# Chapter 6
# CONCLUDING REMARKS

## 6.1 Conclusions

In this thesis, simulations of simple and high order continuum traffic flow models with high resolution schemes have been presented. This research applied TVD type and WENO schemes to solve Riemann problems of the LWR, PW, and Jiang's improved models. The aim of this thesis is to utilize sophisticated numerical methods, which can simultaneously produce accurate and non-oscillatory results elsewhere in the computational domain, to resolve shocks and discontinuities for macroscopic continuum traffic flow models. The goal has been achieved with WENO schemes for the simple and high order continuum traffic flow models. By comparison with the simple numerical methods, Godunov-type TVD slope-limiter scheme, and the exact solutions, WENO schemes have been demonstrated to successfully cope with Riemann problems in continuum traffic flow models. Test problems of LWR model, including shock, rarefaction wave, traffic signal, and square wave cases, were shown to illustrate the dominant accuracy of WENO schemes. WENO schemes also exhibited the capability of appropriately solving high order continuum models with numerical examples, including shock and rarefaction wave problems, for PW and Jiang's improved models. These numerical tests verify that WENO schemes can afford to be applied to simulate complex traffic phenomena, such as shock, rarefaction waves, stop-and-go waves, and local cluster effects.

## 6.2 Recommendations for Further Research

Some improvements are still possible for further work. Due to the intricate algorithm, simulation with WENO scheme costs much execution time and is not efficient. The improvement of computational efficiency in traffic flow models is the critical point in the development of real-time traffic simulation programs. Traffic flow simulations with parallel computing may result in obviously reduced computational time. With the implementation of parallel processing the WENO algorithm, parallel high resolution numerical scheme would be a reliable, fast, and robust method for traffic flow simulation.

Most importantly, the conclusions drawn from this study only indicate whether the numerical approximations behavior like the simple and high order continuum models. The issue whether continuum traffic flow models properly describe real traffic phenomena goes beyond the scope of this research. However, a sophisticated continuum model is really essential to a successful traffic flow simulation. In order to depict realistic traffic flow behavior, various influences of humans, vehicles, and roads on traffic flow should be taken into consideration appropriately in traffic flow modeling. For example, the relaxation time, which is assumed as constant in PW and Jiang's improved models, is known to be a variable. After a sophisticated continuum traffic flow model being developed, the calibration of the model parameters should be carried out. Then it is meaningful and valuable to compare the numerical solutions of the continuum model with field data to evaluate how they perform under realistic traffic conditions.

Finally, efficient coding skills are always important in scientific computing, and they become even more necessary in the implementation of numerical simulation of continuum traffic flow models. The wise storage management and the clear programming flowchart design could have huge influence upon the efficiency and the accuracy of the numerical scheme. There would always be space to improve on this matter.