CHAPTER 7

CONCLUSION

7.1 GENERAL

This chapter details with review of the work contributed during the course of this research work and proposes few suggestions for future work. The main objective of this thesis has been framed to design the SMCs for VASS to enhance the ride comfort. SMC is designed initially, then the fractional order derivative is introduced in the sliding surface then FOSMC is designed. The effect of terminal parameters are analysed by designing the terminal SMC. The combination of the above SMCs are tried. The switching function of the SMCs are implemented in the Fuzzy logic controller then termed as FSMC and FOFSMC.

The SMCs are designed and tested in simulation using MATLAB Simulink. The SMCs are validated for the experimental ASS in real time using LABVIEW software. The performance of the designed controllers is compared in terms RMS, FWRMS and ride comfort level as per ISO2631.

7.2 REVIEW OF THE WORK DONE

In chapter 1, the introduction to the research and literature review are presented. The importance of the considering the each vehicle model is discussed and objectives are framed.

In chapter 2, the quarter car model is chosen to enhance the ride comfort using SMCs. The SMC, FSMC, FOSMC, TSMC, FOFSMC,
FOTSMCs are designed and simulated for the QCM with SB. The same SMCs are checked for other road profiles. Three road profiles are considered to produce the vibration in the suspension system. The single bump is the standard input with bounded input and bounded output. The random road is simulated as per the ISO 8606. The sinusoidal road is a periodic road disturbances considered as the third road input. All the three inputs are given to the system individually and the performances are analysed.

The FWRMS is computed as per ISO2631 and uncomfort level of the suspension system with and without controllers are compared. To quantify the time response of the system the RMS values are computed and compared. The power spectrum density is plotted with respect to frequency to check the performance of the designed SMCs in the human sensitive frequencies. The FOSMC, TSMC and FOTSMC are performing better than the SMC. The performance of the FSMC and SMC are similar but the force produced by the FSMC is less than the SMC, similarly the FOSMC and FOFSMC are performing.

In chapter 3, the quarter car with driver model is consider for analysis. As FOTSMC, TSMC, FOSMC are performing better than other SMCs, only these three SMCs are designed for QCDM. Since the seat suspension is included in the system, the performance of the SMCs with single suspension and dual suspension are analysed and compared. The dual suspension with saturation limit is performing better than the single suspension without the saturation. The SMCs are tested for all the three types of road inputs considered in chapter 2. The performance of the SMCs are analysed by varying the driver’s mass form 40 kg to 100 kg, similarly the simulation is repeated for different speed of the vehicle. The FOTSMC performs better than other SMCs in all the considered cases. The ride comfort is also enhanced by the designed SMCs.
In Chapter 4, the half car model which has the interaction between front and rear wheel is analysed by means of the pitch acceleration and body acceleration. The PA is measured at the centre of the sprung mass and BA is measured at both ends of the sprung mass. The FOSMC, TSMC and FOTSMCs are designed for the HCM and simulated for three road inputs individually. The reduction in front car body acceleration, rear car body acceleration and pitch acceleration are improved by FOTSMC in all the considered cases. The ride comfort is also enhanced by the designed SMCs for FCBA and RCBA.

In Chapter 5, the half car with driver and passenger model which deals with the ride comfort of the driver and passenger. As discussed in the previous chapters, the FOSMC, TSMC and FOTSMCs are designed for the HCDPM and simulated for three road inputs individually. The reduction in driver’s head acceleration, passenger’s head acceleration and pitch acceleration are enhanced by FOTSMC in all the considered cases. The ride comfort is also enhanced by the designed SMCs for HAD and HAP.

In chapter 6. The designed SMCs are tested for the experimental active suspension system. The displacements are measured by the LVDTs and conditioned through a signal conditioning circuit the sent to the personal computer through the data acquisition card. These signals are useful to compute the state variables (suspension deflection and car body velocity) for the design of SMCs. The SMCs are implemented in the LabVIEW software which produces the control signal to the electric actuator through the data acquisition card. The performance of the SMCs are analysed in terms of RMS, FWRMS and PSD. The FOTSMC performs better in reduction of BA than other SMCs in simulation and real time experiments.
7.3 SCOPE FOR FUTURE WORK

Few suggestions for future research work are given below,

- The designed SMCs can be extended for the full car with four passenger model.
- To increase the complexity in the system, nonlinearity in vehicle model can be considered and other types of nonlinear controllers can be designed to improve the performance.
- While designing the SMCs, the uncertainty in parameters, internal disturbances, sensor noise and car evolution can be considered to have the more realistic system.
- In addition to the head acceleration of the driver and passenger, whole body vibration can be analysed.
- The vehicle response in addition to pitch, yaw and roll movements also can be analysed which are actually involved in an on-road vehicle.