E 2011
- 6 E. Campos 15 days stay at LIRMM, 2011
- 7 J. Torres visited LIRMM on june 2011



SAUC-EUROPEAN CONTEST

1. Ivan Torres and R. Lozano joined the team of ENSIETA, UK-2009
2. Ivan Torres, with the ENSTA team at Lerici, Italy 2010,
3. I. Torres, E. Campos, J. Torres and R. Lozano, with the team of ENSTA, Lerici Italy 2011



Collaborations: SAUC-E European AUV contest (NATO Italy)

2010



2011



INDUSTRIAL PARTNERSHIP



"the world's leading international pure-play geophysical company"

Development of an AUV for petrol exploration from geophysical data.
It is supposed to produce around 2000 engines in 2014. Protocol of collaboration ready to sign, I. Torres.



Partnership PCP of E. Campos. AUV for wall following and monitoring of submarine platforms. E. Campos will make some industrial stays.

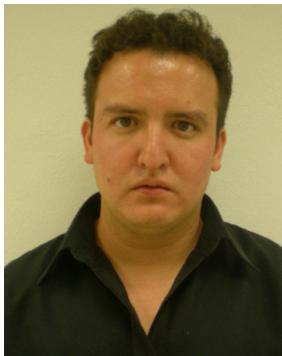


Bioprocess Control: Water Treatment

(September 2010)

THE TEAM

M Sc



Abraham Rodríguez

M Sc



Irandhi Gutierrez



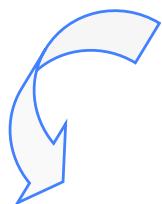
Alma Rosa Domínguez



Jorge Torres



Water Treatment



Modeling
Control
State estimation



Last but not the least !



Once upon a time,..., April 2008

In the middle of the way, September 2010



!! GRACIAS !!

