Re-Adaptive Alternative Stages for Traffic Signal Control

Master's Thesis of Sunghyun Jang

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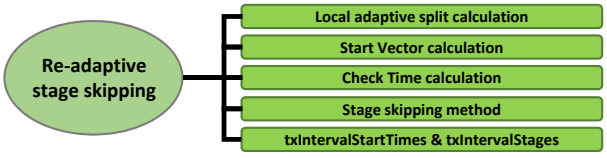

Figure.1 Re-adaptive stage skipping algorithm based on five functions

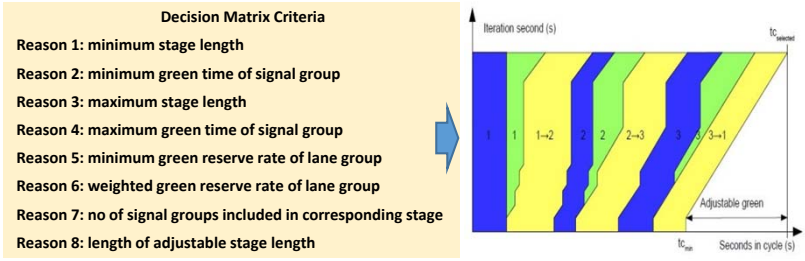

Figure.2 Local Adaptive Split Calculation based on decision matrix [Lin & Poschinger, 2015]

1. Re-adaptive stage skipping algorithm

Sitraffic MOTION (Method for the Optimization of Traffic signal control In Online-controlled Networks) is an adaptive traffic network control system developed by Siemens AG. Lin [2015] implemented an integrated macroscopic adaptive and microscopic actuated control method referred to re-adaptive stage skipping algorithm, based on five new calculation methods in order to apply the microscopic stage skipping traffic control method to local adaptive split calculation. However, in this algorithm, pedestrian signals combined with vehicle streams cannot be skipped, if here is vehicle demand. Frequent activations of pedestrian signals by calling the stage may cause reduction of intersection capacity and efficiency. Within this thesis, a new stage skipping algorithm for alternative stages which are mutually exclusive from pedestrians shall be implemented.

2. Development of a new algorithm for alternative stages

A new algorithm should be compatible with the previous re-stage skipping algorithm and other calculation methods. A new concept is developed to apply alternative stages for stage skipping method. The new concept is to replace non-requested stages in the operating stage sequence with the corresponding alternative stages. Also, the new algorithm develops a new Start Vector equation which can cover all of possible stage skipping cases and solve the issues that the previous algorithm cannot reflect the earlier or later start of the next stage after stage skipping. Above all, the new algorithm is developed to work with different part of re-stage skipping algorithm without the change of basic principles in the previous five calculation methods and LASC.

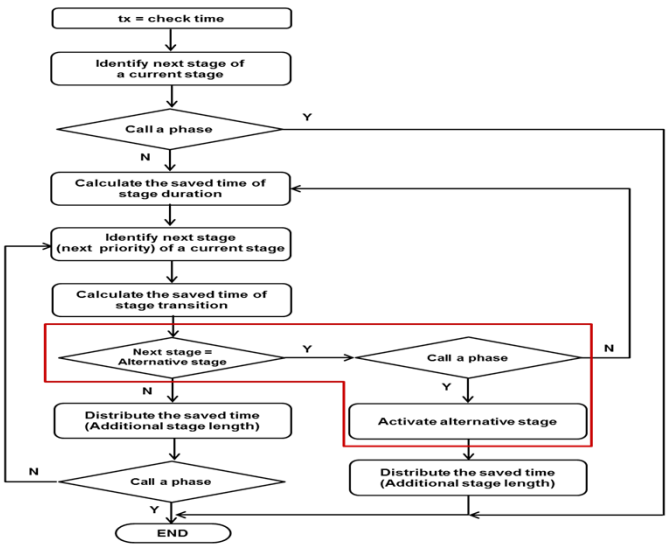

Figure.3 A new algorithm flow chart

A new calculation process of Start Vector

In the Beginning of a cycle (Backward Calculation)

SV_0 = (offset + tc) % tc

$$SV_i = \begin{cases} (tc + SV_{ne} - T_{pr\to i}^{stageTransition} - T_i^{minStage} - CV_i - T_{addStage\,i}) \,\%\, tc, \\ 999, \qquad if\ skipped\ stage \end{cases}$$

$$SV_{ne} = \begin{cases} SV_0, \text{ if the last stage} \\ SV_{i+1}, \qquad else \end{cases}$$

After skipping a stage (Calculation process from the next stage to last stage)

$$SV_{pre} = (SV_{next\ stage\ c} + T_{addStage\,c}) \,\%\, tc$$

$$SV_i = \begin{cases} SV_{pre}, \qquad if\ the\ next\ stage\ of\ the\ current\ stage\ \ after\ stage\ skipping \\ (SV_{pre} + T_{pr\to i-1}^{stageTransition} + CV_{i-1} + T_{i-1}^{minStage} + T_{addStage\,i-1}) \,\%\, tc \\ 999, \qquad if\ skipped\ stage \end{cases}$$

$$SV_{pre\,i+1} = SV_i$$

$$SV_0 = \begin{cases} SV_{pre}, \qquad if\ the\ next\ stage = \ the\ first\ stage \\ (SV_{last} + T_{pr\to last}^{stageTransition} + CV_{last} + T_{last}^{minStage} + T_{addStage\,last}) \,\%\, tc \end{cases}$$

3. Evaluation on SUMO simulations

A simulation study is conducted to evaluate the functionality and the performance of the new algorithm in a real intersection by SUMO (Simulation of Urban Mobility), as simulation software. The new stage skipping algorithm with alternative stages shows significant improvement in delay time and the number of stops compared with two other control methods, although it increases delay time for pedestrians by 10%, because of pedestrian signals skipped by alternative stages.