I-95 CC – Volume & Turning Movement Project
Steering Committee Meeting #7
February 13, 2018

Agenda:

	Topic	Speaker
1	Welcome & Project Status Update	Denise Markow, I-95 Corridor Coalition Stan Young, NREL
2	Ubiquitous Volume Estimation on Lower Functional Class Roads	Yi Hou, NREL Venu Garikapati, NREL
3	Traffic Volume Estimation using GPS Traces: Florida and New Hampshire Update	Kaveh Sadabadi, UMD CATT
4	First Look on AADT Estimation	Yi Hou, NREL
5	Next Steps & Wrap Up	Stan Young, NREL Denise Markow, I-95 Corridor Coalition

Next Steering Committee Meeting: June 27, 2018

Meeting Notes:

- ***Project Tasks Status Update – Stan Young, NREL***
  - Reviewed the project goals, objectives, and status
  - Stan briefly explained the status of currently available volume data and its limitations.
  - Stan reviewed the current outlook on accuracy measures and the general accuracy question, "How good is good enough?"

- ***Ubiquitous Volume Estimation on Lower Functional Class Roads – Yi Hou & Venu Garikapati, NREL***
  - Motivation: Traffic sensors for any given city cover only 5-10% of the road network – how do we apply this to the rest of the road network in a practical and affordable way?
  - Previous studies focused on freeway volume estimation, this study was looking at lower functional class roads.
  - Goal: use traffic sensors, probe data, as well as other relevant information in a machine learning algorithm to estimate lower functional class volumes.
  - Venu reviewed the previous freeway volume estimation model creation and results
  - Lower class road studies include the following roadway classes: principal arterial, minor arterials, major collectors, minor collectors, and local streets.
  - Lower class roadways comprise a much larger proportion of roadway miles, lane miles, and VMT, but their HPMS monitoring cycles are longer and methods of monitoring are less permanent.
  - In this study, they collected 9 months of data comprised of 359 locations, 35,000 data points in 48-hour short-term counts (compared to the previous freeway study's 3 months of 14 ATR locations, 52,000 data points).
  - Model training was conducted similarly to the freeway study – locations were evenly and randomly divided into 10 groups – 9 locations for training and 1 for validation.
  - Volumes were much lower than the freeway study.

- About 80% of observations were on principal and minor arterials – volumes on minor streets were very low.
- Utilized TomTom probe data.
- Utilized XGBoost machine learning algorithm.
- Evaluated with MAPE (mean absolute percent error), MAE (mean absolute error), EMFR (error to max flow rate) and R^2.
- In results, MAPE and EMFR for the model were 30% and 50% less than linear regression, respectively.
- MAPE is not a great accuracy measure at low volumes – other accuracy measures fare better, specifically MAE.
- The model is well fit and not biased – but underestimates extremely high volumes (which is likely a training set issue).
- XGBoost is useful because it can output most important variables for model estimation (in this case hour, temperature, average speed, GPS count, probe count (though probe count is less significant than freeway estimation))
- There were no questions during this presentation.

- ***Traffic Volume Estimation using GPS Traces: Florida and New Hampshire Update – Kaveh Sadabadi, UMD CATT***
  - Overview
    - Previous estimation focused only on ATR locations. This study scaled estimation process to statewide estimation.
    - Previous study used Maryland 4-month 2015 INRIX data based on 45 ATR locations – were able to achieve hourly 23% MAPE, 4-7% ETCR
    - Currently using 2016 Q4 Florida and 2017 Q3 New Hampshire INRIX data
      - 173 Florida ATR locations
      - INRIX data snapped to XD segments
      - Future studies will apply same methods to New Hampshire dataset
  - Florida Dataset
    - GPS probe data from INRIX
    - 75M trips, 3.4B points, about 3x as big as Maryland dataset
    - About the same penetration rate as Maryland dataset
    - This data is snapped to XD segments which cut down processing time significantly
    - Vehicle classification breakdown: 54% cars/light duty trucks; 30% medium duty trucks; 16% heavy duty trucks
    - Also has probe speed data from HERE
    - NPMRDS TMC shapefile features conflated to the openstreetmap
    - Included data from permanent weather stations
    - Utilized TTI hourly volume estimates
    - Utilized ATR count data from FDOT
      - Used for training/evaluation
      - Used to estimate probe penetration rate
    -
  - Model
    - Advanced Neural Network (ANN)

        - Validated using 172 ATR locations as training and 1 for evaluation, repeated 173 times
    - Results
        - Error metrics comparable to Maryland dataset
        - Results: MAPE 25%, EMFR 7% ("beginning to become useful"), ETCR likely lower and in the "acceptable" range but has not been calculated yet
        - Florida dataset analysis includes lower-class roads that weren't in the Maryland data set and performs as well or better
        - Noted challenges with low-volume roads – 7 ATR locations have 0 observed GPS counts for the entire dataset
    - New Hampshire Dataset
        - 7M trips, 595M pts, about a third as big as Maryland data set
        - Data is snapped to XD segments
        - Problem: 70% of snapped waypoints are located outside NH
    - Questions:
        - Mena Lockwood (VDOT) asked about light/medium/heavy truck breakdowns. Prezmek Sekula (UMD CATT) explained that medium duty trucks are from 14,000-26,000 lbs and heavy-duty trucks are greater than 26,000lbs

- ***First look on AADT Estimation - Yi Hou, NREL***
    - AADT estimation uses same modeling method as previous analyses but researchers built a whole new model (compared to aggregating the current models)**.**
    - 20% of locations had AADT less than 5000.
    - Variables Included:
        - TomTom – GPS daily average speed and daily probe count
        - Road characteristics (class, urban vs rural, speed limit, latitude/longitude)
        - Didn't include hourly weather, AADT, and several other variables used in previous studies.
    - Model Comparison
        - Results: 33% MAPE
        - Previous efforts by other researchers found this task challenging. Their results showed MAPE at 100% or above, 165% error using linear regression instead of modeling
        - Model results are well fitted and non-biased
        - Probe data has significant impact on AADT volume estimation (~40% greater MAPE if it is not included)

- ***Wrap up – Stan Young, NREL***
    - The studies shown during this meeting comprised a considerable representation of non-freeway (that is roadway that are not FRC1 or FRC2, FRC1 is mostly vehicles per hour of 1000 and above and FRC2 which is mostly 1000 vehicles per hour and below).
    - Below 350 vehicles per hour MAPE will be artificially inflated because denominator shrinks so quickly. We suggest using MAE instead of MAPE in these cases.

- Qualitatively, principal and minor arterial volumes estimates are good and stable, major collectors is borderline, and road classes lower then collectors are likely not to perform well with volume estimation using probe data.
- The volume estimations need to be accompanied by a low volume filter/flag that warns when volumes are getting into ranges where error may be significant.
- Florida results were promising because EMFR was consistently below 7% even on FRC2 and lower volume.
- Reminder: for ETCR and EMFR, < 10% is useful and <5% is the target. We're approaching that accuracy. MAPE is very volume dependent (10-15% is good for high; 20-25% for mid; 30-50% for low (and at low switch to MAE)).
- Off-Freeway Take-aways
  - Stable, unbiased estimates at low volumes
  - Performance is volume dependent
  - Accuracy targets by volume class are met
  - Need confidence or error estimate
- Initial AADT Results
  - Positive, but requires iteration
  - Compares favorably to MNDOT study but not apples to apples
- Next Steps
  - NREL – refine AADT initial efforts
  - UMD to extend work to NH
  - Candidate Next Steps
    - Technical Work
      - Develop low volume / confidence flag or metric
      - Develop accuracy metric indexed to abnormal/special events (how does the model perform in unusual situations like the eclipse)
      - Determine relative importance of input (temp/time/location/probe data)
      - There are issues when volumes exceed training data (how robust are these neural networks when they're outside their 'comfort zone'?)
      - Determine error with respect to probe counts
    - AADT work – framework, high and low volume, PFS
    - Truck Volumes/Turning Movements

- ***Closing Remarks & Discussion – Denise Markow*** (I-95 Corridor Coalition)
  - Denise thanked all members for their participation and reminded them about the **next steering committee meeting will be held in June 27 2018 – more information to follow.**
  - Final Questions/Discussion
    - Steve Brown (PANYNJ) asked how comfortable the presenters are with identifying type of vehicle by making inferences on the data (can the data show you you're looking at large trucks, etc.). Stan Young (NREL) responded that between HERE, INRIX, and TomTom, each data stream have different "flavors" – INRIX and UMD tend to be richer in fleet data – these come with data attributes – as far as he knows the researchers haven't looked into that. Kaveh Sadabadi (UMD-CATT)

explained that vendors give data distributions based on weight class but given trajectory and start/end we can data mine to get more insight (doable, but hasn't been done yet). Researchers can focus on one specific weight class just with existing data.

Presenter Contact Info:

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Action Items:

#	Action Item	Whom	Status
	VTM Steering Committee Meeting – July 27, 2017		
1	I-95 Corridor Coalition and Stan Young (NREL) to follow up with FHWA about FHWA's interest in the VTM project as it moves to Phase 2.	Trish Hendren	FHWA meeting is being scheduled for mid-December
	Previous VTM Steering Committee Meetings		
2	DOTs willing to submit traffic count data for validation (specifically continuous traffic counter data shortly after it is collected and prior to publishing to public) should contact Shawn Turner, TTI	Member agencies	

Participants:

Project Team:
Denise Markow, Patricia Hendren, I-95 Corridor Coalition Stan Young, NREL Kaveh Sadabadi, UMD CATT

Steering Committee:	
Mike Bruff	City of Durham MPO
Erik Sabina	Colorado DOT
Wenjing Pu	FHWA
Robert Binns	Georgia DOT
Rick Ayers	HERE Technologies
Mei Chen	Kentucky Transportation Center
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Steven Lemire	New Hampshire Department of Information Technology DOT
Amar Pillai	North Carolina DOT
Venu Garikapati, Yi Hou	NREL
Scott Benedict	Pennsylvania DOT
Steve Brown, Stephanie Molden	Port Authority New York & New Jersey
Michael Dennis	South Carolina DOT
Laura Schewel	StreetLight Data
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