ABSTRACT

This research develops the use of electric machines as propeller driver for producing ship thrust. This type of ship should be able to move like a diesel propulsion ship including starting (acceleration), running (speed constant) and braking (deceleration). In the ship propulsion system, load torque of induction motor is very dynamics because it is influenced by the torque produced by propeller and disturbances. The disturbances come from ocean waves, ocean currents, wind and ship motions. Therefore, speed of the electric machines need to be controlled.

Focus of the research discuss the speed control of induction motor by using direct torque control (DTC). This method is selected because the torque and flux are directly controlled by the voltage vector of the inverter. Development of the speed control of induction motor is conducted to improve the performance of system based on values of settling time and overshoot. Contribution of this researches are modelling of ship propeller using SCNN, self tuning PI controller ($K_p$ and $K_i$) using SCNN and SCNN as controller.

The SCNN propeller model is designed to imitate the characteristics of ship propeller. This model has four inputs and two outputs such as blade area ratio (BAR), advance coefficient ($J$), pitch-diameter ratio ($P/D$), blades number ($Z$), torque coefficient and thrust coefficient. Learning of SCNN propeller model is conducted by using back-propagation algorithm with training error of $10^{-3}$. Training datas use the curve open-water characteristic of Wagenigen Seri-B propeller. Specification of the propeller is $Z$ of 4, BAR of 0.55 and $P/D$ of 0.50-1.40. Simulation results show that SCNN propeller model can follow the characteristic of Wagenigen Seri-B propeller.

Second contribution of this research is designing the self tuning for PI controller model using SCNN. Two inputs and two outputs of this model are error value, change of error, parameter of proportional and integral. Next contribution is designing SCNN controller model to substitute PI controller. Structure of SCNN controller consist of a hidden layer and five neuron. Learning algorithm of the both controller use back-propagation with training error of $10^{-3}$.

Simulation of speed control employ induction motor of 200 HP. Strategies of simulation are conducted in the operating conditions of normal and disturbance. Disturbance condition is done by injecting the sinusoidal disturbance of 100 N.m with frequency of 2.5 Hz.

Simulation results in the normal condition show that PI-SCNN and SCNN controller can eliminate overshoot until 100%, compared to PI controller. Whereas, settling time value of PI controller can be decreased by PI-SCNN and SCNN controller by 76% and 92%. Simulation results in the disturbance condition operation show that PI-SCNN and SCNN controller can reduce the speed fluctuation of 71 % and 97 %, compared to PI controller.

Key words: Induction Motor, DTC, PI, SCNN, Self Tuning PI-SCNN