6.1 Conclusion

Modeling and controller design for hybrid system in general has been carried out in this work. A benchmark hybrid three tank system was taken as a real time system to implement and test the designed model and controller. Initially a hybrid feedback control system was developed. A discrete controller was designed for the model. The discrete controller was implemented in MATLAB using STATEFLOW. The model was realized in SIMULINK. Four different models and respective discrete controllers were designed for four different configuration of the system. The performance of the discrete controller was found to be satisfactory. A stability analysis of the hybrid three tank system was performed. Stability test was performed for four different configurations of the three tank system. It was found that the system was piecewise quadratic stable.

A hybrid state space model was derived for two different configuration the three tank system. The derived model was verified and validated using MATLAB. A hybrid MPC controller was designed for the three tank system. The designed controller was first tested on the model. Satisfactory servo and regulatory response was obtained from the simulation. The tested controller was then implemented on the physical three tank system in the lab. The controller performance was highly satisfactory. It gave good servo and regulatory responses.

Hybrid system models were obtained for the three tank system. The developed model encapsulated the continuous as well as the discrete dynamics of the system. It was possible to comprehend the hybrid dynamics of the system, when both, continuous and discrete variables were included in the modeling procedure. The model developed was also verified and validated. This was important,
since the performance of the designed controller will be entirely dependent on the developed model. Hybrid model development was the first objective of the research work.

Two controllers were designed for the three tank system. A discrete controller and a hybrid MPC controller. The controllers were tested on the models. The performance of the both the controllers were satisfactory, since both gave food servo and regulatory response. This meets the second objective of the research work.

To attain the third objective a HTTS was chosen for implementing the designed controller. The effectiveness of the developed model and the designed controller was demonstrated by implementing the same on a physical three tank system. The hybrid MPC controller gave good servo and regulatory responses. This also validates the developed model.

6.2. Future scope

Hybrid system is relatively new research area in control theory. A wide range of real world problems can be modelled in hybrid framework. Hybrid system modelling, system identification, fault detection and controller synthesis of systems which exhibit both continuous and discrete dynamics, are some of the open areas in hybrid dynamical systems to be investigated. Very particularly, there is a large number of process control systems that can be brought into the hybrid framework. Most of the process control systems include a mixture of discrete and continuous dynamics. Elements like solenoid valves, level switches, sensors etc. bring in the discrete dynamics into the process. Study of such processes with a hybrid systems perspective will enable one to perceive and understand the systems dynamics much better. The scope in the study of the hybrid systems is limited only to one’s ability to perceive hybrid dynamics in systems around us.