International Journal of Innovative Computing, Information and Control
Volume **3**, Number **4**, August **2007**

ICIC International ©2007 ISSN 1349-4198
pp. **897–906**

APPLICATION OF THE INTEGRAL SLIDING MODE CONTROLLER WITH FUZZY LOGIC TO SUBMERSIBLE VEHICLE

Xin Song and Jia-Wei Ye

Department of Naval Architecture and Ocean Engineering
South China University of Technology
Guangzhou 510640, P. R. China
piop1@163.com

Li-min Wu

Department of Electronic Communication and Information System
Air Force Radar Academy
Wuhan 430019, P. R. China

Received September 2006; revised January 2007

Abstract. *In this paper, a new sliding mode controller is proposed for the heading control of the submersible vehicle. Within a fixed boundary layer around the switch surface, since the fuzzy logic is applied, the chattering phenomenon is eliminated by smoothing the switch signal. Outside the boundary, the sliding mode control is applied to driving the system states into the boundary layer. Moreover, the switching surface with integral component is adopted for compensating the outside constant disturbances and eliminating the steady state error. In order to prove the effectiveness of the new controller, several methods are compared and the simulation results show that the proposed new controller owns good performance of the heading control in the presence of uncertainties about the dynamics and hydrodynamic disturbances.*

Keywords: Submersible vehicle, Fuzzy logic, Sliding mode controller, Heading control, Robustness

1. **Introduction.** Submersible vehicles are now playing a major role in oceanic observation and ocean research. The current application areas in a submersible vehicle are mainly in autonomous and unmanned vehicles. The precise control problems present several difficulties, owing to the non-linear dynamics, the presence of disturbances, and observation noise, especially in shallow, confined water areas where wave surges, tidal currents, coastal currents and artificial objects create a complex environment for the operation of a submersible vehicle and therefore the sensor information is imprecise. Therefore, the application of submersible vehicle for exploration (such as detection of bridges or embankments) in shallow waters remains a big problem. The stability of the submersible vehicle is undesired. The influence of the hydrodynamics acts on the submersible vehicle is considered to be the nonlinearities and uncertainties of the dynamics. However, usually, it is not easy to measure or estimate the actual hydrodynamic forces acting on the submersible vehicle. In order to extend the capabilities of submersible vehicles to underwater manipulation and intervention, it is necessary to develop the stable, robust and high performance control techniques for the submersible vehicles.