

## CHAPTER 5

### CONCLUSIONS

Throughout this thesis, comparisons have been made between the usage of intelligent cruise control (ICC) and conventional cruise control (CCC) at both the macro-level and micro-level. Comparisons were also made to manual driving at the micro-level. The following sections reiterate the conclusions made in chapters three and four of this thesis. The final section includes recommendations for further research.

#### 5.1 Conclusions

##### 5.1.1 *Macroscopic Analysis*

As stated in the first chapter of this thesis, the purpose of the macro-level analysis was to determine the effects of ICC on driver workload. Comparisons were made regarding the use of cruise control buttons and brake interventions. The conclusions drawn are:

- There was no difference in the usage of the ON and SET buttons between ICC and CCC.
- ICC resulted in a higher usage of the ACCEL button and a lower usage of the COAST button compared to CCC (ACCEL button used 27.2 versus 15.3 times per 100 km, while COAST button used 15.3 versus 16.3 times per 100 km).
- There was no statistical difference in the use of the CANCEL and RESUME buttons between ICC and CCC.
- The number of brake interventions while ICC was engaged was higher than CCC (5.8 versus 3.9 times per 100 km).

There is no evidence from these conclusions that ICC reduces the amount of driver workload compared to CCC.

The analysis included two additional statistics: overall usage and near encounters. It was found that ICC was used more than CCC in these similar trips (55 versus 40 percent usage) and that there was no difference in the number of near encounters for ICC and CCC.

### *5.1.2 Microscopic Analysis*

The first half of this thesis focused on entire similar trips performed by each volunteer who participated in the FOT. The second half, however, focused on portions of these similar trips representing specific roadways. The two selected road classes were high speed arterial and freeway. Unfortunately, it was determined that the recorded range data for the selected freeway facility was erroneous. Results pertaining to the use of this data are inconclusive.

The first analysis performed in the fourth chapter compared day-to-day operations of similar trips. It was determined that day-to-day headway, speed and acceleration variability existed for the high speed arterial. Similarly, day-to-day acceleration and speed variability existed for the freeway facility.

The second analysis determined, for each chosen facility, the most probable speed, acceleration and headway (arterial only) values. The following conclusions are drawn from this analysis:

- The most probable manual driving speed on the high speed arterial was lower than the most probable ICC or CCC driving speeds.
- The most probable freeway driving speeds for manual, ICC and CCC were within a 10 km/h interval.
- The most likely acceleration rates on either the high speed arterial or freeway facility were within -0.05g to 0.05g for manual, ICC or CCC driving modes. The range of acceleration values observed for the high speed arterial were greater than on the freeway based on manual driving mode.

The third analysis determined the probability of using cruise control on either the high speed arterial or freeway. The conclusions are:

- Cruise control (ICC or CCC) was used more on the freeway facility than on the high speed arterial.
- ICC was used more than CCC at speeds less than 75 km/h on the high speed arterial and for all speeds on the freeway facility.

The final analysis considered the speed-headway relationships for each driving mode based on high speed arterial data. It was found that manual driving resulted in larger headway values than either ICC or CCC at speeds less than 80 km/h. It was also determined that the ICC speed-headway curve was similar (not identical) to the CCC speed-headway curve. The aggregated mean headway-speed charts, however, showed more similarity between ICC and manual than ICC and CCC.

## 5.2 Recommendations

The objective of this thesis, as described in the first chapter, was to determine differences between ICC, CCC, and manual driving modes. Specifically, this meant the determination of workload changes (number of cruise control button presses), cruise control usage, changes in accident risk, and car-following relationships.

As indicated in the previous section there was no evidence to suggest that ICC reduced driver workload with respect to buttons pressed and brake interventions. As was determined, the number of brake interventions while ICC was engaged was higher than CCC (5.8 versus 3.8 times per 100 km). This could be due to an increased number of vehicle cut-ins ahead of ICC vehicles compared to vehicles under CCC control. Therefore, it is recommended that further investigation be conducted into differences in vehicle cut-ins ahead of cruise control (ICC and CCC) vehicles.

As described in chapter 4, the micro-level analysis was based upon data extracted from similar trips performed by two volunteer drivers resulting in data for two particular roadways. It is recommended that further micro-level analysis be performed for additional roadways using drivers of both genders and multiple age groups for a given facility. In this way the results would be more representative of all drivers.

In addition to expanding on the data set used for micro-level analysis further investigation of the car-following relationships is recommended. It was determined that the speed-headway relationships for ICC and CCC were similar, but not identical. Therefore, exploration into the differences of these two speed-headway curves is recommended in order to compare these two cruise control options.

Finally, it is suggested that scope be expanded to include both longitudinal and lateral movement behaviors. A change in either behavior could impact system safety. Specifically, it is recommended that further investigation be conducted into differences in lane-changing behavior between ICC and CCC.

In conclusion, this thesis has demonstrated that the use of intelligent cruise control does not reduce driver workload (usage of cruise control buttons and brake interventions). Furthermore, this thesis has shown that the speed-headway relationships of ICC and CCC are similar. It is cautioned, however, that the speed-headway relationships were based on data for a particular high speed arterial performed by one driver. Overall, this thesis has provided a basis for further intelligent cruise control research.