Steps Towards Achieving Vision Zero using Video Analytics and Artificial Intelligence

Bringing Street Safety to the next frontier of Smart Cities
Service Integration – Seamless

Thank You

Clear and Usable Roads
Working Street Lights
Electricity
Running Water

Answered calls for Service 911
More than 1.25 million people die each year as a result of road traffic crashes. Road traffic injuries are the leading cause of death among people aged between 15 and 29 years. Nearly half of those dying on the world’s roads are “vulnerable road users”: pedestrians, cyclists, and motorcyclists. Road traffic crashes cost most countries 3% of their gross domestic product. Without sustained action, road traffic crashes are predicted to become the seventh leading cause of death by 2030. The newly adopted 2030 Agenda for Sustainable Development has set an ambitious target of halving the global number of deaths and injuries from road traffic crashes by 2020.
Traditional Crash Reporting Process

1. Crash occurs
2. Police officer collects information
3. Accident report completed by police officer
4. Copy of accident report submitted to the transportation dept.
5. The transportation dept. enters select crash information into database
Open Data

Toronto Police Service
Open/Big Data Portals

Mission Guiding Principals
- We will be actively accountable and trusted.
- We will be transparent and engaged
- We will be inclusive and collaborative
- We will be sustainable and affordable

data.torontopolice.on.ca
Fatal Collisions

This dataset is a subset of the Killed and Seriously Injured (KSI) dataset from 2006-2016. These events include only Fatal Collisions. To learn more about Fatal Collisions click here. Download Metadata

Attributes

About

KSI - Open Data

Shared By: TorontoPoliceService
Data Source: services.angst.com

View Metadata
Create Webmap
Create a Storymap
Vision Zero is a multi-national road traffic safety project that aims to achieve a highway system with no fatalities or serious injuries involving road traffic. It started in Sweden and was approved by their parliament in October 1997.

**Reactive:** Reacting to a problem after it arises

**Proactive:** Preventing problems before they arise
City of Bellevue’s Vision Zero Initiative: Why?

Hit-and-run driver nearly kills woman on bike in Bellevue
BY KOMO NEWS | WEDNESDAY, MARCH 23RD 2016

Car strikes, kills toddler in stroller in Bellevue
Originally published September 29, 2015 at 11:03 am | Updated September 30, 2015 at 10:37 am

77-year-old pedestrian killed by teen driver in Bellevue
BY TIM HAECK, KIRO Radio Reporter | December 1, 2014 @ 10:17 am
Artificial Intelligence and Humans achieving better outcomes together

Urbanization, Mobility Ubiquitous Internet Access, Data

Increased Traffic/Road Congestion

Chess Ratings Over Time

[Courtesy of Murray Campbell]
Video Analytics Pilot Project

City of Bellevue, WA
Video Analytics Strategy

Leverage city’s traffic camera system to:

1. monitor counts and travel speed of all road user groups (vehicle, pedestrian, and bicycle)
2. document the directional volume of all road user groups in an intersection
3. assess unsafe “near-miss” trajectories and interactions between all road user groups.
Partnership Milestones

- Milestone 1: Demonstrate the capability of vision technologies by detecting relevant events in the sample traffic videos (e.g., detecting cars, pedestrians, and bikes and tracking their movements).

- Milestone 2: Demonstrate an end-to-end system of stored video that will, continuously detect and store the events, and present aggregated information.

- Milestone 3: Pilot deployment of end-to-end system (running on servers provided by Microsoft) in the City of Bellevue traffic control center. The system will run off of a live feed.

- Milestone 4: Support additional scenarios (e.g., near-collisions of cars with pedestrians and bikes or patterns of bikers crossing a busy intersection).
Object Detection
Multi-modal Traffic Counts
Temporal Distribution Charts
Near-Miss Incidences
Hybrid Cloud Video Analytics Platform

Azure Canada Central
Municipal Edge
Region Edge
Province Edge

Azure Canada East
Azure Services

- Artificial Intelligence & Machine Learning
  - Machine: Deep Learning, Machine learning, Prediction,
  - Cognitive: Vision and Knowledge
  - Custom Vision
  - Video Indexer
- Analytics
  - Stream
  - Analysis

Video decoder → Foreground and Line-based object detector → Object Classifier Deep Neural Network → Directional lane level Counts
### Busiest Intersections

<table>
<thead>
<tr>
<th>Location</th>
<th>Last Hr Total</th>
<th>Week ADT</th>
</tr>
</thead>
<tbody>
<tr>
<td>BellevueWay NE12th</td>
<td>2492</td>
<td>40847</td>
</tr>
<tr>
<td>150th Eastgate</td>
<td>2450</td>
<td>34345</td>
</tr>
<tr>
<td>150th SE38th</td>
<td>2220</td>
<td>42276</td>
</tr>
<tr>
<td>116th NE12th</td>
<td>2093</td>
<td>25295</td>
</tr>
<tr>
<td>150th Newport</td>
<td>1164</td>
<td>19260</td>
</tr>
</tbody>
</table>

### Alerts

- **High Traffic**
  - 150th Newport Newport E WBR
    - Last 15min: 104
    - Mean 15min: 67.8
    - Deviation: 53.5%
  - 116th NE12th 121W WBL
    - Last 15min: 17
    - Mean 15min: 6.8
    - Deviation: 158.9%
  - 150th Newport Newport E WBL
    - Last 15min: 20
    - Mean 15min: 10
    - Deviation: 100.0%
  - 150th SE38th 38E EBR
    - Last 15min: 1
    - Mean 15min: 1.7
    - Deviation: 646.5%
  - 150th Newport Newport W EBR
    - Last 15min: 4
    - Mean 15min: 1.3
    - Deviation: 200.0%
  - 150th Newport Newport W BBR
    - Last 15min: 2
    - Mean 15min: 1
    - Deviation: 100.0%
Bellevue Traffic Analytics

Traffic Volume Per Intersection

<table>
<thead>
<tr>
<th>Intersection ID</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>116th NE12th</td>
<td>184K</td>
</tr>
<tr>
<td>150th Eastgate</td>
<td>244K</td>
</tr>
<tr>
<td>150th Newport</td>
<td>148K</td>
</tr>
<tr>
<td>150th SE38th</td>
<td>310K</td>
</tr>
<tr>
<td>Bellevue Way NE8th</td>
<td>288K</td>
</tr>
<tr>
<td>Total</td>
<td>1,174K</td>
</tr>
</tbody>
</table>

Traffic Volume Per Day

<table>
<thead>
<tr>
<th>Date</th>
<th>116th NE12th</th>
<th>150th Eastgate</th>
<th>150th Newport</th>
<th>150th SE38th</th>
<th>Bellevue Way NE8th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thursday, Mar 29, 2018</td>
<td>34K</td>
<td>39K</td>
<td>24K</td>
<td>49K</td>
<td>44K</td>
</tr>
<tr>
<td>Friday, Mar 30, 2018</td>
<td>29K</td>
<td>37K</td>
<td>23K</td>
<td>43K</td>
<td>42K</td>
</tr>
<tr>
<td>Saturday, Mar 31, 2018</td>
<td>20K</td>
<td>31K</td>
<td>20K</td>
<td>38K</td>
<td>45K</td>
</tr>
<tr>
<td>Sunday, Apr 1, 2018</td>
<td>14K</td>
<td>23K</td>
<td>17K</td>
<td>38K</td>
<td>42K</td>
</tr>
<tr>
<td>Monday, Apr 2, 2018</td>
<td>28K</td>
<td>35K</td>
<td>19K</td>
<td>43K</td>
<td>36K</td>
</tr>
<tr>
<td>Tuesday, Apr 3, 2018</td>
<td>32K</td>
<td>42K</td>
<td>25K</td>
<td>48K</td>
<td>43K</td>
</tr>
<tr>
<td>Wednesday, Apr 4, 2018</td>
<td>27K</td>
<td>38K</td>
<td>21K</td>
<td>42K</td>
<td>37K</td>
</tr>
</tbody>
</table>

Intersection Location scaled by Traffic Volume

- Bellevue
- Mercer Island
Count Accuracies

• Lane-level and directional accuracies over 90%
• Overall intersection count with 97% accuracy
• Tested on sunny and rainy days at various hours

<table>
<thead>
<tr>
<th>Direction</th>
<th>Ground Truth</th>
<th>Our Count</th>
<th>Error (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bellevue Way (South) → (North)</td>
<td>359</td>
<td>371</td>
<td>(-)3.3%</td>
</tr>
<tr>
<td>Bellevue Way (South) → NE 8th (West)</td>
<td>115</td>
<td>111</td>
<td>3.4%</td>
</tr>
<tr>
<td>NE 8th St (East) → Bellevue Way (North)</td>
<td>280</td>
<td>277</td>
<td>1.1%</td>
</tr>
</tbody>
</table>

Query planning allows us to keep up with frame-rate *without* dropping accuracy

Higher accuracy in counts than even the magnetic loop based detectors embedded in the roads!
# Video Analytics for Municipalities

## City Planning

**Scenario**
Urban mobility insights to enable city planners to quickly make more informed decisions.

**Partner:** City of Bellevue

## Validation

**Scenario**
Enable city planners to validate the impact of infrastructure investments.

**Partner:** City of Bellevue

## Operational Efficiency

**Scenario**
Real-time signals to automate traffic management systems taking into account the changing dynamics of urban mobility.
The Cloud
Enable innovation at lower cost with the agility to scale up or scale down based on demands. Reduces time to execute new products and pilot new services.

Big Data, Open Data, Machine Learning, Artificial Intelligence
Bring insight into analysis and service delivery. Enabling the ecosystem to leverage data to create new use cases. Driving data driven conversations that help predict instead of report.

Internet of Things
Connect infrastructures to make emergency systems more efficient, or reduce service response times across devices, cloud, analytics, and backend systems.

Security
Achieve a balance of security and citizen empowerment, with effective security controls across identity, device, data and apps, and infrastructure. Protect data against unauthorized access, detect attacks and breaches, and respond and adapt to prevent it from happening again.
Final Thoughts

• Video Analytics with Artificial Intelligence and Machine Learning allow
  • For tracking the trajectory of *many* objects not possible for people
  • People to make better/more informed decisions

• Collaboration/partnership amongst corporations, governments and research/not for profit organizations is key to achieving Vision Zero

• More information
  • Institute of Transportation Engineers March 2017 Journal
  • City of Bellevue Traffic Dashboards
  • Signify (formally Phillips Lighting)