



Modelling and Control of Blowing-Venting Operations in Manned Submarines

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Motivated by the study of the potential use of blowing and venting operations of ballast tanks in manned submarines as an alternative control system for manoeuvring, we first propose a mathematical model for these operations. This model extends previous works where only blowing is considered. Then, the model is applied to the control of an emergency manoeuvre by using only blowing and venting. To this end, we formulate a suitable constrained, nonlinear, optimal control problem where controls are linked to the variable aperture of blowing and venting valves of each of the tanks. The state law is composed of a system of nonlinear differential equations where the equations modelling blowing and venting processes are coupled with the Feldman, (it variable mass), coefficient based hydrodynamic model for the equations of motion. In a second part, we carry out a rigorous mathematical analysis of the model: existence of a solution for both the state law and the optimal control problem is proved. Finally, we address the numerical resolution of the optimal control problem by using a descent algorithm. Numerical experiments seem to indicate that, indeed, an appropriate use of blowing and venting operations may help in the control of an emergency manoeuvre.

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