Key Findings from 108th Ave and Main St

City of Bellevue, Washington

Case Study

October, 2019

Executive Summary

The City of Bellevue has been one of the world leaders in testing video analytics which provides new insights on crash prevention. Street Simplified provides analytics on where drivers run red lights, speed, block intersections and nearly get in crashes. Street uses these tools to uncover underlying crash causes and to help cities take proactive action to reduce those causes. The City of Bellevue and Street Simplified teamed up to evaluate Street Safety Analytics at the intersection of 108th and Main in Bellevue, Washington. The video for the study was collected using two cameras on opposite corners of the intersection from 8 AM Aug. 26th through 8 AM Aug. 27th 2019. The video was processed through the Street Simplified Analytics pipeline. The results were generated completely automatically with no manual counting, verification, or filtering of the data. Over two dozen insights were gleaned from the study, but this case study will focus on the three highest risks.

Key Findings

- Near misses with 108th southbound left vehicles and northbound through vehicles
- Three conflict participant near misses on 108th southbound left with 108th northbound through and pedestrians crossing the east crosswalk
- Speeding on Main St eastbound which is 10 mph or more above the speed limit for over 5% of through vehicles. Similar speeds are seen on Main St westbound but these events occur five times less often

Study Background

Street simplified uses neural networks and machine learning to convert raw video into intersection insights. The study used two commercially available high resolution cameras to record data, generating over a terabit of raw video during the 24-hour study period. This video was processed to detect each road user at the intersection, measure each vehicle's speed, and track the path that each road user took. This information was then used to identify event types that are proven to increase crash risk such as near misses, red light running, speeding, intersection blocking while opposing motions are green, pedestrian/bike crossings off designated crosswalks, and pedestrian/bike crossings while opposing vehicle motions are green. Several hundred events were detected during the study period including over 100 near misses with post encroachment time 2.5 seconds or less, over 100 speeding events 10 mph or more above the speed limit, and over 100 intersection blocking events 48 of which occurred on the 108th SB left which was the primary crash risk. A few pedestrian and cyclist jaywalking and red light running events were detected, but the events appeared to be low risk and not enough events were detected to show significant trends.

Analytics

Several key analytics generated as part of the study are presented in the following figures. The figures highlight the three key findings of the study and provide detailed examples of how the analytics were used to identify each finding.

The most significant finding of the study was a pattern of near miss events on 108th southbound left turning vehicles with 108th northbound through vehicles. 17 near miss events with Post Encroachment Time (PET) less than 2.5 seconds were detected during the study period. 1 near miss almost resulted in a crash. 2.2% of left turning vehicles on 108th SB were part of a near miss during the study period. Figures 1 to 4 show examples.

Two of the near miss events detected above involved pedestrians crossing the east crosswalk on 108th. This scenario put left turning vehicles in a dilemma where they had to decide between blocking the intersection and potentially being struck by oncoming vehicles or cutting off pedestrians in the crosswalk. This is illustrated in Figure 5 and 6.

In addition to the highest risk near misses mentioned above, high speed vehicles were identified on both west bound and east bound Main St with ~80% of the speeding events occurring on Main St eastbound. Street Simplified uses 10mph above the speed limit as the threshold for classifying a speeding event. The speed limits on Main St EB and WB were 30 MPH, thus any event 40 MPH or more on these through movements will be flagged as a speeding event.

KEY TERMS

Near Miss

An event that almost resulted in a crash. Often one or more road users took actions which prevented a collision. Near misses tend to be rare events but are 10s to 100s of times more frequent than crashes.

Post Encroachment Time (PET) or Near Miss Margin

The time between when the first road user leaves the conflict point and when the second road user enters it. A post encroachment time of 0 means that vehicles were in the same spot at the same time and a crash occurred. A post encroachment time less than five seconds can signal unsafe behavior.

Conflict Point

The location where conflicting road user paths cross. The fast majority of intersection crashes occur at or near these points.

Speeding Event

Any event where a vehicle traveled an average of 10 miles or more above the speed limit while passing through the intersection.

Neural Network

A technique which enables a computer to draw a box around every road user in an image and classify each road user.

Machine learning

A technique in which previously known patterns are used to predict future events.
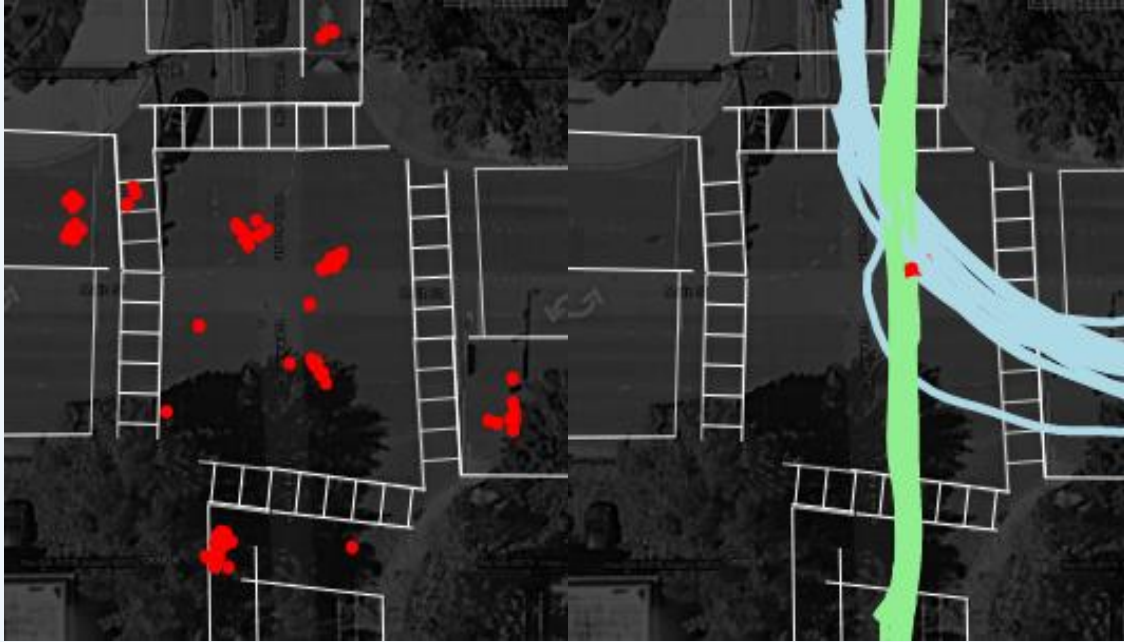
Figure 1. Left: Near miss locations identified during study. Right: High risk near miss scenario with 108th SB left vehicles and 108th NB thru vehicles.

Figure 2. High risk near miss event on 108th SB left with 108th NB through. Vehicles almost collide, abruptly stop, and maneuver around each other to complete their motions. The top left and right views are the videos used for the study overlaid with the vehicle path information and vehicle speeds. The bottom left pane shows the conflict type, the post encroachment time (near miss margin), and the average vehicle speeds of each road user. The bottom right pane is a google maps overlay showing the paths each road user took, and the location of the near miss.

26-Aug-2019 18:39:03

◆ Vehicle
▮ Pedestrian
● Bicycle
✦ First Road User
✳ Second Road User
✖ Position of Near-Miss

Near Miss Event
Near Miss margin =0.63s
Vehicle (1) speed =17mph
Vehicle (2) speed =22mph

Figure 3. Shadows as a contributing factor to the conflicts shown above. Heavy shadowing of northbound vehicles could inhibit visibility to southbound left turning vehicles. Left turning vehicles are observed either failing to see oncoming vehicles or misjudging distance and speed. Once the through motion vehicle exits the shaded area the left turning vehicle has less than 3 seconds to react. The top right view is similar to the view that 108th southbound drivers have of the scene.

26-Aug-2019 18:39:05

◆ Vehicle
▮ Pedestrian
● Bicycle
✦ First Road User
✳ Second Road User
✖ Position of Near-Miss

Near Miss Event
Near Miss margin =0.63s
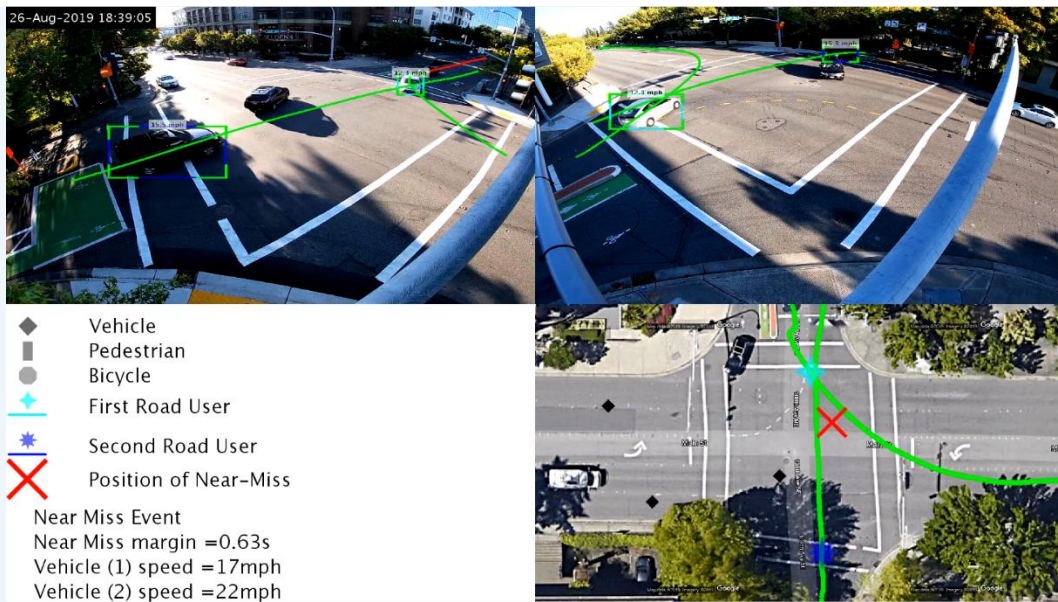Vehicle (1) speed =17mph
Vehicle (2) speed =22mph

Figure 4. Occlusion as a contributing factor to conflicts. In this snapshot a left turning vehicle traveling northbound on 108th occludes the through motion vehicle behind. The southbound vehicle on 108th begins to make the turn, only to find another approaching through vehicle coming towards it.

Figure 5. Three conflict participant near miss involving 108th southbound left vehicle, 108th northbound through vehicle, and southbound pedestrian in the East crosswalk. The left turning vehicle took a sharp left near a pedestrian to avoid being hit by a fast approaching through vehicle. The post encroachment time between the two vehicles was only 0.67 seconds which is not enough time for either road user to stop.

Figure 6. A second three conflict participant near miss involving 108th southbound left vehicle, northbound 108th through vehicle, and southbound pedestrian in the east crosswalk. In this case, the through moving vehicle on northbound 108th was occluded by a right turning vehicle of the same color. The left turning vehicle committed to the motion, blocking the through motion lane, but slowed down to avoid hitting three pedestrians crossing the street. The through moving vehicle quickly accelerated, then slowed to allow the left turning vehicle to clear the intersection.
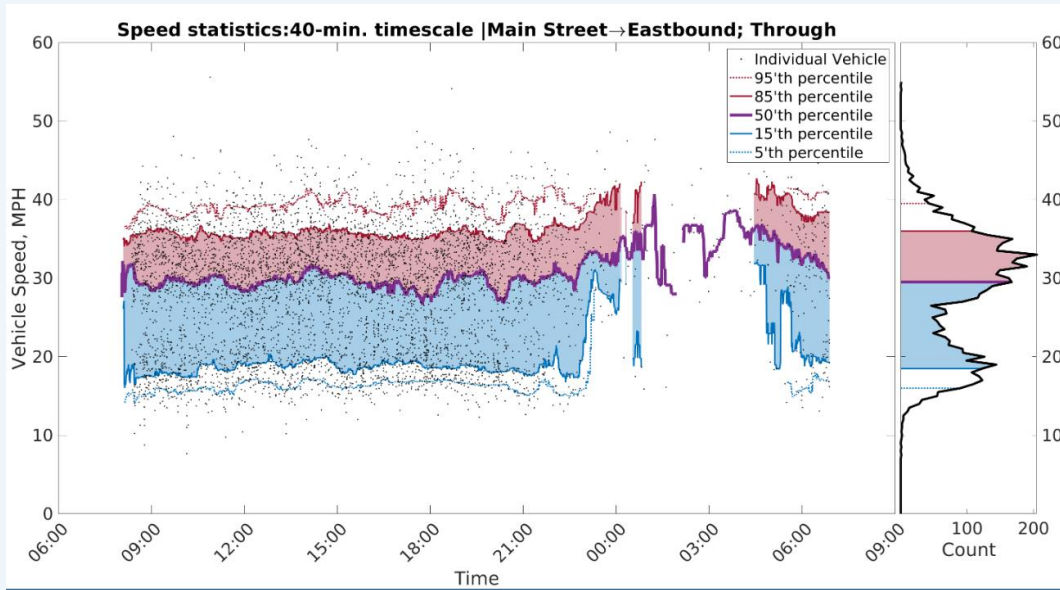
Figure 7. Vehicle speeds on Main St eastbound through. Each black dot represents the speed of a single vehicle half way through its motion. The section of data without blue and red boarders is at night, where not enough vehicles made through motions to estimate the 15th and 85th percentiles. The curve on the right is a histogram of vehicle speed over the study period. One will notice that the 95th percentile is at 40 MPH meaning that 5% of all through motion vehicles on this approach were traveling 40 MPH or more.
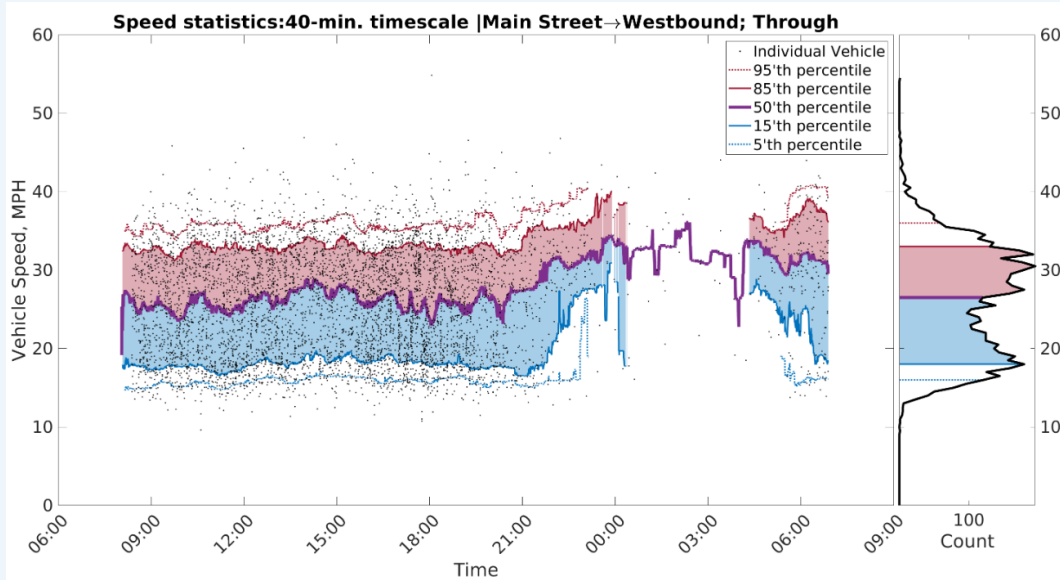
Figure 8. Vehicle speeds on Main St westbound. In comparison to eastbound motions, far fewer vehicles reach 40 MPH or more, even though the traffic volume eastbound and westbound is nearly the same over the study period.
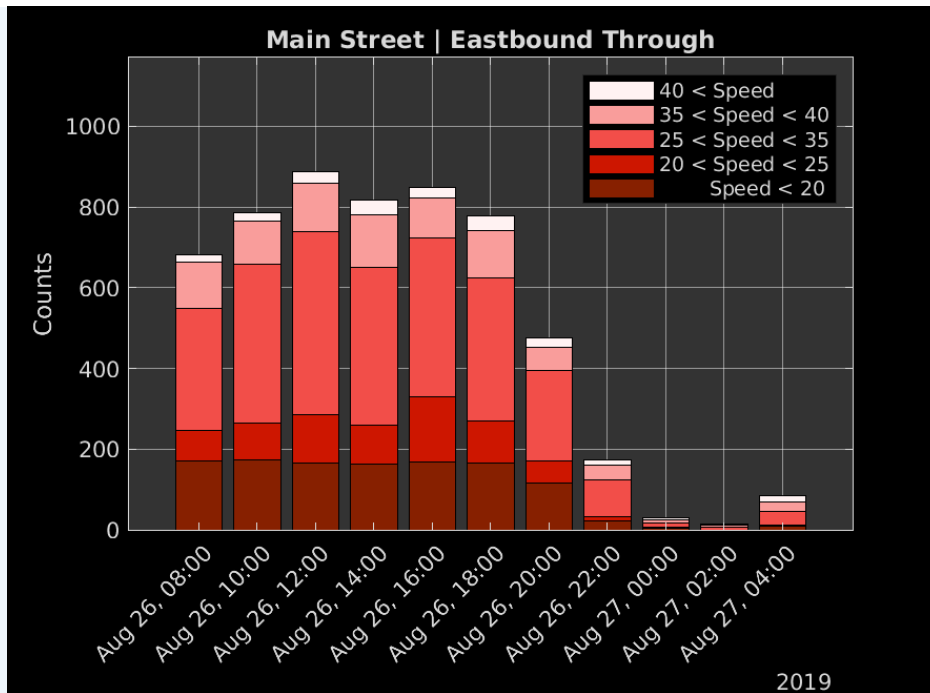
Figure 9. Histogram showing counts of vehicles traveling different speeds over the course of the study day for Main St eastbound through.
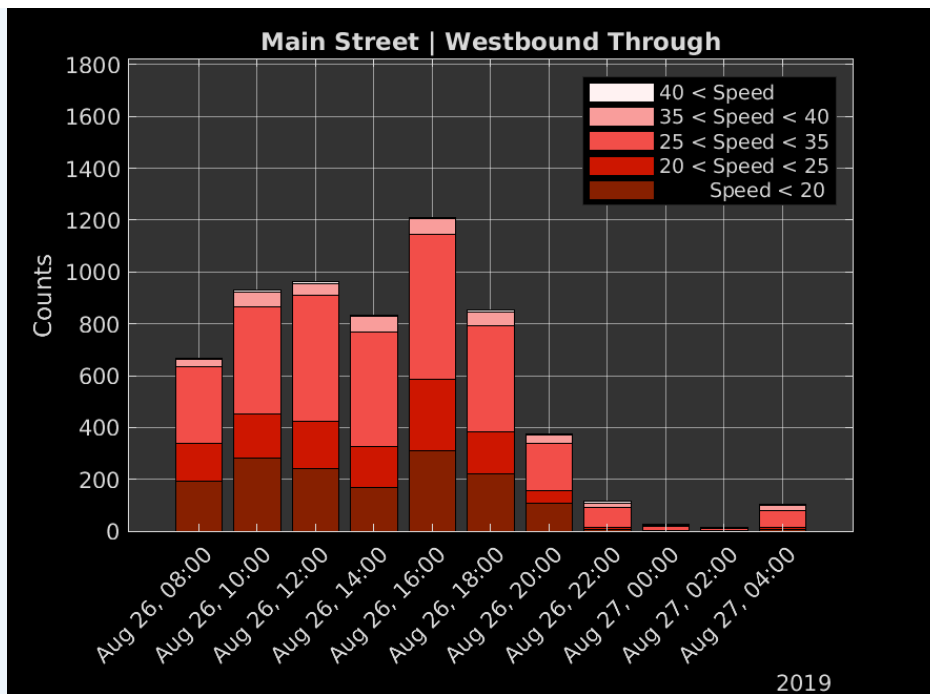

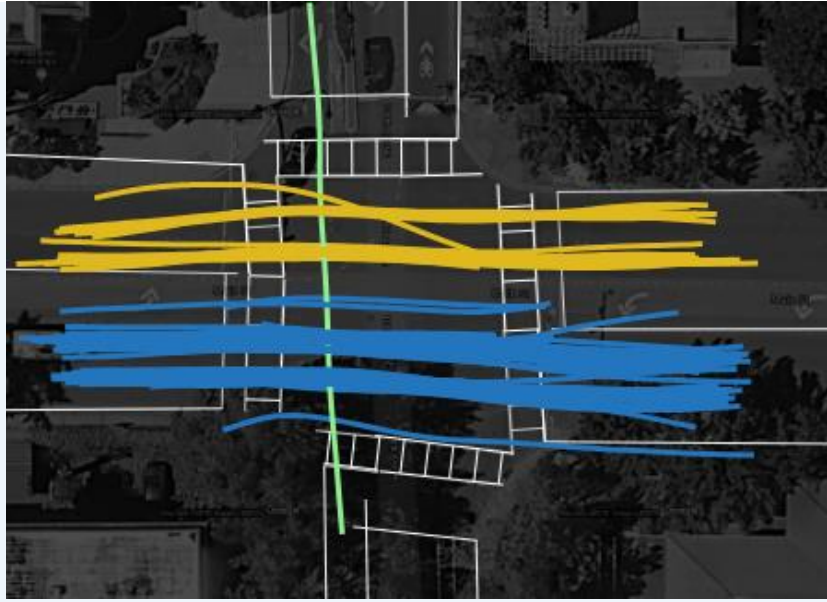*Figure 10. Speeds histograms for Main St. westbound through.*

Figure 11. Vehicle paths of vehicles traveling 10 MPH or more above speed limit on 108th and Main.
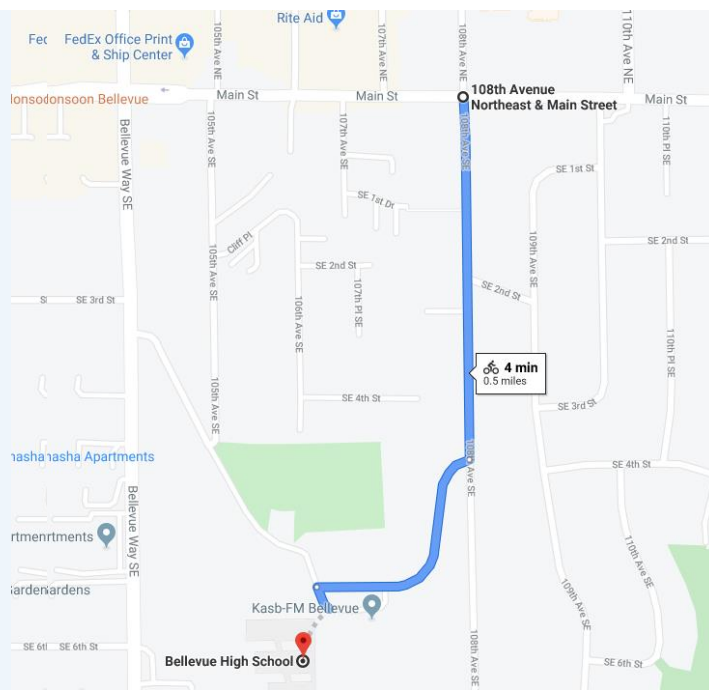

Figure 12. 108th and Main is within a half mile of Bellevue high school and 108th is designed as a bike arterial between the school and the city center. Consistent speeding on Main poses an increased risk for pedestrian and bike traffic coming from the school.

Outcomes

The City of Bellevue recently installed protected/permissive signal heads on the left turns on 108th and Main to reduce conflicts between through motions and left turning motions. Bellevue is also investigating what can be done to decrease speeding on Main street in light of the study findings. Street Simplified is working with the City of Bellevue on a before/after study to validate the impact of these improvements.

Contacts

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