CHAPTER 7

CONCLUSIONS

7.1 CONCLUSIONS AND THE CONTRIBUTIONS OF PRESENT WORK

The accuracy and consistency of obtaining the surface roughness in work rolls are so important in steel industry that it may reflect on the quality of the rolled sheet metal during rolling process. The combined ANN model and Taguchi Technique described in this work for obtaining the optimal machining conditions for achieving desired surface roughness on rough, finish work rolls could provide an improved generalization capability over the statistical Taguchi Technique.

In this work, optimum grinding conditions for the desired surface roughness were found with a minimum number of experimental runs using Taguchi’s orthogonal array. In a neural network modelling, more the data for training the network, higher will be the accuracy of the prediction. But the data generations are costly and time consuming. The proposed methodology overcomes this problem by systematic procedure for data collection for training the neural network using design of experiments using less number of experimental runs. Additional data were included for training based on those factors that have more significant impact on surface roughness using Taguchi methodology. It is observed that the present methodology is able to make accurate prediction of surface roughness by utilizing small sized training and testing datasets.
A neural network based code is developed for this purpose, in which, the size of training and testing data is increased until desired prediction accuracy is obtained. The code also predicts the upper and lower estimates of surface roughness. Thus the prediction can be represented in the form of fuzzy number, which provides an idea about the error in a prediction and allows for fuzzy-based control of the process. The data filtration module incorporated in the code removes the spurious data, which increase the prediction accuracy of the network model.

The multiple performance characteristics such as surface roughness, power required at wheel spindle and material removal rate were optimized through fuzzy logic with the Taguchi Method. Additionally, with the fuzzy model type, it is possible to incorporate human knowledge based on the experience. The analysis of variance proved that the grinding wheel dressing condition (i.e., dressing depth) also significantly affect the ground surface roughness apart from the wheel speed, traverse speed and In-feed.

In this work, the application of response surface methodology from the point of view of work roll grinding is presented. By using the grinding parameters, the second-order response surface models for the grinding power and the surface roughness in the work roll grinding were developed. Therefore, it is possible to predict the grinding power and the surface roughness before conducting grinding, and the grinding conditions satisfying constraints for industrial application can be selected very easily from the developed surface plots.

The methodology integrates process modelling, employed to fit an appropriate model from experimental data, regression analysis and multi-objective optimization. From the results it is observed that the higher wheel speed, work speed, traverse speed and in-feed remain same at all weight-age conditions of the three objectives but other parameters vary according to the
importance of the objectives considered by the decision maker. The pareto-optimal conditions obtained may give clear ideas to the decision maker for better operating conditions to achieve better results in work roll grinding process.

The developed response surface models for surface roughness and grinding power are limited with its boundary conditions and are non-transferable. This means that it is only valid for the considered grinding wheel-component-grinding machine combination.

### 7.2 SCOPE OF FUTURE WORK

This investigation has thrown light into the improvement of quality and productivity of grounded work roll components with optimizing the process parameters by integrating Design of Experiment concept with artificial intelligence approaches. Further, this study shows that the possibility of improving the quality of the work roll components by including other parameters such as static and dynamic characteristics of the machine. This optimization study can be implemented to various machining processes to achieve maximum productivity and required quality.

Future works should be concentrated on development of other artificial intelligence methods for application in flexible work roll grinding systems which incorporating on-line surface roughness prediction and material removal rate. Further the flexible work roll grinding system can be attempted to any material/component of any shape, size, and any configuration by varying the grinding wheels/cutting tools and process variables in various machining/grinding processes to achieve maximum results on the rolled components.
In rolling industries, finish work rolls have been given more attention than rough work rolls since it may affect the product quality directly. For these reason, in this work multi-objective optimization strategy adopted only for finish work rolls and the strategy has been demonstrated. As a future work, the similar strategy can also be adopted and demonstrated for rough work rolls to obtain further improvement in the productivity.

In future, the study can be extended to more than three objectives, different work material and hybrid optimization techniques. The efficiency and accuracy of different algorithms such as ANN and GA used in this study can further be improved by adopting different techniques and methods and these can be taken as a future work.