AN ARCHITECTURE FOR SUPERVISING THE TELEMANIPULATION OF AN IAUV-MOUNTED ROBOTIC ARM

Marian BADICA[1], Florian SCHRAMM[1], Philippe GRAVEZ[1], Peter WEISS[2], Juan Vincente CATRET MASCARELL[3]

[1]Cognitics, Robotics and Interaction Unit, Commissariat à l'Energie Atomique (CEA), Fontenay-aux-Roses, France,

[2]Offshore Department, Cybernetix, Marseille, France,

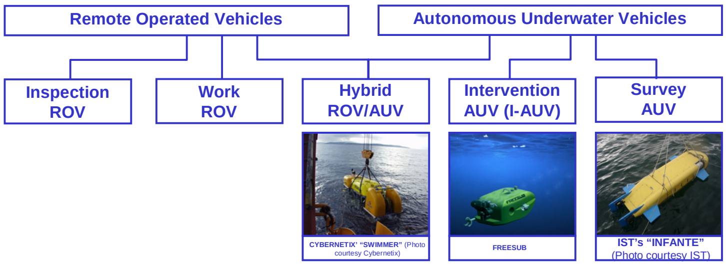
[3]Institute for the Protection and Security of the Citizen (IPSC), Joint Research Centre (JRC), Ispra, Italy

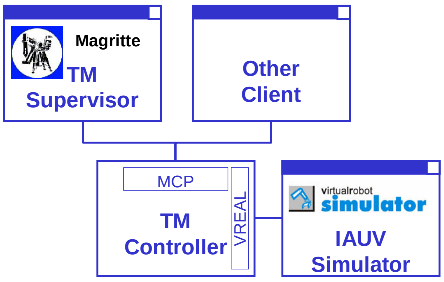
ADVANCED TECHNOLOGIES

DTSI / Cognitics, Robotics and Interaction Unit
B.P. 6 F92265 Fontenay-aux-Roses CEDEX
TEL 33 1 46 54 91 17 FAX 33 1 46 54 75 80

Introduction

Autonomous Underwater Vehicles (AUVs) can be divided in different classes :





Architecture Overview

The architecture consists in three sub-systems which are inter-connected via a limited rate communication channel.

TM Supervisor : graphical supervisory module situated at surface which permit to operator to program the tasks, to simulate and to supervise their execution.

IAUV Simulator : reproduces the operation of the robotic part of the IAUV by simulating its kinematics and geometry.

TM Controller : control module of the robotic arm; contains the servoing loops, the software interfaces with the TM supervisor, and the IAUV simulator.

Visual Servoing

Configuration

6 DOF Samm manipulator arm manufactured by Cybernetix, France

Camera is eye-in-hand configuration

Control algorithm

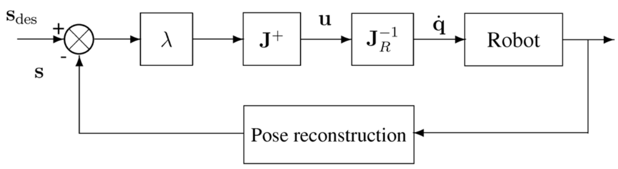
The error vector $\mathbf{e} = \mathbf{s} - \mathbf{s}_{\text{des}}$ is calculated from perfectly matched 3D point pair from an initial and final view of the target $\mathbf{s}^T = \begin{bmatrix}\mathbf{s}_1^T & \dots & \mathbf{s}_n^T\end{bmatrix}$ $\mathbf{e}^T = \begin{bmatrix}\mathbf{e}_1^T & \dots & \mathbf{e}_n^T\end{bmatrix}$

The velocity of points $\mathbf{s}_i$ in affine camera space are related to the velocity screw of the camera center $\mathbf{u}^T = \begin{bmatrix}V^T & \Omega^T\end{bmatrix}$ through an image Jacobian $\mathbf{J}_i = \begin{bmatrix}-\mathbf{I}_3 & [\mathbf{s}_i]_\times^T\end{bmatrix}$

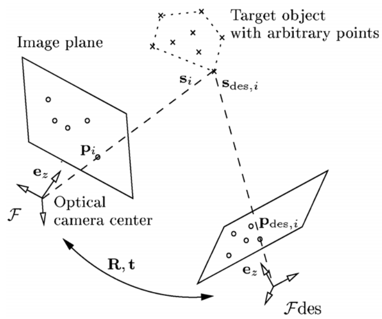
The linearizing control law based on a pseudo-inverse with $\mathbf{u}$ as the usual velocity control is $\mathbf{u} = -\lambda \left(\mathbf{J}^T\mathbf{J}\right)^{-1}\mathbf{J}^T\mathbf{e}$ where: $\mathbf{J}^T = \begin{bmatrix}\mathbf{J}_1^T & \mathbf{J}_2^T & \dots & \mathbf{J}_n^T\end{bmatrix}$

Pose reconstruction

POSIT algorithm is used when geometric model of the target is available (at least four points in the object frame)



Visual servoing overall control scheme

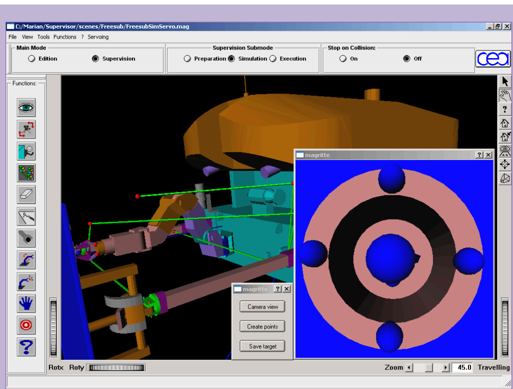


Control problem

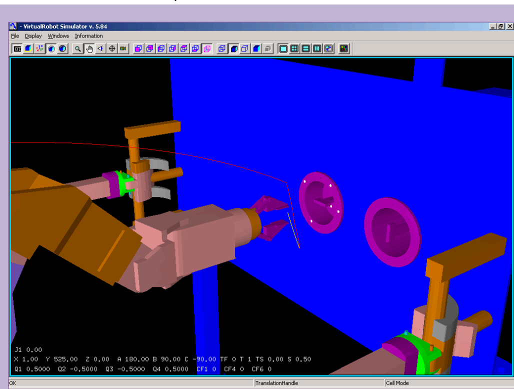
Result & Conclusion

Approach to an object (valve): performed using graphic programming, to get the object in the camera field of view, and then task programming and visual servoing

Slightly different models on TM supervisor and IAUV simulator: promising results were obtained



Screenshot of Magritte supervisor containing the graphic programming elements and the task programming interface for visual servoing



Simulation on VRS of the deployment of the manipulator arm; the red trace is the trajectory of the end-effector for model-based control and the yellow one, for visual servoing

list

FREESUB Autonomous Underwater Vehicle for Subsea Interventions

Research Training Network

cea