Chapter 6
Conclusions and Recommendations

6.1 Summary

The main objectives of this thesis are to investigate a high fidelity tracked vehicle model and to develop the dynamic model of the Continuous Haulage System as the first task of the autonomous CHS project. All existing tracked vehicle models are reviewed and modified to suit our task. The modified model is programmed using MATLAB$^{®}$, and simulated with a digital computer. The simulation results are then compared against the experimental data obtained from a field test to validate the model. It has been clearly shown that the model is able to closely predict the phenomena that occurred during the maneuvering of the tracked vehicle on flat terrain.

The development of the dynamic model of the CHS is based on Newton's laws. By employing the Newton's second law of motion, the system of equations of motion of the CHS can be obtained. The CHS model is also programmed and simulated on a digital computer, but the model validation is neglected due to high cost. The simulation program can simulate the CHS with any number of MBCs; however, a higher performance personal computer is preferred when the number of MBCs in the system is increased, to yield satisfactory running speed. Although the simulation results have not been verified with the experimental data, they do show the close trends to what happened in the real world.

6.2 Future Works

Tracked Vehicle Model:

In modeling the lateral and the moment of turning resistance between the ground and tracks, the Coulomb friction is assumed, and the direction of the friction is simply assumed to be perpendicular to the track. However, the direction of the real friction is opposite to the direction of the track sliding on the ground, which is varying over the length of the track. Thus, one may improve the tracked vehicle model by determining the

direction of sliding of every point along the track, and calculate the lateral and the moment of turning resistance based on the above concept.

The Continuous Haulage System Model:

Due to a lot of assumptions that have been made before modeling the continuous haulage system, many possible ways to improve the CHS model are listed below:

1. The model can be improved to work with the MBC that has the center of gravity that does not coincide with the geometric center by including the parameters e_x and e_y in deriving the kinematic model of the CHS.

2. Including the effect of the connecting pin forces to the track-terrain interaction.

3. Instead of using the simplified model of the Dolly travel limit, a subroutine that will monitor the Dollys' positions may be added in the main program for checking whether the Dolly has reached its limits. Once this event occurs, the whole new set of equations of motion must be derived before solving for the accelerations of each component in the system.

4. Determine the equations of motion of the system by using other approaches such as Lagrange's equation and method of the Lagrange multipliers, and compare the results obtained from different approaches.

5. An alternative numeric integration method may be selected for solving the system of ordinary differential equations instead of the one used in this thesis.