NCDOT
Research Digest

Research Project Title RP 2019-29: Predicting Lane Change Intensity within Urban Interchange Influence Areas (IIA)

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Picture *(related to the project)*:

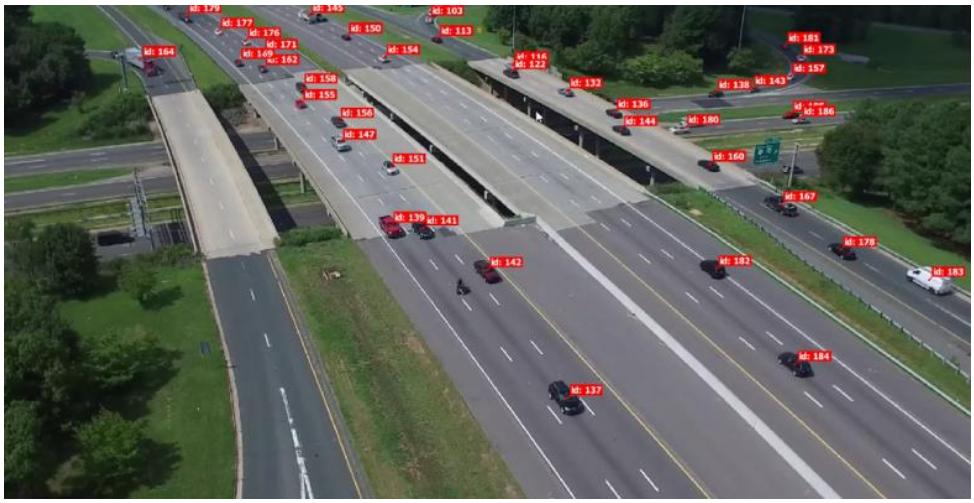

Figure 1: Vehicles in a video frame are being tracked by an automated vehicle tracking tool to estimate lane change frequency at an interchange

Brief Summary of Findings:

This research project provides NCDOT with a tool for predicting freeway lane changes at interchange influence areas (IIAs). The tool estimates the total number of lane changes on a segment using two different models, one that assumes knowledge of the minimum number of lane changes (MLC), and a second one that does not. On average, the observed number of lane changes across sites was 1,373 lane changes/hour (lc/h). Generally, low rates of lane changes were associated with low values of MLC, short segment lengths, low vehicle miles of travel (VMT), and low or congested average speed. Ttwo models have been implemented in a web-based tool, including s a computational engine, a user guide, and an input variables calculator. In addition, the team tested a proposed geometric treatment intended to reduce lane change frequency at the I-40EB weaving segment between Harrison Blvd. and Wade Avenue. The testing methodology was microsimulation using VISSIM. The model was calibrated based on field observed OD flow distributions and travel times. This analysis revealed that the treatment

generated total travel time savings of 16.2 hours per hour, which is applicable to two hours in the PM peak on a typical weekday. The treatment also reduced the simulated overall lane change frequency by a significant 22%.

Background:
Empirical evidence suggests that excessive lane changing at freeway interchanges in NC urban areas results in increased turbulence, decreased safety, and high levels of acceleration and deceleration cycles with the potential for emission increases. When operating in near-capacity conditions, those mostly discretionary lane changes may result in a bottleneck activation and associated (and unnecessary) drops in mobility quality of service. In a recently completed study for NCDOT on the systematic identification of recurring freeway bottlenecks, the top 12 identified bottlenecks in the Research Triangle region occurred in an interchange influence area (IIA). With anticipated traffic demand to remain on an upward trajectory in NC and with little to no likelihood of major capacity additions in the foreseeable future, approaches that can improve the efficient use of the available roadway capacity are sorely needed. One obstacle to predicting lane changes empirically is the difficulty in measuring them in the field. These challenges motivated the research team to explore the application of more readily available traffic and geometric characteristics data to predict lane change intensity at IIAs.

Specific Research Objectives:

- The primary objective of this research was to develop a practical tool for NCDOT to enable the prediction of the expected intensity lane changes at an IIA, based exclusively on data sources that are readily available to the department.
- A second objective was to evaluate treatment strategies targeted to reduce lane change intensity and thus reduce unnecessary traffic turbulence near interchanges.

What research work was done?

- In order to develop the predictive models, the team collected and extracted traffic flow rate, speed, and lane change count data from 15 freeway sites. The team utilized a combination of an automated tool and manual counting to track and extract lane change information.
- The proposed models estimate the total number of lane changes on a freeway segment using two different sub-models, one that assumes knowledge of the number of the mandatory or minimum number of lane changes (MLC), and a second model that does not. Both models were developed based on the *regression tree* approach.
- The development process of the regression trees includes a self-validation process through the *k*-fold cross-validation technique. In addition, a site-specific validation was also conducted, which revealed that there is a benefit from cross-site modeling, and there is scientific generalizability for the modeling approach.
- The research team tested a proposed geometric treatment that was intended to reduce lane change frequency at the Interstate 40 eastbound weaving segment between N. Harrison Ave. and Wade Avenue. The testing methodology was microsimulation using VISSIM microsimulation model. The model was calibrated based on observed origin-destination (OD) flow distributions and OD travel times measured from field Bluetooth units at the site. Key findings revealed that the treatment generated a total travel time saving of 16.2 hours per hour, which is applicable to two hours in the PM peak on a

typical weekday. The treatment did reduce the simulated overall lane change frequency by a significant 22%.

Implementable Research Product:

- A web-based tool to predict lane change intensity at IIAs using macroscopic traffic and geometric characteristics data
    - An excel-based calculator to estimate two critical input variables for the tool: i) minimum lane change intensity and ii) average speed of a traffic stream for different segment types.
- Two VISSIM models for the weaving segment between N. Harrison Ave. and Wade Ave. on Interstate 40 eastbound: one for the existing scenario and the other for a proposed treatment scenario.

How will the research product be used?

- The web-based lane change prediction tool can be used to i) estimate lane change intensity at an existing IIA using macroscopic traffic and geometric characteristics data ii) predict lane change intensity at an IIA after a treatment is implemented iii) predict lane change intensity for a planned IIA.
- The VISSIM models can be used to assess the current mobility condition during peak hours at the weaving segment between N. Harrison Ave. and Wade Ave. on Interstate 40 eastbound. The models can also be used to evaluate any future treatments at the site.

Who within NCDOT will use the research product?

Congestion Management Unit and its consultants; Spot mobility unit; Design unit

How the use of the research product will benefit the Department:

This one time intensive data collection and analysis study offers the department for the first time the ability to predict lane change intensity on any freeway segment in the state. It also will enable the department to test the effectiveness of some treatments on the number of total as well discretionary lane changes.