CHAPTER 7

CONCLUSION AND FUTURE SCOPE

7.1 SUMMARY

The identification of a nonlinear system with the support of the Linear Parameter Varying modeling method, is proposed. The main contribution of the research involves the modeling of a 210MW coal fired boiler system, using the LPV modeling technique. The 210MW boiler system is divided into six subsystems. The subsystems are the boiler furnace, boiler drum, primary superheater, furnace gas, attemperator and secondary superheater. For each subsystem, first principle models are developed, using the mass and energy balance equations. The open loop responses of the developed first principle models are obtained, to illustrate the dynamic behaviour of the system. The subsystems are combined together to obtain the integrated boiler model of the 210MW coal fired boiler.

The development of the LPV model of boiler furnace, boiler drum and integrated Boiler system is carried out separately. The data needed for the development of the LPV model of the boiler furnace are collected from the first principle model of the system. The output responses, furnace temperature and heat transferred by radiation to the riser of the boiler furnace of the LPV model and the first principle model of the boiler furnace are compared.

The data needed for the development of the LPV model of the boiler drum is collected from the first principle model of the boiler drum. The
entire operating trajectory is divided into four linear regions, and the linear transfer function models are developed. The linear transfer function models are interpolated, using the triangular weighting function by considering the drum level as the scheduling variable to obtain the LPV model of the boiler drum. The LPV model of the boiler drum is validated, by comparing it with the first principle model of the boiler drum.

The 210MW coal fired boiler system represented as an integrated boiler, is used for the LPV model identification. The inputs of the integrated boiler system, such as the fuel flow, air flow, feed water flow and attemperator spray flow, and output variables, such as the steam flow, steam temperature, furnace temperature and furnace pressure are considered for the LPV model identification. Steam flow is taken as the scheduling variable. Linear transfer function models are developed for the linearised regions of the entire operating trajectory. The linear transfer function models are interpolated using the weights, which are the functions of the scheduling variable (steam flow) to formulate the LPV model. The LPV model of the integrated boiler system is validated by comparing it with its first principle model.

The LPV model of the boiler furnace, boiler drum and integrated boiler system is carried out by simulation. In order to validate the LPV model using real time data, the conical tank system is used. The entire operating region of the conical tank system is linearised into four regions, and the linear transfer function models are developed. The LPV model is determined by interpolating the linear transfer function models, using weights obtained by the triangular weighting function.

In the control part, the multi-model PI controller and adaptive PI controller are designed and implemented for the first principle and LPV
model of the Boiler drum process. The PI controller settings are determined, based on the internal model control method.

The multi-model PI controller for the LPV model of the Integrated Boiler system is also carried out in this research work. The direct synthesis method and internal model control method are closely related, and produce identical controllers. Hence, the PI controller settings are determined, based on direct synthesis method.

The multi-model PI controller and adaptive PI controllers are designed and implemented for a real time conical tank system, and the same has been implemented for the LPV model based system.

7.2 CONCLUSION

From the extensive simulation studies of the boiler system, it is found that the LPV model output of the boiler furnace (furnace temperature and heat transferred by radiation to the riser) tracks the first principle model output of the boiler furnace (furnace temperature and heat transferred by radiation to the riser) in the assumed three regions of the operating trajectory. The LPV model of the boiler drum is validated by comparing its output (drum level) with the first principle model’s output (drum level). The LPV model’s output tracks the dynamic characteristics of first principle model accurately in the entire operating trajectory. The LPV model of the integrated boiler system produces the steam flow, steam temperature, furnace pressure and furnace temperature as outputs. In the assumed operating region, the dynamic characteristics of the LPV model outputs are validated with those of the first principle model outputs. The developed LPV model of the conical tank system is validated, using real time data. The LPV model output (level of the tank) tracks the real time data accurately over the entire operating region.
The multi-model PI controller is designed and implemented for the LPV model of the Integrated Boiler process, the first principle and LPV model of the Boiler drum system. The adaptive PI controller is designed and implemented for the first principle and LPV model of the Boiler drum system. The servo response and time domain specifications for all the operating regions are analysed for all the models, and the LPV model based controller shows an improved performance in terms of the rise time, settling time and overshoot.

The multi-model PI controller and adaptive PI controllers are designed and implemented for the real time conical tank system, and the same has been implemented for the LPV model based system also. The performance analysis is done, based on the servo response and time domain specifications. The servo performance is analysed in all the operating regions of the system. The LPV model based adaptive PI controller shows improved performance in terms of the overshoot.

### 7.3 SCOPE FOR FUTURE RESEARCH

The result of this work gives rise to some possible future directions in the field of LPV modeling and control for industrial processes. Some of them are listed below:

- The identification of linear parameter-varying models of industrial processes like Fluidized Catalytic Cracking Unit and reforming unit can be attempted.

- The linear transfer function models are developed as the first order system in the proposed work, which can be increased as a higher order system.
• The linear parameter varying modeling of the conical tank system is proposed. It can be extended to other benchmark systems also.

• A single scheduling variable is used in the proposed work. It can be extended for two scheduling variables to control complex systems.