CHAPTER 6

SUMMARY AND SUGGESTIONS FOR FUTURE WORK

6.1 INTRODUCTION

This chapter provides the main features and contributions made in this research work. The adaptive N-PID and predictive controller implementation procedure and their benefits for complex nonlinear system stabilization are briefed in summary of the work done. The detailed simulation study carried out in CSTR under linear and nonlinear condition is briefed and the performance comparison results also presented to conclude and show the effectiveness of the proposed schemes. The final section of this chapter presents the possible suggestions for the future enhancement of present research work.

6.2 HIGHLIGHTS OF THE WORK DONE

The below mentioned works are carried out during the course of work:

1. The mathematical modeling of the CSTR is obtained under linear and nonlinear operating conditions.

2. The design procedure of adaptive PID is discussed briefly and the parameters are tuned through the conventional and soft computing techniques. The Modified hybrid approaches
viz., MGA and MABC are proposed to get better performance from the adaptive controller.

3. The design procedures of LMPC and NMPC were discussed. The Fuzzy based, Neural Networks based and LSSVM based NMPC design for the CSTR process is discussed and implemented.

4. The predictive controller parameter optimization is done through modified optimization techniques which improves the prediction performance.

5. Performance comparisons of the proposed methods were presented to show the effectiveness of the closed loop control system

6.3 SUMMARY

The Aim of this research work is to develop and implement adaptive and predictive controllers for the nonlinear control system stabilization. The primary contribution of the present work is design an adaptive N-PID controller for the CSTR process. The N-PID was designed for the nonlinear model which is derived from the local linear models of the process using soft computing techniques such as GA, SA, PSO and ABC. In this work, modified hybrid optimization approaches viz., MGA and MABC were proposed to get the improved performances. The implementation results of the proposed scheme are presented in chapter.3. From the results, it is concluded that the objective of adaptive controller design for the complex system is achieved.

The second objective of the research work is to design a predictive control scheme for the nonlinear CSTR which overcomes the issues involved in adaptive N-PID scheme. The predictive controller for entire operating
range is designed by using soft computing techniques such as neural networks, SVM and LSSVM. It requires nonlinear model of the process which is derived from the NARMA model identification and LSSVM model identification techniques. In this work, LSSVM based predictive controller design was proposed and the results presented in chapter.4 were compared with its counterparts. From the results, it is observed that the objective is completely attained and gives better performances.

The next objective of the work is design an optimum predictive controller by using soft computing techniques. The predictive controller parameters were selected by MGA and MABC approaches which provide better stability and improved closed loop performances. From the results presented in chapter.5, it is concluded that the optimized predictive controller provides better results than its counterparts. Hence it is concluded that the objective defined is achieved with better results.

The extensive range of tests has been performed on the CSTR in order to show the servo and regulatory performances, stability and robustness of the proposed control schemes. A wide simulation studies were carried out using conventional controllers and predictive controllers. From the results, it has been demonstrated that the predictive controllers has many advantages viz., better tracking, disturbance rejection and good robustness compared with the adaptive N-PID controller. The comparison results of the proposed schemes were presented to show the effectiveness and the ISE, IAE and ITAE, time complexity of the each method, MSE values and the prediction time of the proposed schemes were also studied broadly.

From the results, it is concluded that predictive controller outperforms than the conventional methods with respect to tracking, stability, noise rejection and robustness.
The limitations of the proposed schemes are the N-PID settings derived for particular regime is not suitable for other operating regimes, there is no standard procedure exist to select EGA and EABC algorithm parameters and it requires more computation time for optimization. In MPC, the limitations are huge training data set requirement for model prediction and there is no standard procedure available for prediction and control horizon selection.

6.4 SCOPE FOR THE FUTURE WORK

The following suggestions have been derived based on the outcome of the present research work for the researchers to enhance further the present work. The possible suggestion can help the industry to implement further enhanced closed loop scheme for the complex nonlinear system. Thus, the following section presents possible suggestions for future research work.

- The real time CSTR process may be modeled under higher order operating conditions and under dead space conditions.
- The adaptive controller design proposed further can be enhanced by introducing latest optimization algorithms such as Penguins Search Optimization Algorithm (PeSOA) reported by Youcef Gheraibia et al (2013) and Intelligent Water Drops Algorithm (WDA) reported by Basem O Alijla (2014), etc.,
- In hybridization methods, more than two methods can be used to get benefits of each one.
- The online adaptive schemes may be developed for the complex system using soft computing techniques.
• An approach which can solve complex optimal problem can be introduced to ensure the implementation of MPC in real time.