## Abstract

Gearshift quality and ecodesigning are two important factors, considered in recent advancements in designing automotive transmission, needed for meeting emission regulations and better shifting for enhanced driving experience or drivability. Model based design using various control technologies and system dynamics have been employed on Automatic Transmission with planetary gearsets for realizing the aforementioned objectives. This comprehensive approach aims to combine shift quality improvement and ecodesign, where these were considered mostly as two exclusive objectives reported in literature. This work aims to deal with these three issues, namely, fuel efficiency, emission and gearshifting together with the consideration of passenger load variation as uncertainty factor that can be addressed through modeling of effective transmission control. The automatic transmission system model has been designed in this work for multistage planetary gearbox, wherein to identify suitable gear ratios, the deformation and power flow efficiency are analysed. The developed model is tested on the MATLAB platform for simulation, utilizing the New European Driving Cycle, to specify the best operating range. The proposed approach helps to specify the driving conditions and efficiency while designing multistage planetary gearbox. As sensors cannot be mounted on the wheel for measuring torque at the driving shaft, an estimator is necessary for feedback control that requires designing of observers. Extended Kalman Filter is implemented here for torque estimation. The variation in passenger load affecting vehicle powertrain's dynamic characteristics, as pertinent but unconventional factor is considered in modeling. This passenger load dynamics affects vehicle performance, such as, the torque supply to the wheel, control of speed and quality of gearshift. A sliding mode control strategy is developed for planetary gear transmission to counteract such effect in order to augment eco-driving. The control laws are derived utilising adaptive variants, namely, Dynamic-terminal and Super-twisting types of sliding mode control, which are robust in nature and it eliminates time-consuming calibrations, where a comparison of control shows the latter has faster convergence capability. The findings obtained also from the processor-in-the-loop testing validate the result of model-in-loop simulation confirming suitability of this observer based controller. The proposed adaptive non-linear closed-loop design thus improves transmission system.

Keywords: Automatic transmission, Ecodesign, Fuel consumption, Planetary gearbox, Robust control, Sliding mode control, Transmission control.