# Development of Local Traffic Control Optimization Algorithms Using the Cell Transmission Model

## Master's Thesis of Qin Zhang


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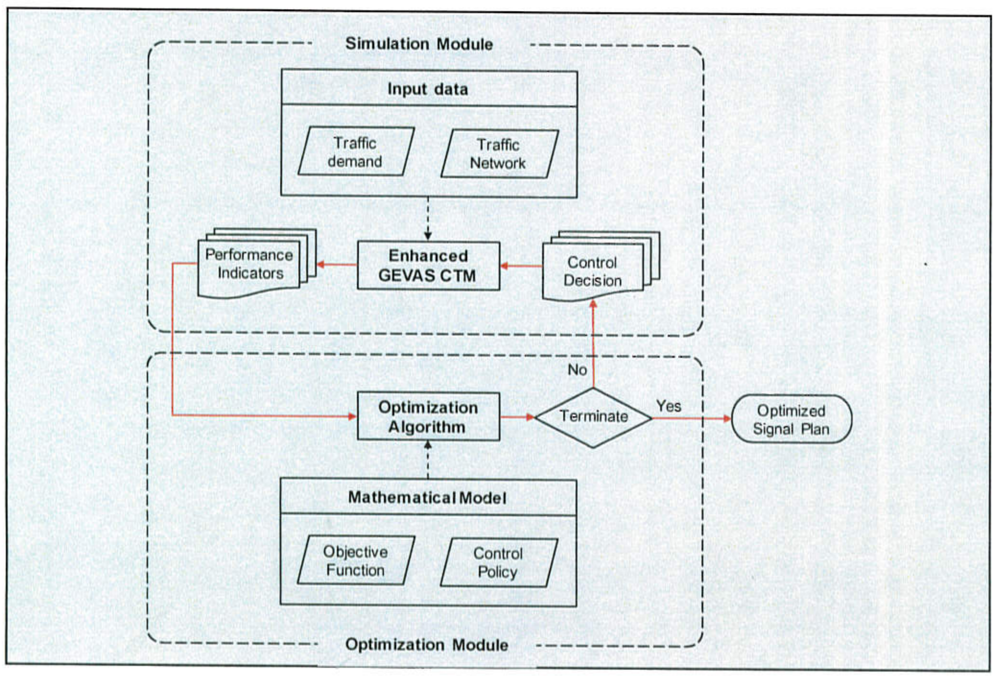



Traffic signals play significant roles in the local traffic control system. They can directly improve the quality of traffic flows and ensure traffic safety. In this thesis, a model-based control strategy is proposed for signal timing optimization at an isolated intersection. Firstly, we enhance permitted left turns in an existing code of Cell Transmission Model (CTM) developed by GEVAS software. Then, we emphasize developing two optimization algorithms, namely simulation-based dynamic programming (SDP) and memory bounded A* algorithm (MBA*). SDP is formulated based on the forward dynamic programming, and MBA* is a combination of dynamic programming and heuristic algorithm. Both SDP and MBA* optimize the phase durations as well as phase sequences. To facility the optimization, a set of control policies, e.g. minimum green time and the intergreen time, are considered. Finally, the quality of these two algorithms are assessed by a series of experiments at test intersections to evaluate the quality of two proposed algorithms.

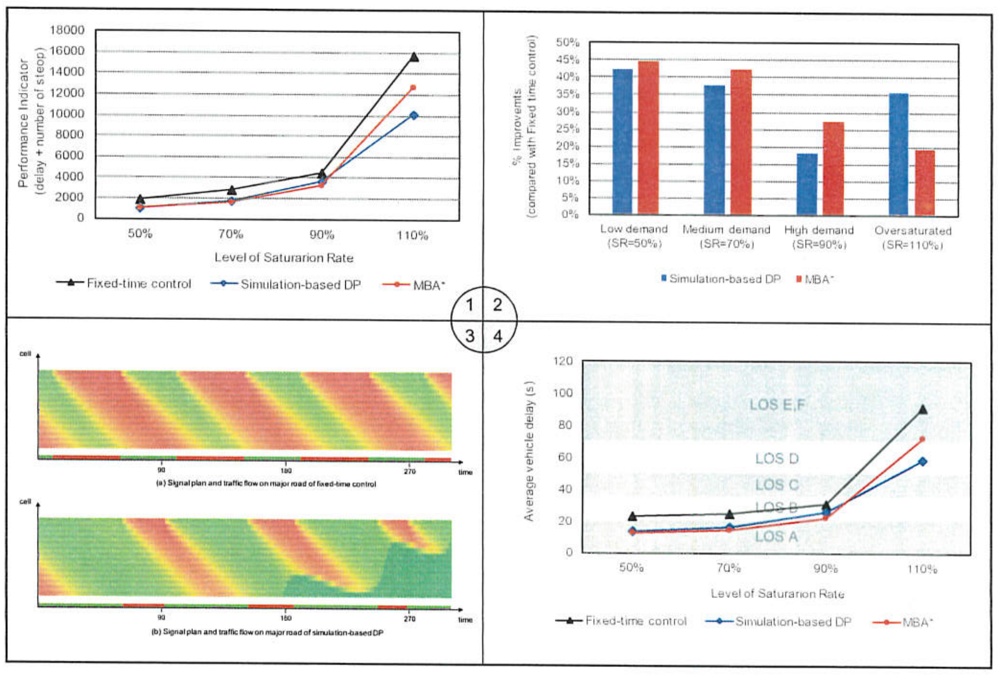
There are four main findings in term of the performance and efficiency of the algorithms.

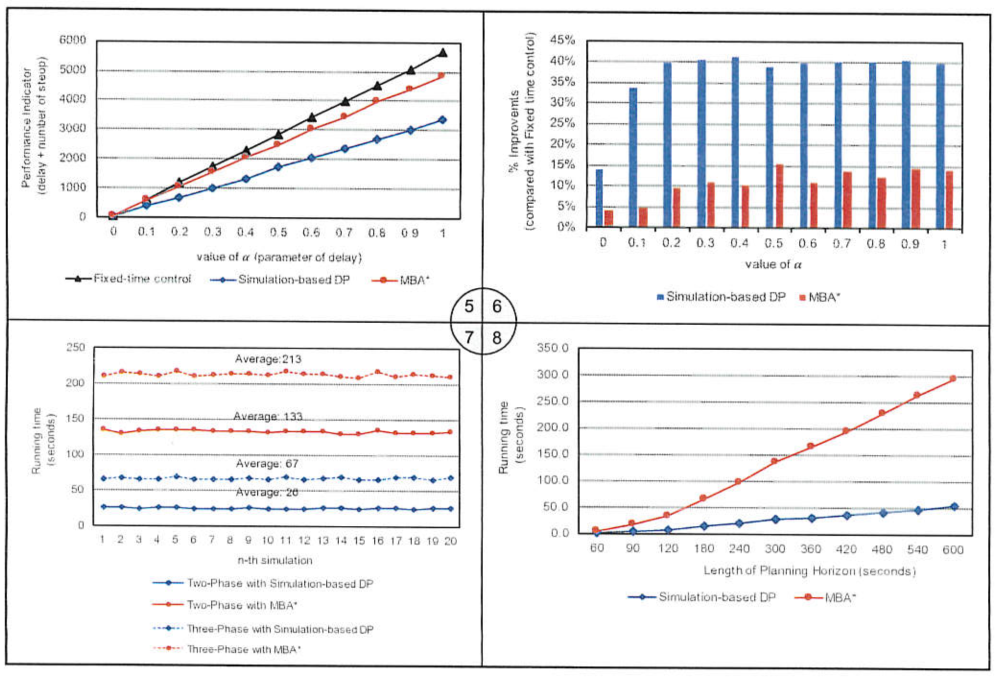
**Finding 1:**

The results of both algorithms are promising. They indicate that the performance of SDP and MBA* outperform that of the fixed-time control in all test cases. Both algorithms can lead to a higher level of service with less delays and less number of stops. These benefits from SDP and MBA* tend to be more obvious at a low and medium demand level. However, the improvements of both algorithms compared to fixed-time control decline at a high or oversaturated demand.

**Finding 2:**

MBA* leads to less delays and number of stops than SDP in an unsaturated condition, whereas SDP presents a significantly better performance in an oversaturated condition.




**Finding 3:**

Figure 6 shows a stable and good performance in most of the cases. However, when the weight of number of stops is set to 0.9 or 1, the improvements of both algorithms compared to fixed-time control dramatically decrease. It reveals that two proposed algorithms contribute more to the improvement of total delays and they are not ideal methods for improving the number of stops.

**Finding 4:**

Figure 7 and 8 show the efficiency of SDP and MBA* in terms of different number of phases at the intersection and different lengths of planning horizons. Generally, SDP always has a higher efficiency than MBA*. In details, the running time of both algorithms were higher at the intersection with more phases control system. Then, the running time grows rather linearly with the increasing length of planning horizons.