Video Analytics towards Vision Zero

2017 ITE/IMSA Annual Joint Meeting
February 13, 2017

Franz Loewenherz
Principal Planner
City of Bellevue, WA
Worldwide: Traffic Fatalities


<table>
<thead>
<tr>
<th>RANK</th>
<th>LEADING CAUSE</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ischaemic heart disease</td>
<td>12.2</td>
</tr>
<tr>
<td>2</td>
<td>Cerebrovascular disease</td>
<td>9.7</td>
</tr>
<tr>
<td>3</td>
<td>Lower respiratory infections</td>
<td>7.0</td>
</tr>
<tr>
<td>4</td>
<td>Chronic obstructive pulmonary disease</td>
<td>5.1</td>
</tr>
<tr>
<td>5</td>
<td>Diarrhoeal diseases</td>
<td>3.6</td>
</tr>
<tr>
<td>6</td>
<td>HIV/AIDS</td>
<td>3.5</td>
</tr>
<tr>
<td>7</td>
<td>Tuberculosis</td>
<td>2.5</td>
</tr>
<tr>
<td>8</td>
<td>Trachea, bronchus, lung cancers</td>
<td>2.3</td>
</tr>
<tr>
<td>9</td>
<td>Road traffic injuries</td>
<td>2.2</td>
</tr>
<tr>
<td>10</td>
<td>Prematurity and low birth weight</td>
<td>2.0</td>
</tr>
<tr>
<td>11</td>
<td>Neonatal infections and other</td>
<td>1.9</td>
</tr>
<tr>
<td>12</td>
<td>Diabetes mellitus</td>
<td>1.9</td>
</tr>
<tr>
<td>13</td>
<td>Malaria</td>
<td>1.7</td>
</tr>
<tr>
<td>14</td>
<td>Hypertensive heart disease</td>
<td>1.7</td>
</tr>
<tr>
<td>15</td>
<td>Birth asphyxia and birth trauma</td>
<td>1.5</td>
</tr>
<tr>
<td>16</td>
<td>Self-inflicted injuries</td>
<td>1.4</td>
</tr>
<tr>
<td>17</td>
<td>Stomach cancer</td>
<td>1.4</td>
</tr>
<tr>
<td>18</td>
<td>Cirrhosis of the liver</td>
<td>1.3</td>
</tr>
<tr>
<td>19</td>
<td>Nephritis and nephrosis</td>
<td>1.3</td>
</tr>
<tr>
<td>20</td>
<td>Colon and rectum cancers</td>
<td>1.1</td>
</tr>
</tbody>
</table>
USA: Traffic Fatalities

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
From 2005 through 2010 there were 60 collisions recorded by the Bellevue Police Department and the WSP at this location.

In 2013, WSDOT built a new roundabout at the intersection of the WB I-90 on- and off-ramps and WLSP SE/180 Ave SE.
Vision Zero: Reframing Traffic Deaths & Injuries as Preventable

Amy Carlson, Vice President, CH2M HILL

Vision Zero =
All of us getting home safe each night.

Amy Carlson, Vice President, CH2M HILL
Conflict-Based Approach: Don’t Wait For Crashes to Happen

Hyden’s Safety Pyramid (adapted from Hyden, 1987)
Conflict-Based Approach: Public Involvement Strategy

Total Points Placed

<table>
<thead>
<tr>
<th></th>
<th>Total Points Placed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ped Facilities</td>
<td>514</td>
</tr>
<tr>
<td>Bike Facilities</td>
<td>573</td>
</tr>
<tr>
<td>Ped Behaviors</td>
<td>57</td>
</tr>
<tr>
<td>Bike Behaviors</td>
<td>22</td>
</tr>
<tr>
<td>Car Behaviors</td>
<td>452</td>
</tr>
<tr>
<td>Total</td>
<td>1618</td>
</tr>
</tbody>
</table>
Leverage a city’s existing traffic camera system to simultaneously:

- monitor counts and travel speed of all road user groups (vehicle, pedestrian, and bicycle);
- document the directional volume of all road user groups as they move through an intersection; and,
- assess unsafe “near-miss” trajectories and interactions between all road user groups.
Partnership Momentum

OVERSIGHT
- Microsoft
- City of Bellevue
- University of Washington

GOVERNMENT
- WSDOT
- S DOT
- New York City DOT
- LA DOT
- City of Redmond
- Snohomish County

RESEARCH
- UBC
- The University of British Columbia
- Lund University
- McGill
- Polytechnique Montréal

NON-PROFIT
- ITS America
- ITE
- Vision Zero Network
- Cascade Bicycle Club
- People for Bikes
**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 that will, continuously in real-time, 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).
Turning Movement Counts Sample: 116th NE & NE 12th
### Object Classification Accuracy

When it really is...

<table>
<thead>
<tr>
<th>Classified-as</th>
<th>Truth</th>
<th>Vehicles</th>
<th>Bikes</th>
<th>Peds</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vehicles</strong></td>
<td></td>
<td>0.95</td>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Bikes</strong></td>
<td></td>
<td>0.08</td>
<td><strong>0.67</strong></td>
<td>0.16</td>
<td>0.08</td>
</tr>
<tr>
<td><strong>Peds</strong></td>
<td></td>
<td>0.15</td>
<td>0.15</td>
<td><strong>0.73</strong></td>
<td>0.05</td>
</tr>
<tr>
<td><strong>None</strong></td>
<td></td>
<td>0.09</td>
<td>0.03</td>
<td>0.11</td>
<td><strong>0.81</strong></td>
</tr>
</tbody>
</table>

We recognized it as...
How Neural Networks Work

**training**
during the training phase, a neural network is fed thousands of labeled images of various objects, learning to classify them.

**input**
new image is shown to the pretrained network.

**first layer**
the neurons respond to simple shapes, like edges.

**higher layer**
the neurons respond to complex shapes.

**top layer**
neurons respond to highly complex abstract concepts that we would identify as different objects.

**output**
the network predicts what the object most likely is based on its training.

- **90% ✓**
- **10% ✗**
Trajectory Detection & Turning Movement Counts
Volume Charts

VEHICLE DISTRIBUTION CHARTS BY TIME OF DAY

MONTH: MAR, 2016
DATE: 5.1.2016 - 5.1.2016

CARS
- 30,000 cars/day

BUSES/TRUCKS
- 400 buses & trucks/day

PEDESTRIANS
- 1,000 pedestrians/day

BICYCLISTS
- 100 bikes/day
Near-Miss Detection
Near-Miss Detection
January 2017: Collect Pre-Recorded Traffic Camera Footage
February-March 2017: Finalize Video Annotation User Interface
ITE NEWS

ITE Joins Video Analytics towards Vision Zero Partnership

ITE is one of several organizations joining the City of Bellevue, WA, USA, Microsoft Corp., and the University of Washington in supporting their Video Analytics towards Vision Zero Partnership. Through this effort, the City of Bellevue, Microsoft, and the University of Washington will develop a video analytics platform that could fundamentally transform how jurisdictions approach traffic safety analysis.

According to the partners, although traffic collisions can happen anywhere, there are often early warning signals in the form of near-miss events at specific locations. These signals could provide insight into when, where, and why crashes are most likely to occur, helping transportation professionals to better target safety improvement projects. The new technology in development offers unprecedented ways to map, manage, and analyze near-miss data in real-time. This data will provide essential information so that governments can evaluate the effectiveness of current safety programs and pinpoint interventions.

ITE, along with ITS America and the Vision Zero Network, have agreed to host a public-facing webpage that links to the video annotation user interface. We encourage our members to participate in the crowdsourcing platform when it is launched in the coming months. Stay tuned for more details once the site is available through all of ITE’s communication channels.

Please join ITE and ITS America at a discussion on the Video Analytics towards Vision Zero Partnership during the week of the Transportation Research Board Annual Meeting. ITS America is hosting a lunch meeting in their Washington, DC, USA office on Monday, January 9, from 12:15 p.m. to 2:00 p.m. Please RSVP by contacting Annie Chang at anchang@itsa.org.

More information can be found at www.bellevuewa.gov/pdf/Transportation/Video_Analytics_towards_Vision_Zero.pdf.

ITE Journal

January 2017
Spring 2017: Invite Public to Participate
Summer 2017: Classify Near-Miss Events

<table>
<thead>
<tr>
<th>Focused object</th>
<th>Vehicle</th>
<th>Pedestrian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Vehicle time to collision (Vehicle TTC)</td>
<td>Pedestrian time to vehicle (Pedestrian TTV)</td>
</tr>
<tr>
<td>Definition</td>
<td>Vehicle TTC = ( \frac{L}{V} )</td>
<td>Pedestrian TTV = ( \frac{L_d}{v} )</td>
</tr>
<tr>
<td>Study</td>
<td>Previous study (Matsui et al. 2011b)</td>
<td>Present study</td>
</tr>
</tbody>
</table>

**Time to Collision (Matsui et al., 2013)**

**Post Encroachment Time (Van der Horst et. al., 2014)**

**Swedish Conflict Technique (Hyden et. al., 1987)**
Bellevue's Vision Zero Initiative: From Video Analytics to Corrective Measures

For More Information

Franz Loewenherz
Transportation Department
floewenherz@bellevuewa.gov
425-452-4077