CHAPTER 6
CONCLUSIONS AND FUTURE WORKS

6.1 Conclusions

The index for Automated Manual Transmission (AMT) is shifting speed and shifting stability, which is dominated by clutch control. The prototype of clutch actuator for AMT by ITRI had been developed for one year. Disengaging speed and control stability are always the difficulties to be overcame because there is no guideline to help modification.

In this study, all these problems are solved. Through the creation of dynamic model and tendency analysis, parameters that dominate the disengaging speed have been found out. Through optimization method, disengaging time of the clutch actuator is reduced from 0.234 second to 0.089 second in the evolution design, which is better than many commercial AMT systems. Through the design of control function and using optimal control method with the combination of control model and dynamic model, the stability of AMT clutch control is improved. By the combined model, a complete clutch control system from controller to clutch travel can be simulated to provide information for control parameters turning. And through optimization method, the control parameters are turned to provide a very stable clutch control. As shown in Table 5.2-5 and Figure 5.2-3, IMC, the index of stability in this study, has been reduced to half of the original design.

Besides the contribution of modifying the clutch control speedier and more stable, the study also builds up a program for simulation and optimization of vehicle transmission system. The program combines dynamic simulation, control simulation, and optimization into a unit. Dynamic characters from engine, through clutch and gear box, to vehicle loading, and the relative control of TPS, clutch, and gear shifting, can be simulated in the program. The shifting process simulation is the emphasis. Besides, through the combined optimization

module, both mechanical parts and control parameters can be optimized according to the design requirements.

Moreover, since the program is created in modules, not only AMT can be simulated. It can be modified to simulate many other transmission systems. Manual Transmission (MT), Double Clutch Transmission (DCT), and hybrid transmission can all be simulated just by substituting or modifying one or two modules.

6.2 Future Works

In the future works of this study, some directions can be focused on as listed below.

First, for practical utility of this study, modification of parameters according to experiments is necessary. Deserving to be mentioned, all the results in this study are not "absolute" results. Most of the data in this study are "theoretical", and some hypotheses are supposed. Modifications with experiments are thought to be necessary for providing a set of practical results and confirming the hypotheses.

Second, the development of AMT transmission system is prevalent in recent years. There are many novel technologies in such field, like double clutch transmission (DCT) [8], which has been used on Audi TT and BMW M3, and torque tracking control method [9], which has been used on Opel Corsa and Benz Smart. Since the program created in this study is in modules, it is easy to modify it to such new types. Such works must be helpful for the development of AMT system.

Third, not only AMT, hybrid vehicle is famous in recent years. Many studies of hybrid vehicle focus on auto clutch which shifts power between fuel and electrics. Such structure is very close to the auto clutch on AMT of this study. The program produced by this study provides a good base to simulate and optimize such structure. Future study on such topic can

deal with the system just by adding another electrical power source module and redesigned the control strategies.

By the way, the development of AMT is not for a long time, there are many chances for new innovations. And hybrid vehicle is another hot topic that can be followed according to this study. The basic program for simulation and optimization has been created in this study, which must be a practical tool in future studies. According to this foundation, lots works of vehicle transmission problems are waiting for expansions in the future works.