A Probabilistic Approach to Evaluate Safety During Intergreen Interval

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Key words: signalized Intersection, intergreen, safety

Background

- Differences in signal operation policies between Germany and Japan

(1) Signal Control Approach

A. Group-based signal control (Germany)
   - Compatible traffic movements
   - Displayed signal phasing

B. Stage-based signal control (Japan)
   - In response to demand change in the case of adaptive control
   - Unused green times

(2) All-red Time Design

- Germany
- Japan

(3) Signal Display Sequence

(Y-and-R, 1s)

Purpose

Q: To what extent do the above differences affect safety performance during intergreen interval?

- To investigate the impacts of German signal operation policies on safety during intergreen interval in the context of Japan traffic, while accounting for the random nature of traffic

Methodology

- Traffic Conflict Technique (TCT)

\[ R = P \times I \]

Where, \( R \)=risk evaluation, \( P \)=occurring possibility, \( I \)=conflict severity

- Proposed Conflict Severity Measure

\[ \text{PET} = Y + AR + t_c - T_e + t_0 - \tau \]

Where, \( \text{PET} \)=Post Encroachment Time (PET)
- with the change of phase
- \( S_c \)=clearing distance
- \( V_c \)=clearing speed
- \( t_0 \)=starting response time
- \( I_t \)=entering time
- \( T_e \)=entry time of the last cleared vehicle
- \( Y \)=yellow time
- \( AR \)=all-red time
- \( L \)=vehicle length
- \( \tau \)=starting response time

Data

- Necessary data: traffic volumes; signal timing and geometric parameters; driver behavior (\( V_c, T_e, \ldots \))
- Data collection method: video recording; reduction by image processing program
- Obtained Data: 3 typical intersections in Germany and 12 in Japan; at least 2h video for each site.

Case Studies

- Base case: Japanese control policy + Japanese all-red design
- Case 1: Japanese control policy + German all-red design
- Case 2: Japanese control policy + German all-red design + German Y-and-R signal
- Case 3: German control policy + German all-red design + German Y-and-R signal

Conclusion

Safety and its reliability at Japanese intersections might significantly drop if simply changing the all-red time from the value based on Japanese method to the value based on German method or applying the Yellow-and-Red signal, without supplementary countermeasures. However, safety level is possible to be maintained if completely replacing Japanese policies with the German policies.

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