

Thesis Title	Stability Control for Underwater Vehicle: Path Trajectory Tracking
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Abstract

This research is on the developing of a small autonomous underwater vehicle (AUV) for surveying the shell of battle ship of the Royal Thai Navy (RTN) for plan maintenance system (PMS). The maximum depth operation of the semi-autonomous AUV is at 25 meters. The AUV can be either controlled by a joystick or by programming. The shape of the vehicle is similar to a gas tank. It is made of stainless steel with 3 millimeters thickness, 45 centimeters outside diameter and 60 centimeter long. With the finite element analysis for 50 meters depth, the safety factor for this AUV is 4.77. The AUV consists of 3 pairs of thruster that align with the main axis of the AUV' body center. The thruster was developed beneath magnetic coupling principle which is very well waterproof. The control system of the AUV consists of embedded PC (as a main control unit on the AUV), an accelerometer (to measure roll, pitch and yaw angle of the AUV), and PSoC microcontroller (for pulse-width modulation (PWM) generate to control 6 thrusters speed). For the remote control system, there are a computer PC and joystick for user to control and monitor the AUV that was connected to LAN wire. The LabVIEW program was used for all operation control systems. The data were communicated by NI OPC and LinkMaster program.

This paper is divided to 4 experiments, which are the AUV yawing control by PID control, the simulation on passive velocity field control (PVFC), the velocity field control assistance for autonomous underwater vehicle path control, and the user controlling by joystick. 1) The AUV

yawing control by PID control was used for single-input single-output (SISO) system. The result showed that it could control desired angles of the AUV and could also control the continuous changing angle. 2) The control simulation of passive velocity field control combined with PID control which was used for AUV path trajectory tracking by 3 m. radius circular path on 10×10 m. space. This part was to find a mathematical and augmented model of the system, equation of motion (EOM) and fine tune gains of the system. The simulation result of control system showed that the controlling can make the AUV converge to every point of desired path. 3) Control testing of velocity field control assistance for the AUV path control by 1 meter radius circular path on 3×3 m space. The EOM was derived from the result of added mass. The VFC was assisted for LQR together with reduce-order state estimator in order to be a full state. The simulation result showed that the AUV can be controlled and it converged to the desired path. The control testing was done in 3×3 m pool. A USB camera was used for tracking a red circular plate and sent the signal to a vision system in LabVIEW program, then converted to be coordinates of the AUV. The result showed that VFC could transform nonlinear systems to be linear system which is easy to control and robust. 4) The manual control testing by joystick and computer. User could control the vehicle to follow the desired position and desired angle.

Keywords : Autonomous Underwater Vehicle / Linear Quadratic Regulation /
PID / PVFC / Reduced-Order State Estimator / Velocity Field Control