CHAPTER 6
CONCLUSIONS AND RECOMMENDATIONS

6.1 – Summary of the Thesis

The main purpose of this thesis is to further model and optimize the AVI system, specially to improve the coverage of travel time data collection and the accuracy of freeway travel time forecasting. To do so, first, AVI system functionality was presented; the reader reliability and accuracy was studied. Next, the genetic algorithm approach was described and used to optimize the AVI sites locations. The approach was tested in an assumed transportation network and obtained very positive result. Third, a study of freeway travel time forecasting was performed. Neural networks models were applied and compared with other travel time prediction technologies. The results obtained from this study are promising. Automated Vehicle Identification system in San Antonio, Texas was tested by these models as a case study. This chapter draws conclusions from the previous chapters and gives some recommendations for future research.

6.2 – AVI Travel Time Data Collection

As mentioned in the literature review, accurate travel time information is very beneficial for ITS applications. Because of this, it is important to evaluate the reliability and accuracy of AVI readers. The study in this thesis indicated that AVI system is highly accurate in calculating travel times. The mean difference between AVI- and GPS-calculated travel times was found to be 0.04 seconds, with a standard deviation of 0.99 seconds. The level of travel time accuracy generated by the AVI system was found to exceed those often reported for loop detectors. The highly accuracy of AVI tag data provides highly accurate data source and improve the accuracy and reliability of travel time forecasting.

6.3 – AVI Antennas Site Location Optimization

In the mean time, the AVI antennas site location are mostly combined with its nature, while the number of AVI site equipment determined by available funding and desired area of coverage. This study developed a model to solve the locations of the automated vehicle identification site

problem in the large-scale transportation networks. The developed model was tested on an assumed transportation networks. The results are promising in this stage.

The optimized AVI antennas site locations will maximizes the "coverage" of the network and thus produces more representative traffic data information. The accuracy and reliability of overall traffic data collection system and travel time forecasting also will increase because of this.

6.4 – Forecasting Freeway Travel Time with A Neural Network

The estimation and predication of link travel times in a road traffic network are critical for many intelligent transportation system (ITS) applications such as route guidance system (RGS), advanced traveler information systems (ATISs) and freeway traffic management systems. Most studies have been done in this area. This thesis examined artificial neural networks (ANNs) for forecasting freeway link travel time.

Two ANN models was designed and tested based on data obtained from San Antonio TransGuide AVI system. The ANN models were used to forecast one through five time periods ahead into the future, and the best model for a given situation was determined by the lowest mean absolute percentage error. It was found that when forecasting one and two time periods into the future the ANN model that used only the preceding travel times from the observed link was best. However, when forecasting three, four and five time periods into the future the ANN models that employed link travel times on links immediately upstream and downstream from observed link gave the better result. Hence, the NNM1 model could be used to forecast the travel time in one time period ahead and will produce better result than the most of the typical travel time forecasting technologies currently used.

6.5 – Recommendation for Further Research

A desirable objective of this thesis is to further model and optimize the AVI system. The conclusion of this research not only answered some of the questions, but also generated new questions in the same time.

First, for AVI site location optimization problem, the developed model was tested on a relatively small numerical example. Testing of the model developed on the greater transportation network such as San Antonio transportation networks is one of the directions for the future research. The development of models based on other Metaheuristic approaches (Simulated Annealing, Taboo Search) is certainly one of the extremely important directions for future research. Testing of the model with different O-D matrix, such as peak hour O-D matrix, and include more factors in the objective function is also one of the important directions for further research. Finally, how to combine the model with the application of existing facilities, such as bridge, is another important direction for further research.

For travel time forecasting, while the results demonstrated in this study are promising, a number of issue still need to be resolved before ANN models can be implemented. This study used the data based on 5-min aggregation level which supported by John Reily's previous study in AVI travel time data collecting. Obviously, a sensitively analysis is required to examine the optimal level of aggregation. It also would be interesting to find a more basic issue: Should the data be aggregated or not? This topic is one of the important directions for future research. Lastly, other ANN model structures, such as feedforward ANN with backpropagation, which was successfully used in many studies, may lead to better performance and definitely also is an important direction for future research.

In addition, because of limited data from AVI-equipped arterials, much of the travel time forecasting focused on freeways only. A more complete arterial data set would allow for a better comparison of AVI time accuracy and a comparison of level of aggregation, RMSE, correlation values and forecasting model with those found for freeways. This level of aggregation study is of particular interest given that it is known that travel times vary significantly more on signalized arterials than on freeways.