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A dynamic signal coordination control method for urban arterial roads and its application

Key words: Urban arterial, Control subarea, Coordination control, Correlation degree, Fuzzy logic, Intelligent transportation

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Motivation

- A carefully designed coordination control system for urban arterial roads would be of great significance to improve the traffic conditions of the entire city.
- Traffic flow efficiency is much reduced because of multiple intersections between arterial roads and secondary roads or minor branches.
- A conventional coordination control scheme, in which the whole arterial route is treated as a single coordination system, might not necessarily improve traffic flow efficiency.
- The new method divide the entire arterial road into a number of control subareas, and then apply the signal coordinated control to each subarea as a unit.

Main idea

- The entire system framework includes a control subarea division module and a coordination control module.
- The control subarea division module allocate all intersections of the arterial road to different control subareas according to the calculated correlation degrees.
- The coordination control module carries out the dynamic coordination control for all the intersections in each control subarea.
- If there is only one intersection in a resulting subarea, the subarea control is reduced to an adaptive control for an isolated intersection.

Method

1. The fuzzy computing method to estimate the correlation degree based on hierarchical structure.
2. The method for dividing the control area of urban arterial roads into subareas based on correlation degrees.
3. The Optimal control method for calculating the public cycle time of the control subarea, up-run offset and down-run offset of the section, and the split of each intersection.

Major results

- The new method can reduce the average travel time and the average stop rate effectively.

Table 3 A comparison of results of control performance from using the old and the new methods

Performance index	Direction	Time	New method			Old method		
			Max	Min	Mean	Max	Min	Mean
Average travel time (min)	South to north	Rush hour	39.2	21.7	29.1	51.3	34.5	40.4
		Peek hour	26.4	16.2	20.4	34.5	22.0	27.2
	North to south	Rush hour	37.1	19.3	26.6	47.7	30.2	39.3
		Peek hour	24.5	14.4	18.5	32.9	21.2	25.5
Average stop rate (times per car)	South to north	Rush hour	14.7	5.3	7.4	31.3	14.5	23.6
		Peek hour	8.8	4.1	5.4	26.8	9.6	14.3
	North to south	Rush hour	13.9	5.3	6.6	30.4	10.7	17.8
		Peek hour	7.8	3.9	4.5	22.2	6.1	9.8

Conclusions

- A case study of a real traffic control scenario in Shaoxing City, Zhejiang Province, China showed very satisfactory results.
- The proposed control system is generic in nature and will find broad applications in similar arterial roads with significant mixed traffic flow characteristics.
- If the traffic flow of the arterial road is close to saturation, or the traffic volume of many branches is large and close to that of the arterial road over a long period of time, the presented coordination control method might not be suitable.