Aplikasi Reinforcement Learning Dalam Sistem Kendali Ketinggian Air Coupled Tank Menggunakan Proximal Policy Optimization yang Diintegrasikan dengan Programmable Logic Controller (PLC) = Application of Reinforcement Learning in Coupled Tank Control Systems Using Proximal Policy Optimization Integrated With Programmable Logic Controller (PLC)

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Abstrak

Machine Learning (ML) telah menjadi salah satu teknologi yang sangat populer. Hal ini memungkinkan ML untuk diaplikasikan dalam sistem industri otomasi, seperti pengendalian ketinggian air pada coupled tank. Penelitian ini bertujuan untuk mengevaluasi kinerja metode reinforcement learning, khususnya proximal policy optimization (PPO), dalam mengendalikan ketinggian air pada sistem coupled tank, serta membandingkannya dengan metode pengendalian konvensional, yaitu proporsional derivative integral (PID) controller. Pemilihan PPO didasari oleh kemampuannya dalam menyelesaikan permasalahan kontinu dengan komputasi yang sederhana. Penelitian dilakukan dengan membuat sistem pengendalian ketinggian air pada coupled tank menggunakan perangkat-perangkat seperti control valve, programmable logic controller (PLC), DAQ card, dan water level transmitter. Perangkat-perangkat tersebut dihubungkan dengan MATLAB/Simulink menggunakan OPC server melalui PLC sebagai interface. Hasil penelitian menunjukkan bahwa respon pengendalian menggunakan metode PPO memiliki overshoot sebesar 49.26%, rise time sebesar 104 detik, settling time sebesar 306 detik, dan steady state error sebesar 5.4%. Sementara itu, metode PID memiliki nilai overshoot yang lebih rendah (38.52%), tetapi nilai rise time, settling time, dan steady state error yang lebih tinggi (masing-masing sebesar 118 detik, 502.4 detik, dan 24.62%). Dengan demikian, performa PPO secara relatif lebih baik daripada PID dalam mengendalikan ketinggian air pada coupled tank.

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Machine Learning (ML) has become one of the most popular technologies. It enables ML to be applied in automation industry systems, such as controlling water levels in coupled tanks. This study aims to evaluate the performance of reinforcement learning methods, specifically proximal policy optimization (PPO), in controlling water levels in coupled tank systems, and compare it with conventional control methods, namely proportional derivative integral (PID) controller. The selection of PPO is based on its ability to solve continuous problems with simple computations. The research was conducted by creating a water level control system in coupled tanks using devices such as control valves, programmable logic controllers (PLC), DAQ card, and water level transmitters. These devices were connected to MATLAB/Simulink using an OPC server through PLC as an interface. The research results show that the control response using the PPO method has an overshoot of 49.26%, a rise time of 104 seconds, a settling time of 306 seconds, and a steady state error of 5.4%. Meanwhile, the PID method has a lower overshoot value (38.52%), but higher rise time, settling time, and steady state error values (118

seconds, 502.4 seconds, and 24.62%, respectively). Thus, the performance of PPO is relatively better than PID in controlling water levels in coupled tanks.