CHAPTER 6 CONCLUSION AND FUTURE SCOPE

The research has exhibited the design, development and control of smart power window system via model-based development and validated on dSPACE ace 1104 simulator. The concluding chapter encapsulates various techniques used for improvement in design and development of automotive power window system which is demonstrated in chapter 2, chapter 3 and chapter 4. The research work is applicable to the different type of electromechanical system which is not only used in automotive industry but also used in mechatronics industry, avionics industry, and robotics and automation industry. Various systems like Injection system, anti-lock braking system (ABS), Integrated starter generator (ISG), Electronic stability program (ESP),wiper system and Adaptive cruise control (ACC) may use above technological tool for rapid prototyping and validation may be done using dSPACE simulator. The chapter is formally divided into conclusion and future scope section which are explained as follows.

6. 1 Conclusion

Mathematical modeling, decision tree algorithm development, software in the loop testing and hardware in the loop testing of smart automotive power window is done successfully. The techniques used for development of electromechanical system requires Matlab/Simulink for mathematical modeling and software in loop testing, machine learning using python programming for obstacle detection technique used decision tree classifier algorithm and Control desk by dSPACE for hardware in loop testing. In the power window system model, electrical and mechanical components clubbed together and demonstrated model were produced which is utilizing torque coupled subsystem model for obstacle detection. After extensive research work following observations are identified.

1. The mathematical modeling, simulation and testing of power window system is achieved with MATLAB/Simulink. These modern technological tools support you to execute maximum tests in the early stage of software development cycle leads to diminish product implementation cost and enhance the quality of the automotive system.

2. The simulation model is based on the design and development of electromechanical system, in which mechanical model and electrical models are integrated with the help of toque coupled sub system model using Simulink library.

3. The safety and comfort in the automotive system are enhanced largely by proposed model using simulation. Since the automatic system is controlled through algorithm and actuator is responsible for mechanical movement so safety regulation plays a vital role in the system development.

4. The research work is compared with the existing work done for the hardware implementation of power window control and it is estimated an optimal solution in terms of optimal upward and downward time. Similarly, the transient response of actuator is also improved with a proposed control algorithm.

5. The simulation results demonstrate that the power window controller reduces the lateral offset of a DC motor and driver's workload. The pinch detection techniques with the DT algorithm work more effectively than without the DT algorithm by decreasing the window frame when the power window senses an obstacle.

6. In Hardware in loop testing, physical sensor and actuators of plant model are validated with automotive power window system. The performance of the system is captured and documented in chapter 5. The theoretical viewpoint of the system is tested with software as well as hardware setup model.

6. 2 Future Scope

For the development of further holistic power window system following studies may be incorporated in the research development cycle.

- Number of electronic control unit i.e. ECU usages in vehicles are increasing day by day due to its faster response time and efficiency considering these facts other approach followed for the load assessment of DC motor which should covers frictional loss and holding torque effect to increase the safety of the system.

- Target Link should automatically generate production-quality code for fixed-point and floating-point controllers directly from Simulink models as the requirements of future system validation. The functionality and usability of the window system should be decided based on the auto code generation and instant validation based on code generation approach.