

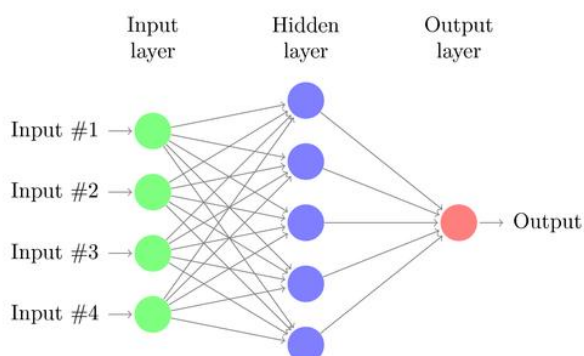
## Research Scope of a Master's Thesis

### “Steering Feedback Torque Computation for Steer-by-Wire System Based on Artificial Neural Network”

For Ms./ Mr. XXXXXX, Registration-Nr.: XXXXXX

Steer-by-Wire (SbW) is a highly prospective steering technology for intelligent vehicles. As the elimination of the mechanical connection between the steering wheel and the steered wheels, it becomes free to adjust steering characteristics for an SbW system, which contributes to improving steering sensitivity, steering stability, and handling performance. On the other hand, how to generate a proper artificial steering feedback torque comes to be a vital and challenging issue.

The target of this research is to design a new method to calculate the desired steering feedback torque which provides the driver with a realistic steering feel, the same as in an electrical power steering (EPS) system. For this purpose, an artificial neural network (ANN, shown in Fig. 1) is adopted to estimate the steering feedback torque, as ANN is capable of learning complex non-linear correlations without requiring specific mathematical models. The development of this ANN requires certain steps. Firstly, piles of steering data are recorded by imposing various steering maneuvers in IPG CarMaker to the vehicle simulator coupled with the well-performed EPS steering testbench (Fig. 2) which is available in our Department Automotive Engineering. Secondly, the inputs of ANN are selected by parameter sensitivity analysis of the test data. Besides, the training and validation of this ANN are conducted based on the steering database. Overall, a proper approximation of the steering feedback torque for SbW system can be developed, which provides the driver with a similar feeling as an EPS system.



**Figure 1.** An 4-3-1 feed-forward network



**Figure 2.** EPS steering testbench

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Within the scope of this thesis, the following tasks have to be finished.

- Knowledge acquisition on EPS testbench and IPG CarMaker.
- Parametric configuration for the EPS testbench and its operating data collection under various steering maneuvers implemented in CarMaker.
- Parameter sensitivity analysis of the test data for the selection of the ANN inputs. And, pre-processing of data to train the ANN.
- ANN training and validation based on the steering database.

**Requirements:**

- Good knowledge of Matlab/Simulink
- Familiar with test data analysis and processing
- Experience with real-time or hardware-in-the-loop systems
- Basic understanding of artificial neural network algorithm

The research has to be planned and done independently. The results must be presented and documented in a suitable format. Moreover, the digital version of the thesis, including all figures, screenshots of online resources, scans of resources that are not digitally available, and the relevant pseudocode, have to be submitted. The results of this work are to be presented in the research seminar.

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