



Chapter Six

CONCLUSION AND RECOMMENDATIONS

This chapter provides a summarized discussion on the observations made in this study. A conclusion and a set of recommendations are presented based on the design, training, optimization, and performance of the proposed model.

6.1 Conclusion

The design and simulation of a neural network-based speed and position estimator for a field-oriented control PMSM was successfully done in the MATLAB/Simulink Environment with the neural network hyperparameters optimized via genetic algorithm. The genetic algorithm optimized the following hyperparameters: Batch Size, Levenberg-Marquardt training parameters (initial μ , μ increase factor, μ decrease factor), activation function for the hidden layer/s, and the number of hidden layers and its corresponding number of neurons. The trained neural network based on the genetic algorithm-optimized hyperparameters managed to attain a mean-square error loss of 0.00001140 on the validation data. The proposed GA-optimized neural network has outperformed the other estimators during steady-state condition, speed range performance, step-response performance, UAV Flight Plan tests, and efficiency. In comparing the proposed network against other neural network estimators, the optimization of the hyperparameters provide significant improvement in the performance of the estimation process leading to a better steady-state and dynamic response of the FOC. During qualification, some conditions provide room for improvement for all estimators including the performance during very low speeds of below 500 rpm, and the margin between the efficiency of the system when using sensors and when using estimators.



6.2 Recommendations

Further improvements can be introduced to the genetic algorithm optimization process such as considering the network complexity and network training time and not just the network accuracy as the basis for the fitness of an individual. This will further enhance the optimization process to account for real-world efficiency when the process is used in mass production.

For the system performance of the estimators, further improvements can still be made to address the high error ripple when estimating at low speeds of below 500 rpm. Also, further investigations are warranted to determine how to improve the efficiency of the system when using estimators to be at par when using sensors.