

Pemodelan Dinamik Underwater ROV Menggunakan LSTM Neural Network = Dynamic Modelling Of Underwater ROV Using LSTM Neural Network

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Abstrak

Pengawasan bawah air sangat penting untuk memantau ekosistem laut, melindungi infrastruktur kritis, dan memastikan keamanan maritim dengan pendeteksian anomali, pelacakan aktivitas bawah air, dan perlindungan area sensitif. Namun, Kendaraan Bawah Air yang Dioperasikan dari Jarak Jauh (ROV) memiliki beberapa tantangan, salah satunya adalah arus bawah air sehingga diperlukan pengendali yang kuat untuk menjaga stabilitas. Skripsi ini memodelkan hubungan antara *input* dari RPM motor dengan *pitch rate* dan *yaw rate* sebagai *output*. Model Sistem Dinamis didapat dengan menggunakan data-data yang diperoleh selama uji lapangan di salah satu kolam uji coba di kota Bandung. Sebanyak 57,788 titik data dikumpulkan selama lima menit dan diolah menggunakan aplikasi MATLAB dengan memanfaatkan jaringan neural LSTM. Hasilnya menunjukkan bahwa dari Model Sistem Dinamis *pitch rate* didapatkan hasil simulasi terbaik dengan *hyperparameter* di dua *layer* LSTM, 900 *Hidden Units*, 1700 *Epochs*, 100 *mini-batch size*, 0.001 *Initial Learning Rate*, 0.8 *Gradient Threshold*, dan rasio *training*: *testing* sebesar 55:45. Selain itu, didapatkan nilai *Root Mean Square Error* (RMSE) *training* dan *testing* sebesar 0.041248 dan 0.2517. Pada Model Sistem Dinamis *yaw rate* didapatkan hasil simulasi terbaik dengan *hyperparameter* di dua *layer* LSTM, 950 *Hidden Units*, 2000 *Epochs*, 120 *mini-batch size*, 0.0005 *Initial Learning Rate*, 0.8 *Gradient Threshold*, dan rasio *training*: *testing* sebesar 55:45 dengan perolehan nilai RMSE *training* dan *testing* sebesar 0.030847 dan 0.70734. Dari simulasi yang telah dilakukan, penulis berhipotesis bahwa hasil simulasi telah cukup optimal untuk digunakan dalam pemodelan Sistem Dinamis pada Kendaraan Bawah Air yang Dioperasikan Jarak Jauh.

.....Underwater surveillance is crucial for monitoring marine ecosystems, protecting critical infrastructure, and ensuring maritime security through anomaly detection, underwater activity tracking, and safeguarding sensitive areas. However, Remotely Operated Underwater Vehicles (ROVs) face several challenges, including underwater currents, necessitating robust controllers to maintain stability. This thesis models the relationship between input from motor RPMs and pitch rate and yaw rate as output. The Dynamic System Model is obtained using data collected during field tests in one of the trial pools in Bandung. A total of 57,788 data points were gathered over five minutes and processed using the MATLAB application, leveraging a neural LSTM network. The results indicate that for the Dynamic System Model, the best simulation results for pitch rate were achieved with hyperparameters in a two-layer LSTM: 900 Hidden Units, 1700 Epochs, 100 mini-batch size, 0.001 Initial Learning Rate, 0.8 Gradient Threshold, and a training-to-testing ratio of 55:45. Additionally, the Root Mean Square Error (RMSE) values for training and testing were 0.041248 and 0.2517, respectively. For yaw rate, the best simulation results were obtained with hyperparameters in a two-layer LSTM: 950 Hidden Units, 2000 Epochs, 120 mini-batch size, 0.0005 Initial

Learning Rate, 0.8 Gradient Threshold, and the same training-to-testing ratio. The corresponding RMSE values for yaw rate were 0.030847 (training) and 0.70734 (testing). Based on the conducted simulations, the author hypothesizes that the simulation results are sufficiently optimal for use in modelling the Dynamic System of Remotely Operated Underwater Vehicles.</p>