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ROUV HEADING BY A FRACTIONAL-ORDER PI CONTROLLER

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ABSTRACT

To control a remotely operated underwater vehicle (ROUV) of the observation ROUVs class, the interactions among mechanical, electronic and information processing elements call for an integrated approach at all design and development stages. Different methodologies must be combined in a multi-formalism modelling approach supported by a suitable simulation and prototyping environment. The proposed approach involves the development of a virtual ROUV prototype in the ROS Gazebo environment, to assess performance in the successive developing steps reliably, and a ROUV controller board (stm32F407, Quad-core Cortex-A7) with a digital camera and an inertial measurement unit (3D accelerometer, 3D gyroscope, compass), to implement and run the control algorithms in real-time. A mathematical model of the system is derived to design a fractional-order PI controller of the ROUV yaw angle in the horizontal plane.

The considered system is "MUVIC-Light", which was developed by the first author to perform inspections at a depth of up to 200 meters (Fig. 1). The characteristic features of such system are a significant elongation (the length of the hull is several times greater than its diameter) and the use of rudders or ailerons to control movement. The Gazebo simulator allows to describe the objects and environment, to define the robot dynamics, and the TCP/IP protocol to transmit video and sensor data to/from the controller board.

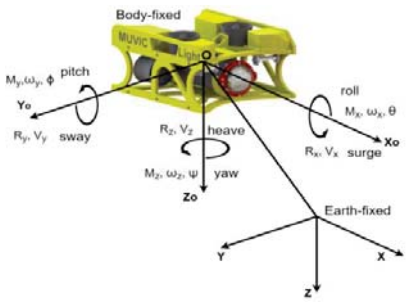

Figure 1. The ROUV coordinate system.

To tune the controller, a nonlinear 6-DOF mathematical model of the ROUV dynamics is derived based on the Euler-Lagrangian formulation. Then, by linearization, a transfer function is obtained, relating the yaw angle and the voltage applied to the motors driving the ROUV. The controller is tuned as in [1]. ROS and Gazebo allow simulation of control system, computer vision, 3D positioning, robot path planning in a realistic environment that can be considered as a digital twin. Namely, the developed codes can be directly used in a real scenario.

REFERENCES

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