Comprehensive Evaluation And Refinement Methodology for AI-Based Traffic Data Extraction System

STRIDE | Southeastern Transportation Research, Innovation, Development and Education Center

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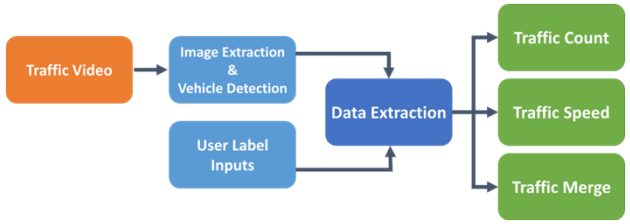
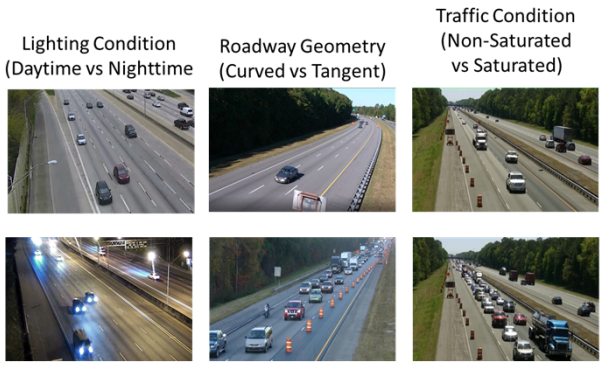
ABSTRACT

- Automatic collection of accurate traffic data, such as vehicle speed, volume, density, and occupancy, is critical for the function of smart cities, as this data can used for traffic simulation modeling, behavior study, and traffic operations.
- While efforts have been made to use AI object detection algorithms for this task. Evaluation using the frame-level AI detection performance does not directly reflect the accuracy of the extracted traffic data.
- This study seeks to assess the accuracy of an AI-based traffic information extraction system in diverse conditions and to demonstrate the feasibility of proposing accuracy improvement methods with a good understanding of the overall system performance.
- To assess the system accuracy, an annotation tool was developed to generate manual reference data to compare with the automatically extracted data. A case study that evaluate an AI system was completed using videos collected in diverse data collection conditions.
- To demonstrate the benefit of comprehensive evaluation, a novel headway post-processing method was proposed based on the evaluation and applied to the system. The proposed post-processing method effectively eliminates the overcounting errors.

AI BASED TRAFFIC DETECTION SYSTEM



DIVERSE TESTING CONDITIONS

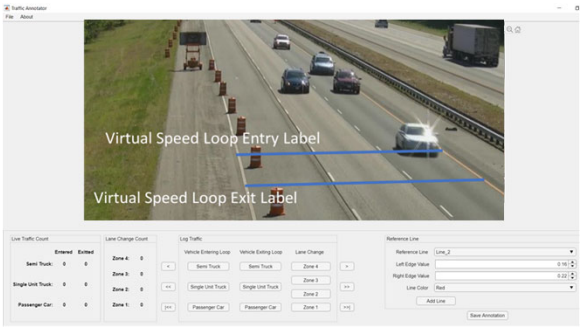


EVALUATION METHODOLOGY

- The evaluation is based around diverse testing conditions to evaluation the system performance under different conditions. Since many existing performance metrics that used by computer vision communities only consider the frame level accuracy, which might not translate well to traffic count and speed measurement accuracy. The evaluation emphasizes on the final outcome that actually meaningful to traffic engineers.

Diverse Testing Conditions | Traffic Count Extraction | Traffic Speed Measurement

MANUAL EXTRACTION OF TRAFFIC DATA



EVALUATION METRICS

Percent Volume Error: $q_{error} = \frac{q_{AI} - q_{manual}}{q_{manual}} \times 100$

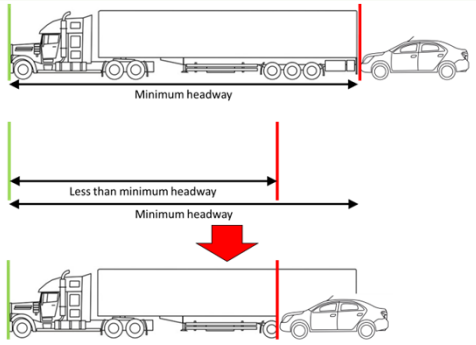
Absolute Speed Error: $v_{error} = v_{AI} - v_{manual}$

CASE STUDY RESULTS

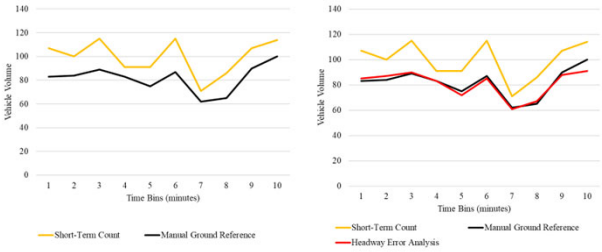
Testing Videos		AI Traffic Count Error (%)	Post-Processed Count Error (%)	AI Traffic Speed Error (MPH)
Traffic Condition	Saturated Traffic 1	+22.0	-1.1	-0.6
	Saturated Traffic 2	+7.6	+0.1	+1.1
	Non-saturated Traffic 1	+5.2	+3.8	-1.2
	Non-saturated Traffic 2	+2.6	+1.8	-3.9
Roadway Geometry	Straight Roadway	+2.3	+1.5	-27.3
	Curved Roadway	+2.6	+1.8	-3.9
Lighting Condition	Daytime Condition	-15.8	N/A	+7.6
	Nighttime Condition	-45.7	N/A	N/A

FALSE POSITIVE CASES

HEADWAY-BASED POST-PROCESSING



- **Volume Count Before and After Head-Based Post-Processing**



CONCLUSIONS AND POTENTIAL BENEFITS

- Evaluating AI system under diverse conditions is important to understand the performance and limitation of AI-Based Traffic Data Extraction System.
- The proposed methodology provides transportation agencies a way to fairly judge different AI solution for traffic data extraction equally.
- The proposed methodology provides researches to understand Ai model's performance under diverse conditions and identify areas for improvements.
- It is recommended to using the proposed methodology to develop a standard testing dataset that can be used by agencies and researchers alike.