Using Drones to Collect Speed Data: A Novel Approach

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Introduction and Motivation

- Speed and volume data are important for many transportation studies
- Collecting this data can be costly using traditional methods such as LiDAR, pneumatic tubes, and manual TMCs
- Small Unmanned Aerial Systems (sUAS) are already being used for civil engineering applications such as bridge inspections
- sUAS have the potential to reduce the hours required to collect speed and volume data

Background

SPEED LIMIT SETTING

- The speed limit setting process in Massachusetts requires large amounts of data to be collected (MassDOT, 2017)
- 100 speed observations at each location every 0.25 miles in the proposed zone (MassDOT, 2017)
- This can be costly and time-intensive in the field

Background

AERIAL IMAGE PROCESSING

Video frames

Source: Samuelsson. O. Vehicle Tracking Algorithm for Unmanned Aerial Vehicle Surveillance. No. June, 2012, pp. 1-76

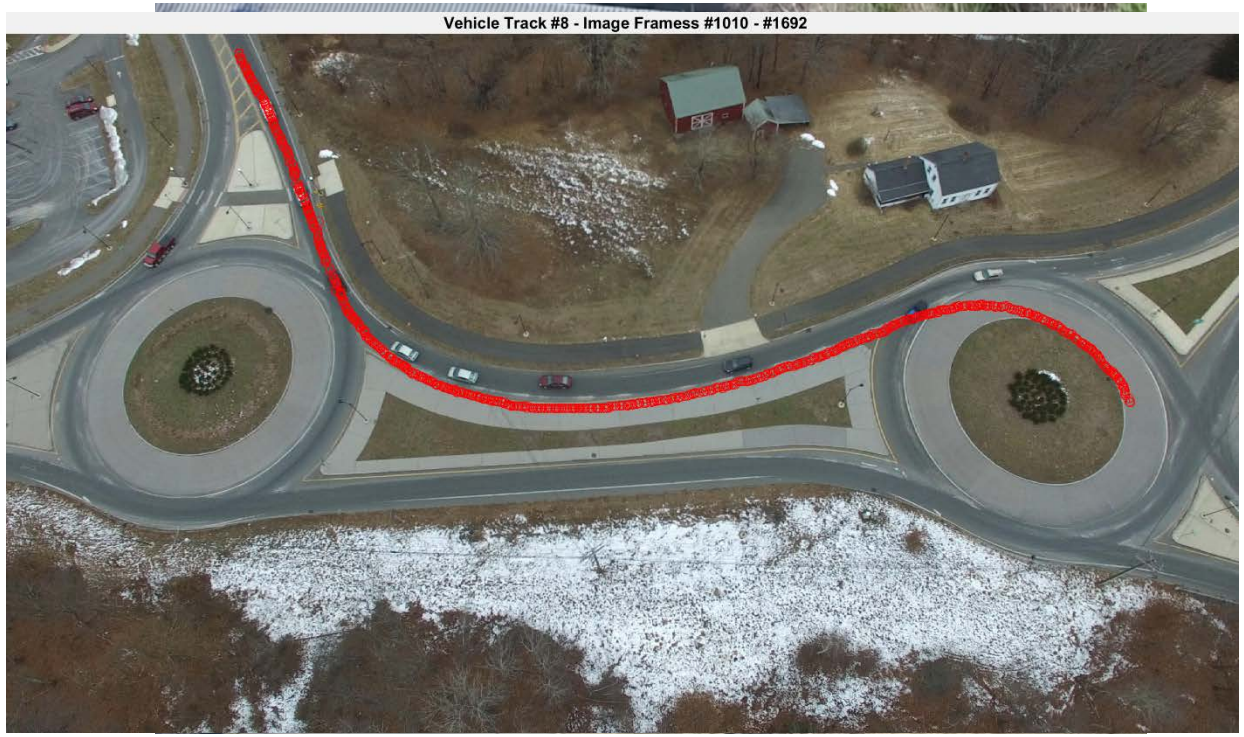
Volume Study

A

- Chose intersection and collect video

- Phantom 3 Pro
- Data collected from 7am to 9am
- Drone's camera has FOV of 94 degrees

Volume Study



Vehicle Tracking

- Kalman filter was used to predict motion
- Based on the closeness of predicted location and observed, the detection will merge to vehicle track

Volume Study

Timestamp	TL-TR	TL-BL	TL-BR	TR-TL	TR-BL	TR-BR	BL-TL	BL-TR	BL-BR	BR-TL	BR-TR	BR-BL
7:00:00	100%	64%	80%	100%	68%	N/A	67%	80%	N/A	76%	N/A	71%
7:09:20	N/A	80%	100%	N/A	90%	N/A	76%	75%	100%	86%	N/A	100%
7:19:00	100%	75%	85%	100%	92%	N/A	93%	96%	100%	94%	N/A	89%
7:28:20	100%	100%	100%	100%	90%	N/A	96%	89%	100%	88%	100%	89%
7:41:05	100%	100%	100%	83%	100%	N/A	94%	100%	86%	90%	N/A	89%
7:50:26	100%	100%	100%	100%	94%	100%	88%	92%	100%	95%	100%	100%
8:00:00	80%	92%	87%	100%	89%	100%	92%	90%	100%	100%	100%	86%
8:09:20	100%	100%	100%	83%	100%	100%	83%	94%	100%	100%	N/A	100%
8:21:00	100%	93%	95%	100%	88%	100%	85%	90%	100%	87%	75%	91%
8:30:20	86%	90%	100%	100%	94%	100%	83%	90%	83%	87%	100%	100%
8:47:41	100%	100%	91%	100%	93%	N/A	97%	89%	80%	88%	100%	86%
8:57:14	100%	100%	100%	N/A	80%	N/A	86%	89%	100%	95%	100%	100%

C

- Analyze time-cost and accuracy of technique

Accuracy

- Recall and precision both **averaged 93%**
- Accuracy was worse from 7:00am to 7:20am due to lighting

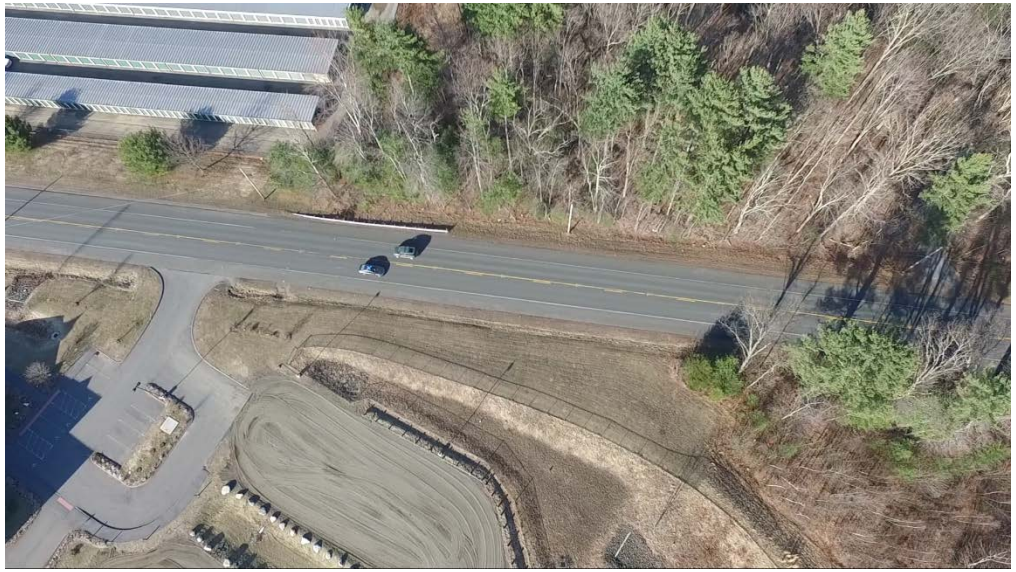
7:00am

7:20am

Speed Study

A

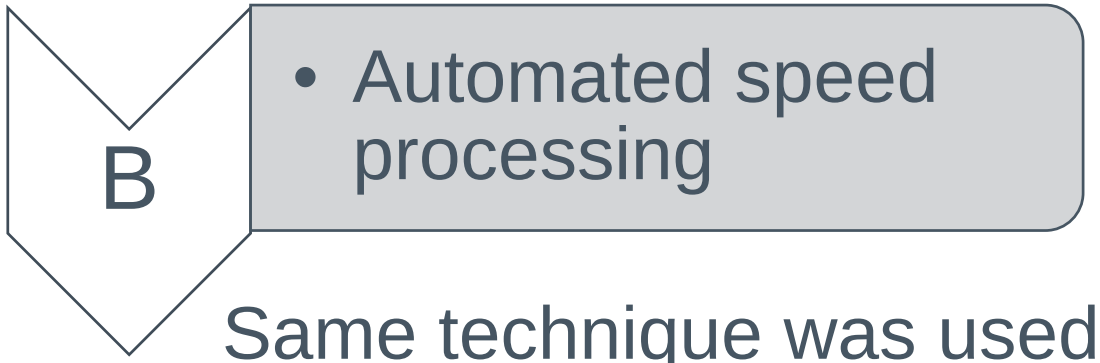
- Chose location and collect data



Route 9, Amherst, MA

- To track specific vehicle, an “X” was placed on top
- Drone flew at 100 meters (328 feet)
- Probe vehicle speeds were tracked using both speedometer and smartphone app

Speed Study



Same technique was used as volume study, plus:

- Camera Calibration
- Speed Computation

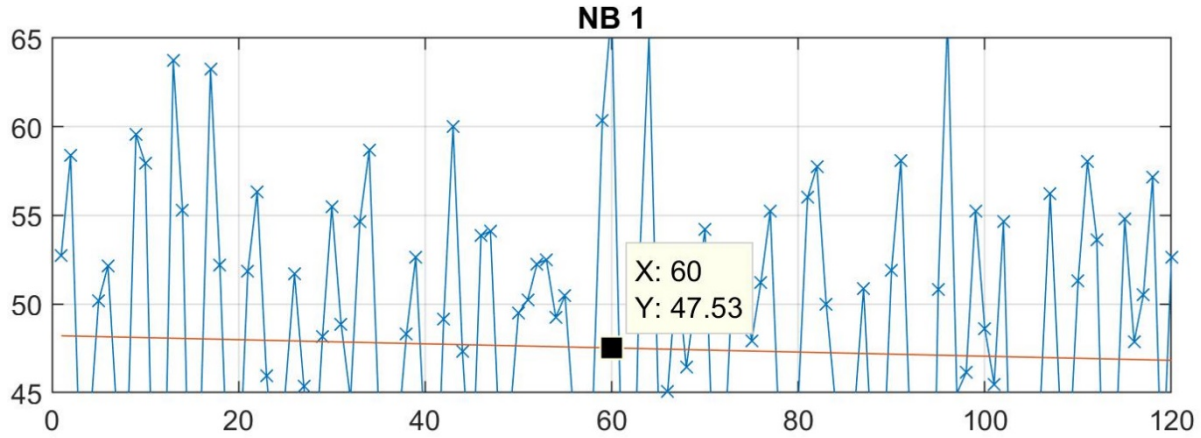
Camera Calibration

- Transformed image coordinate system to world coordinate system

Speed Computation

- Computed the vehicle speed for all vehicle trajectories
- Computed speed based on distance measured in world coordinate system divided by time

Speed Study



Example of median smoothing scheme on derived speed in drive

Camera Calibration

- Transformed image coordinate system to world coordinate system

Speed Computation

- Computed the vehicle speed for all vehicle trajectories
- Computed speed based on distance measured in world coordinate system divided by time

Speed Study

Direction Label	Actual Speed (mph)	Average Measured Speed (mph)	Relative Error
SB 1	45	48.8	8.4%
NB 1	44	47.5	8.0%
SB 2	50	52.9	5.8%
NB 2	51	52.4	2.8%
SB 3	55	59.5	8.3%
NB 3	54	57.3	6.2%
		Average:	6.6%

C

- Analyze time-cost and accuracy of technique

Conclusions

- Our method of UAS and video processing for volume data collection had an **accuracy of 93%**
- Speed data collection has an **average relative error of 6.6%**
- UAS data collection is able to collect all vehicles passing through an area, unlike LiDAR and RADAR sensors
- UAS have the potential to reduce the hours required to collect speed and volume data, especially on multi-lane medium to high volume roads compared to traditional methods

Future Studies

- Specific studies related to:
  - turning movement counts
  - conflict-event studies
  - intersection delay measurement
  - parking utilization tracking
  - queue studies
- Exploring the optimal vehicle tracking method using UAS to gain the most accurate results

Contact

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