Short-term Freeway Work Zone Capacity Estimation Using Support Vector Machine Incorporated with Probe-vehicle Data (Paper No: 15-4248)

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Background

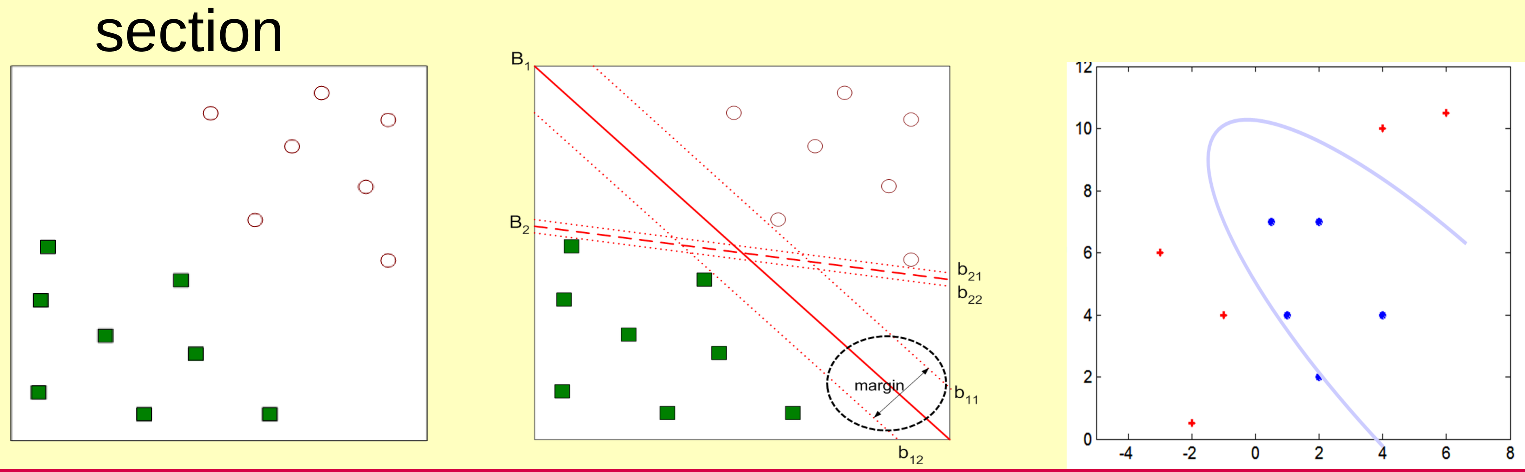
- Effective work zone management requires proper planning
- Proper planning requires accurate and reliable planning tools to estimate work zone impacts on mobility
- Critical element of these models is accurate estimation of work zone capacity

Objective

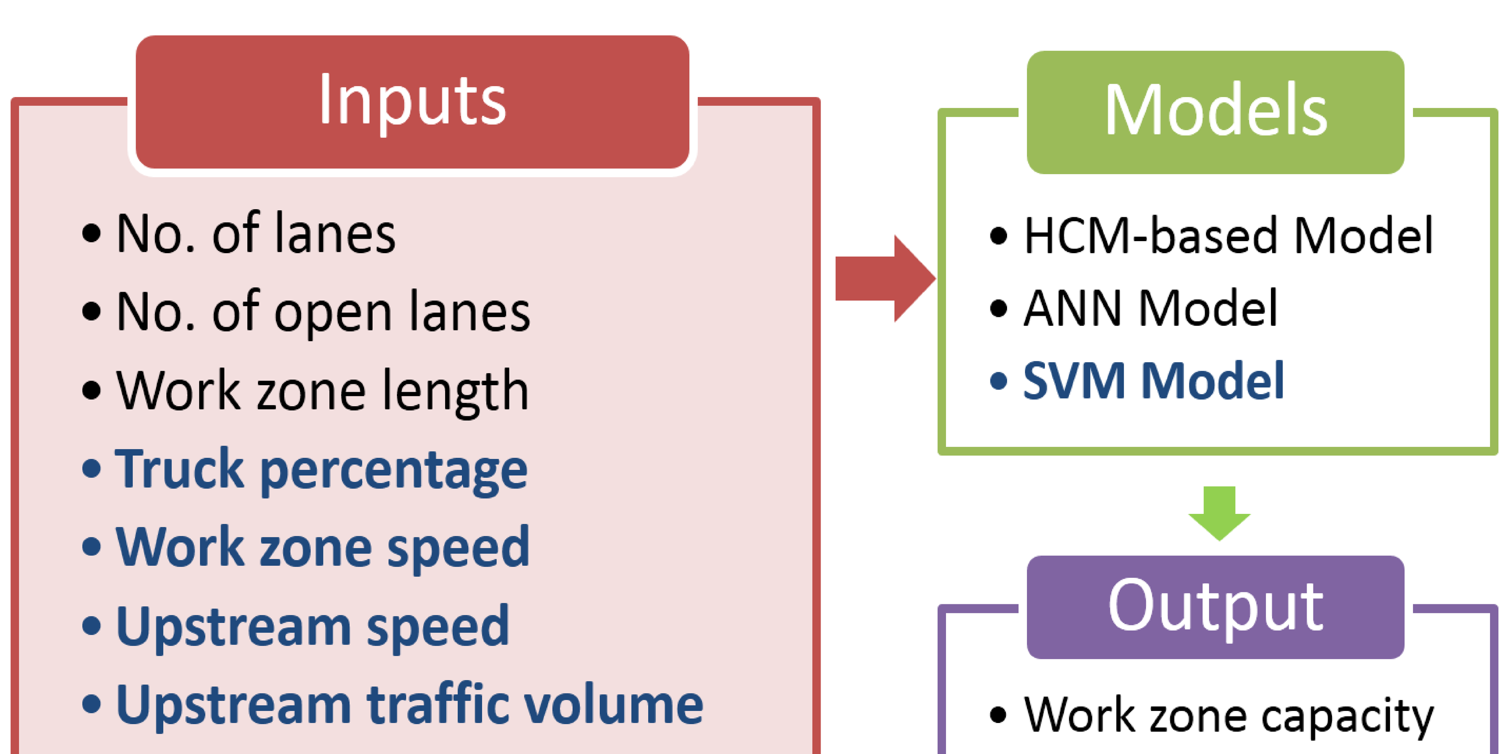
- Develop a short-term freeway work zone capacity estimation model
  - Identify a modeling approach for estimating work zone capacity
  - Use probe-vehicle data to calibrate the model

Support Vector Machine (SVM)

- Analyze data and recognize patterns
- Accurate and efficient pattern recognition algorithm
- Classify data with optimal hyper-plane in the SVM section



Proposed Framework



Case Study

- One short-term work zone site on Interstate Highway 76 (I-76) in New Jersey was selected for the evaluation of the proposed approach
- The traffic volume and speed data for estimating work zone capacity were simulated by VISSIM.

FIGURE 1 Location of Work Zone Site on I-76 and Detectors

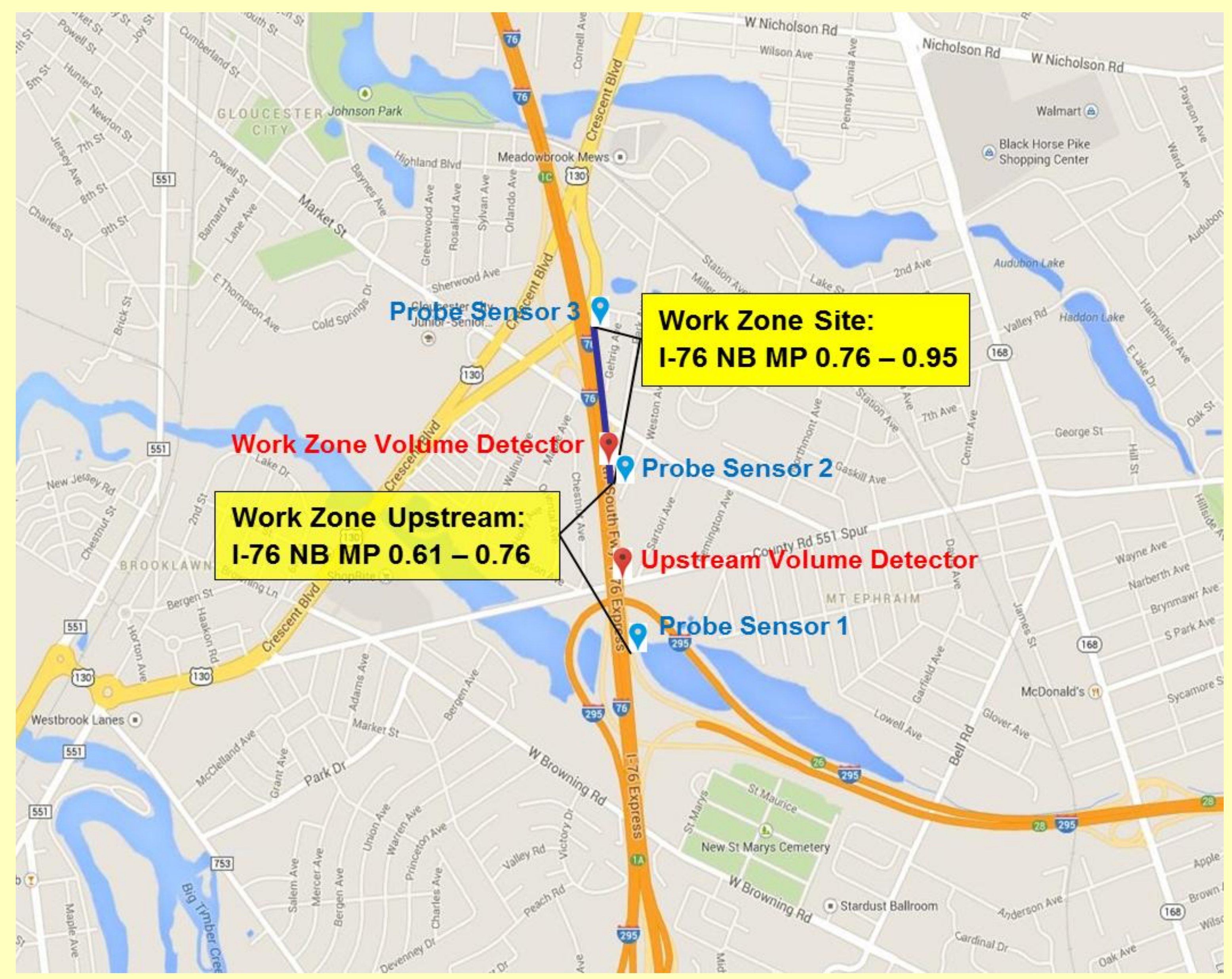


FIGURE 2 Comparison of Observed and Simulated Traffic Counts

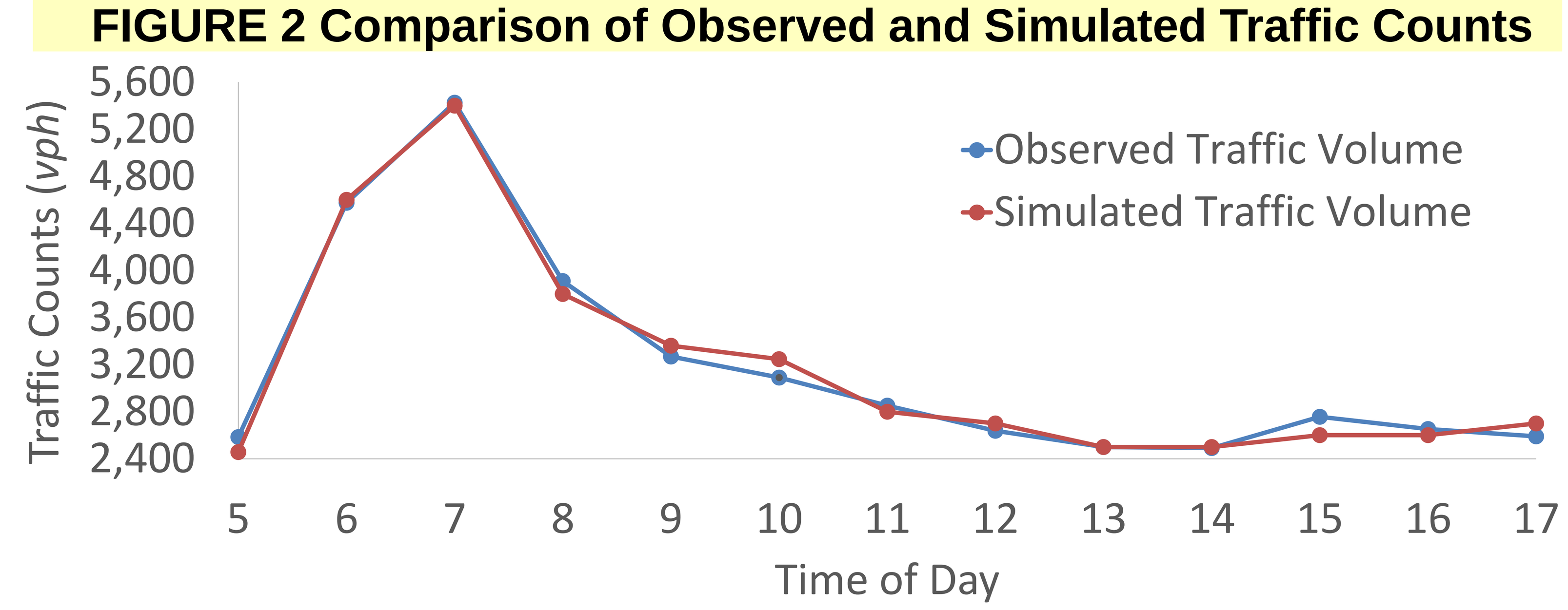


TABLE 1 Work Zone Capacity Estimation Training Data Sample

No. of Lanes	No. of Open Lanes	Work Zone Length (ft)	Truck Percentage (%)	Work Zone Speed (mph)	Upstream Traffic Volume (vph)	Upstream Speed (mph)
3	2	1,010	5.7	36.2	4,696	26.5
3	2	1,010	4.5	40.8	5,830	21.9
3	2	1,010	4.9	35.1	5,266	22.3
3	2	1,010	5.5	38.4	4,382	23.5
3	2	1,010	5.1	29.1	6,892	11.0

Performance Comparison

- Traffic Condition Scenarios
  - Scenario 1: Normal conditions (i.e., no lane closures and reduced-speed zone)
  - Scenario 2: Work zone with lane closure (i.e., one-lane closure and reduced-speed zone)
  - Scenario 3: Reduced-speed zone (i.e., no lane closures, reduced-speed zone only)
- Model Performance Evaluation Measures
  - Mean absolute percentage error (MAPE)

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{\widehat{c_w}(i)-c_w}{c_w}\right|\times 100\%$$

  - Root-mean-square error (RMSE)

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left[\widehat{c_w}(i)-c_w\right]^2}$$

❖ *Where,*

$\widehat{c_w}(i)$: ith estimated work zone capacity;

c_w: work zone capacity simulated by VISSIM (maximum volume).

TABLE 2 Performance Comparison

Methods	Scenario 1		Scenario 2		Scenario 3	
	MAPE (%)	RMSE	MAPE (%)	RMSE	MAPE (%)	RMSE
HCM-based	24.3	553.2	24.3	553.2	24.3	553.2
SVM	2.7	64.3	2.2	55.1	2.2	56.1
ANN	3.8	67.8	2.3	58	2.5	57.8

Conclusions

- SVM model produces smaller errors than other evaluated models (i.e. HCM-based model and ANN model)
- SVM is recommended to estimate short-term freeway work zone capacity in terms of its prediction accuracy