

CCTV Applications for Traffic Management and Measurement: Nationwide Survey and Maryland Case Study

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Background

Can video analytics be used to extract relevant traffic data from existing MDOT-SHA closed circuit television (CCTV) cameras?

Approach

- Nationwide survey of U.S. transportation agencies
 - Learn from video analytics experience
- Maryland Case Study
 - Develop testbed of CCTV footage
 - Analyze vendors' capabilities

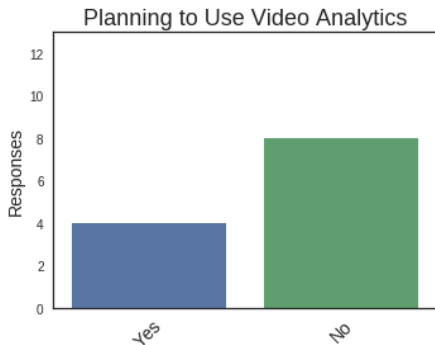
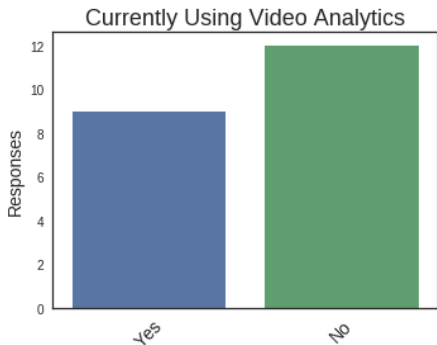


Survey Overview

- Online survey:
 - 19 multiple choice, 5 fill-in-the-blank, and 12 free response
 - Focused on camera infrastructure, video analytics solutions, experiences with vendors, and future plans.
- Distributed to members of transportation agencies from all states
- Relevant points of contact identified:
 - Graduates of I-95 Operations Academy
 - Relevant TRB subcommittee rosters
 - AASHTO 2016 conference attendee list

Agency Usage

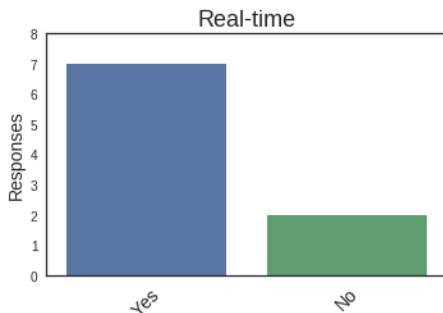
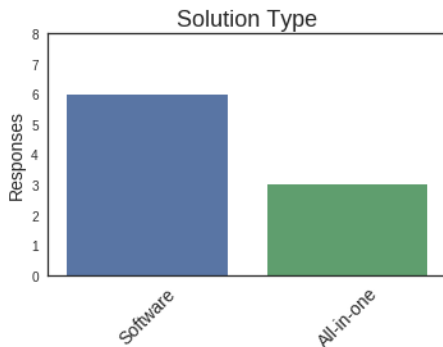
- 21 agencies responded: 9 using video analytics, 4 plan to soon
- Respondents include technicians, engineers, modelers, planners, managers, and directors



Video Analytics Solutions

Of the 9 agencies who reported using video analytics:

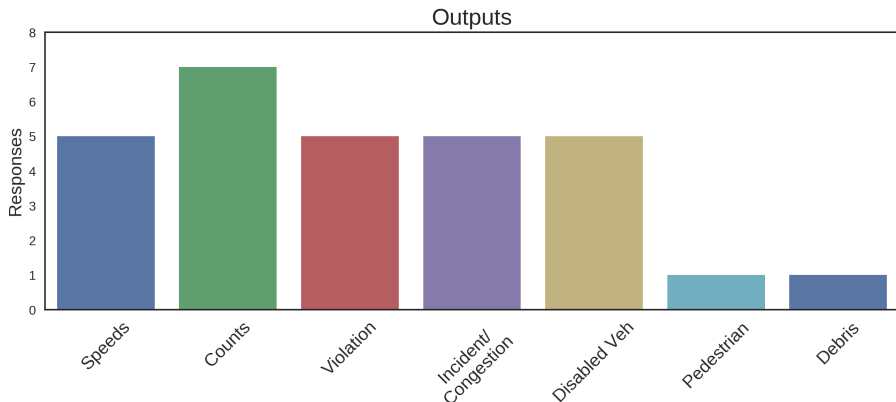
- Camera infrastructure varies significantly (20-800 cameras of various types, frame rates, video encodings, and resolutions)
- 6 are software-only (i.e., no hardware purchase needed)
- 7 deliver data in real time



Data Outputs

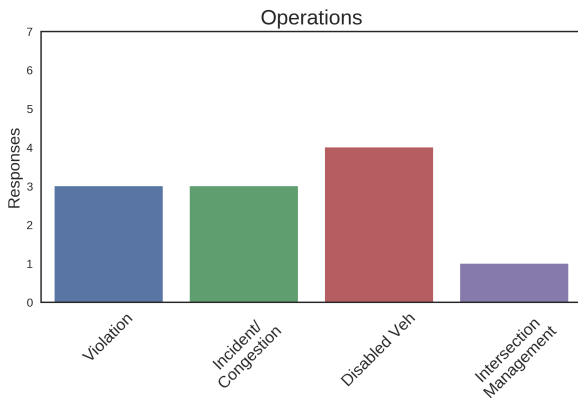
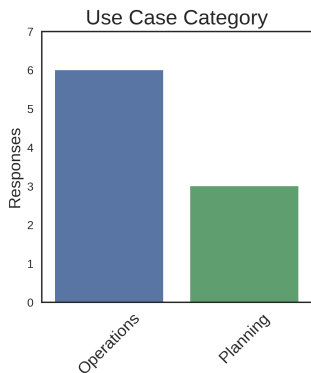
Despite different implementations,

- Speeds, Counts, Incidents, Violations, Disabled vehicles are common to at least 5 agencies



Use Cases

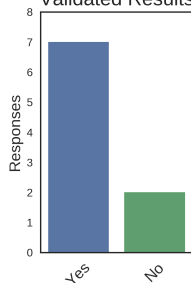
- Operations vs Planning
- Operational perspective focused primarily on detecting and responding to anomalies



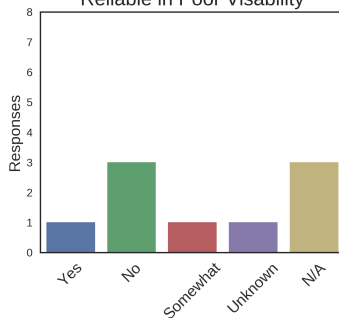
Data Validity

- Reliability unknown or low in poor visibility conditions
 - Extent to which this is problematic depends on application
- About 50% willing to act on results (others more apprehensive)

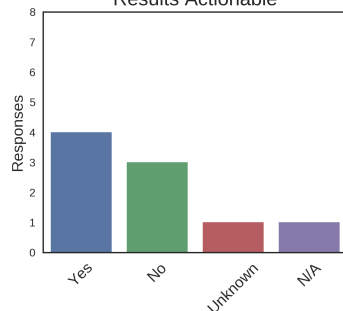
Validated Results



Reliable in Poor Visibility



Results Actionable



Survey Takeaways

- Strong interest in video analytics amongst US transportation agencies
 - 24% of states have agencies using or planning to use
- General concern about reliability of results, particularly during low-light, poor weather, and high-glare conditions
- Suitability of existing solutions depends on application
 - Detecting abnormalities vs. highly-accurate speed/count data

Case Study Overview

Goals

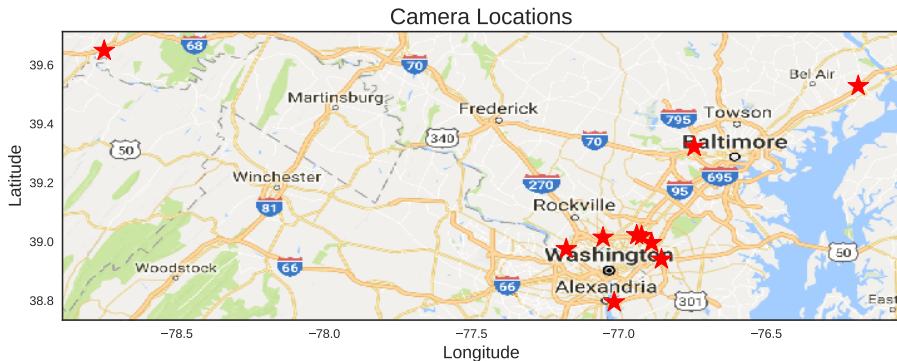
- Focus on existing MDOT-SHA camera infrastructure
- Understand whether video analytics vendors can extract meaningful results from CCTV feeds

Steps

- Identify subset of MDOT-SHA CCTV cameras to study
- Create representative testbed of sample clips from selected cameras
- Invite vendors to demonstrate their products on testbed
- Evaluate vendor performance and draw conclusions

Camera Selection

- 10 representative CCTV cameras selected
- Includes ones with known challenges (e.g., complex road geometry, challenging camera angle, glares/shadows at certain times of the day)



Testbed development

- 360 hours of video recorded at selected cameras during March '17
- 10 representative 1-hr clips selected for testbed
 - Various weather, road geometry, traffic, camera angles, incidents



Vendor Evaluation

- Shared testbed with 6 interested vendors → 2 participated
- Common vendor comments regarding suitability for video analytics:
 - Poor camera positioning
 - Low resolution / contrast
- Vendors A and B provided:
 - Annotated video demo (counting, incident/congestion detection)
 - Data extracted from one testbed video

Evaluation Criteria

- Counts (ground truth = manual counts)
- Speeds (ground truth = probe speeds)

$$MAPD(\%) = \frac{100}{n} \sum_{i=1}^n \left| \frac{y_{validation} - y_{vendor}}{y_{validation}} \right|$$

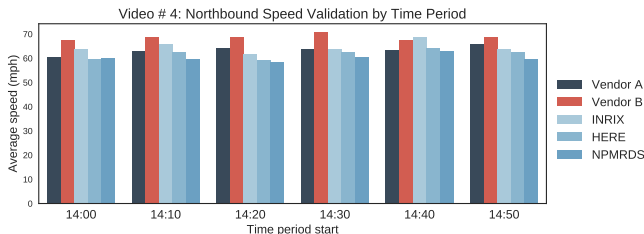
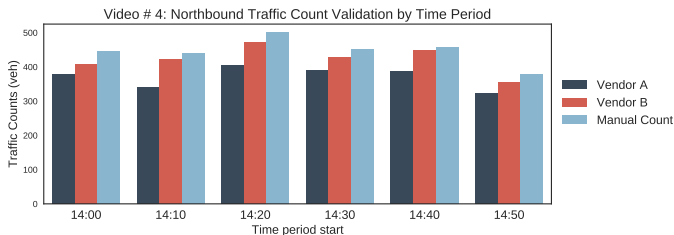
Testbed Video Used for Data Extraction

- Contains snowfall and poor visibility
- Camera focused primarily on Northbound traffic



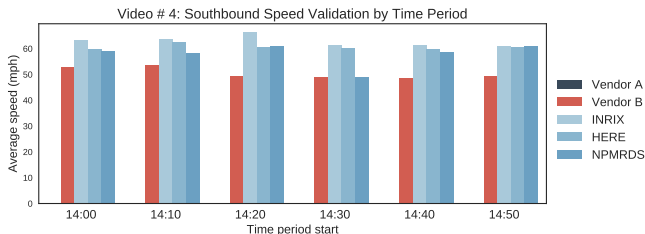
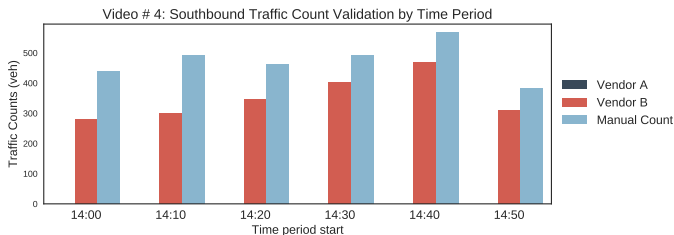
Quantitative Results: Northbound Traffic

- Vendor A: within 15% of manual counts and 4% of probe speeds
- Vendor B: within 5% of manual counts and 7% of probe speeds



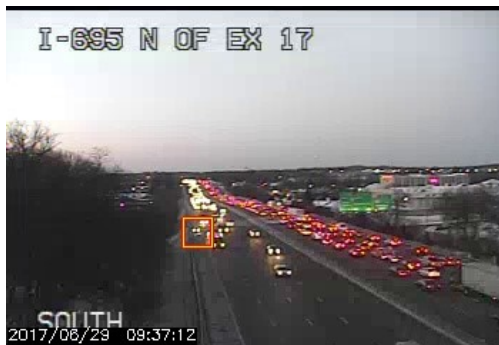
Quantitative Results: Southbound Traffic

- Vendor A: Did not extract data in Southbound direction
- Vendor B: within 25% of manual counts and 20% of probe speeds



Case Study Summary

- Count/speed accuracy is highly dependent on camera positioning and video quality (from vendor comments and quantitative results)
- Even without proper calibration or ideal conditions, video analytics systems may be useful for detecting anomalies



Conclusions

- General optimism about the future of video analytics, but current solutions have challenges (positioning, visibility requirements)
- Based on existing MDOT-SHA camera infrastructure, video analytics solutions currently most suitable for:
 - Anomaly detection (e.g., incidents, congestion)
 - Short-term data collection under ideal conditions

Thank You

Q&A

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Acknowledgments

- Maryland SHA
- Survey participants