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

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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

![Chart showing Solution Type and Real-time responses](image)
Despite different implementations,
- Speeds, Counts, Incidents, Violations, Disabled vehicles are common to at least 5 agencies

![Outputs Diagram]
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)
**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)

Camera Locations
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

![Graph showing traffic validation results](Image)

**Video #4: Northbound Traffic Count Validation by Time Period**

**Average Speed (mph)**

- Vendor A
- Vendor B
- Manual Count

![Graph showing speed validation results](Image)

**Video #4: Northbound Speed Validation by Time Period**

**Time period start**

- 14:00
- 14:10
- 14:20
- 14:30
- 14:40
- 14:50

**Traffic Counts (veh)**

- Vendor A
- Vendor B
- Manual Count

**Traffic Counts (veh)**

- INRIX
- HERE
- NPMRDS
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

![Video #4: Southbound Traffic Count Validation by Time Period](image)

![Video #4: Southbound Speed Validation by Time Period](image)
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.

![Image of highway with traffic]

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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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