SUMMARY AND CONCLUSION

5.1 Conclusion

The problem statement clearly spells out the need for enhanced prediction system in the field of wastewater treatment process. The enhanced prediction system, which has the highest efficiency in predicting the level of effluent COD is highlighted.

Prediction is the most extensively used data analysis to predict future data trends and to design models based on the data. In particular, the applications of prediction models are wider in the field of Environmental Engineering. One of the major environmental issues related to the conservation and protection of aquatic life and in reduction of hazards caused to human health is wastewater treatment system. Agro industries are the major contributors to the worldwide industrial pollution being a major threat to the living world.

This research presents an enhanced prediction system which efficiently predicts the level of effluent COD in agro-food wastewater, which can be reused for other purposes. After the treatment of wastewater, the Chemical Oxygen Demand (COD) test is essential for determining the quality of effluents in the wastewater before it is discharged. The COD test predicts the level of oxygen requirement of the effluents and is exploited for monitoring and controlling of discharges and to assess the performance of the treatment plant. Henceforth, enhanced prediction of effluent of COD level is the major concern of this research.

Data preprocessing, feature selection and prediction are carried out to enhance the prediction system for predicting the level of effluent COD in wastewater. Data preprocessing for the raw data obtained from an anaerobic
digester treating agro-food wastewater is implemented. From the raw data, the missing values present are replaced using k-Nearest Neighbour algorithm. After analysing the raw data, normalization techniques are applied to scale the data between 0 and 1. The normalization techniques namely, Z-Score, Tanh, Bi-weight, Min-Max and modified Dynamic Score Normalization with Mahalanobis distance (DSN-M) are applied to the input data. The experimental results obtained shows that the proposed modified DSN-M technique has better accuracy when compared with the above mention normalization techniques.

Feature selection reduces the dimensionality of features which improves the prediction accuracy and minimizes the computation time. Filter and Wrapper approaches are the two commonly used feature selection methods. Wrapper approaches tend to be much slower than filter approaches as it requires the help of induction algorithm for feature selection. Hence a filter-based feature selection approach has been adapted in this thesis.

Genetic Algorithm (GA), Particle Swarm Optimization (PSO), and Particle Swarm Optimization with Spectral Projected Gradient (PSO-SPG2) are used for feature selection. The feature selection approaches implemented in BPN namely, GA-BPN, PSO-BPN and PSO-SPG2-BPN are compared based on the experimental results and found that the proposed PSO-SPG2 with BPN to be the best method for feature selection, since the number of features selected is less with minimum execution time when compared to other methods.

The proposed methods used in data preprocessing and feature selection are incorporated in prediction phase. Prediction system is designed using Adaptive Neuro Fuzzy Inference Systems (ANFIS) with Modified Levenberg-Marquardt algorithm (MLM) and ANFIS with Runge-Kutta Method (R-K ANFIS). The proposed enhanced prediction system using R-K ANFIS provides very high accuracy in predicting the effluent COD level in agro-food wastewater with minimum errors and it outperforms the ANFIS with MLM.
The entire experiments are conducted and the proposed algorithms are tested in MATLAB 7.11 environment. The performances of the proposed methods are tested with three benchmark datasets and one real time dataset. For all the datasets, more than 95% prediction accuracy is obtained. The proposed enhanced prediction system using R-K ANFIS method gives the highest accuracy of 99.8% for the synthetic sugar-mill wastewater dataset.

An effort has been made to develop an enhanced prediction system that improves the accuracy for predicting the level of effluent COD and minimize the errors between the observed and predicted values with soft computing techniques.

The proposed methodology in this study has fulfilled the objectives by enhancing the prediction system. Thus, the proposed prediction system can assist the anaerobic digestion operators and decision makers for safe discharge of wastewater after treatment.

5.2 Future Directions

For further enhancement, the following recommendations are suggested:

- An approach for hybridizing ANFIS with conventional approaches such as expert systems may be practiced and implemented to yield stronger computational paradigms for solving complex and computationally expensive problems like environmental problems.
- The present work can be extended to collect long term data, for all the stages of the biological wastewater treatment, and to develop intelligent predictive models for predicting the performance of the prediction system.
- The prediction system designed for anaerobic agro food wastewater can be further tuned to fit different agro food concentrations.