Video as a sensor for Intelligent traffic systems

OTEC Conference
October 2\textsuperscript{nd}, 2018
Building Smarter Cities and Communities

Bosch Global Footprint - Four business sectors

Shareholders

1 Robert Bosch GmbH
7 Bosch family
92 Robert Bosch Stiftung

Business sectors and divisions

Mobility Solutions
Industrial Technology
Consumer Goods
Energy and Building Technology

Mobility Solutions
World's largest supplier of cutting-edge automotive technology

Industrial Technology
Leading in drive and control technology, packaging, and process technology

Consumer Goods
World's largest power tool manufacturer
Leading the field in household appliances

Energy and Building Technology
Leading manufacturer of thermo, and building security technology; World's largest supplier of heat pumps

approx. 400,500 associates

95.4 billion dollars in sales in 2017
Video as a sensor

Bosch in ITS

Security and traffic control centers

Road traffic management:
- Monitoring highway & access routes to city
- Traffic management
- VIP prioritization

Bridges & roads:
- Incident detection
- Incident management
- Heat, smoke & fire detection
- Public Address

Public transport:
- Terminals surveillance
- Public announcements
- Smoke, heat & fire detection
- Forensic search
- Perimeter protection
- On-board cameras
Video as a sensor

ITS Camera Options

**MIC 7000i PTZ**
- 1080p 30x zoom lens
- Intelligent Video Analytics
- Ultra Low-Light Day/Night visibility
- H.265 Ready
- IP 68 Ruggedized PTZ Camera with Integrated Wiper

**MIC 9000i PTZ**
- 1080p 30x zoom visible imager
- Integrated uncooled thermal imager
- Intelligent Video Analytics
- Dual visible/thermal analytics “fusion”
- IP68 Ruggedized PTZ
- H.265 Ready

**DINION 8000i HD**
- 1080p 2MP Starlight, 6MP Starlight, and 4K resolution
- Intelligent Video Analytics
- Remote commissioning with WiFi
- PTRZ lens movement for remote commissioning reducing labor costs up to 70%
- IP66 Housing
- H.265 Ready

**DINION 8000 Thermal**
- Uncooled Thermal QVGA & VGA
- 9/30 Frames Per Second processing
- Intelligent Video Analytics H.265 Ready
- Wind load 150 mph; NEMA TS2 vibration, shock
- IPP66 Housing
Video as a sensor

Adding Sense and Structure to Video
Video as a sensor

Video Analytics Overview

Video analytics rules

Alarm rules in parallel

Object filtering

Scenario management

Object classification

>16

8

5
# Video as a sensor

## Machine Learning, Scene-specific Object Detection Advantages

<table>
<thead>
<tr>
<th>Object Separation</th>
<th>Long-term tracking</th>
<th>New object types</th>
<th>State detection</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Object Separation]</td>
<td>![Long-term tracking]</td>
<td>![New object types]</td>
<td>![State detection]</td>
</tr>
<tr>
<td>Parking time: 8 hours</td>
<td>Detector: “shopping cart”</td>
<td>Detector 1: “closed”</td>
<td>Detector 2: “open”</td>
</tr>
</tbody>
</table>
Video as a sensor

Machine Learning Analytics Use Cases

- Parked cars, trucks, ships
- Icicle detection
- Flooding / snow height
- Open / closed barrier

Simultaneous dual and multi-purpose sensor
Video as a Sensor

Video Analytics Solutions

- Safety & Security
  - Intrusion & perimeter protection
  - Façade surveillance
  - Object left behind

- Traffic Monitoring
  - Smart parking zones or occupancy
  - Enforcing no-parking zones
  - Wrong way driver
  - Stopped vehicle
  - Pedestrian in crosswalk

- Business Intelligence
  - In-store retail analytics
  - People counting
  - Occupancy & crowding
Video as a Sensor

Analytics Example: Camera Intelligence and Tracking

Wrong Way Detection
Video as a sensor
Bosch Data Collection Services

- A flexible, windows application that maximizes value of metadata streaming from Bosch’s camera-based video analytics
- Metadata stored in relational database
- Users able to filter on specific information from metadata stream, lowering bandwidth and storage requirements
- BDCS with business intelligence software / dashboards enables instantaneous big picture overview and time savings reporting
Video as a sensor

Off-Peak Delivery Pilot

- Car & Truck counting with Dashboard
- Truck parking analytics, frequency & duration
- Color ID reductions – omit yellow cab
- Future addition: to classify Fed-Ex Vs UPS Truck
- Bus stop violation detection
Video as a sensor

Bosch Data Collection Services – Dashboard Example

NYC DoT Camera Dashboard (Pilot)
Video as a sensor

US-33 Smart Mobility Corridor

- **Project Overview - US-33 Smart Mobility Corridor**
- $15m investment; Estimated Finish Fall 2018
- 35 mile premier public CV/AV proving grounds
- Partnership: ODOT, Honda, TRC, OSU and local governments

- **ITS Applications**

<table>
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<tr>
<th>Application</th>
<th>Description</th>
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<tr>
<td>Wrong Way Detection</td>
<td>Detect and track wrong way driver with PTZ, notify CVs and non-CVs via signage</td>
</tr>
<tr>
<td>Queue Warning</td>
<td>Identify queues and communicate to CVs and non-CVs via signage; notify CVs and non-CVs via signage</td>
</tr>
<tr>
<td>Curve Speed Warning</td>
<td>Identify drivers approaching exit ramp with too high rate of speed and communicate via signage</td>
</tr>
<tr>
<td>Cross Traffic Warning</td>
<td>Use warning on intersections where cross traffic is out of sight, notify CVs and non-CVs via signage</td>
</tr>
<tr>
<td>Connected Roundabouts</td>
<td>TBD</td>
</tr>
<tr>
<td>Red Light Violation</td>
<td>Advance detection and communicate to CVs, potential to trigger SPaT</td>
</tr>
<tr>
<td>Work Zone Warning</td>
<td>Tracking late merge and alert driver and workers</td>
</tr>
</tbody>
</table>

- **Bosch Contributions**

- Intelligent Video Analytics via Treehaven and Industrial E-Net
- V2x Engineering Services by Bosch Engineering Group
Video as a sensor

Bosch Video Based Intersection Detection Concepts

Large Object Detection
- Early Warning

Detail Object ID
- Pedestrian
- Cyclist
- Car
- Bus
- Truck

Small Deployment Footprint Description
- Two Install Points
- Two cameras per pole
- Two power and data junction boxes

One box per two cameras
Video as a sensor

Pedestrian Safety

- Camera analytics detect pedestrians in cross walk and notifies traffic lights to extend red.
- In do-not-cross cases, system can be configured to alert drivers with lights, sound or signage.
- Bosch pan-tilt cameras can track pedestrian and shine high intensity LED on them.
Video as a sensor
Dual and Multi-Purpose Sensor

Secure V2X Proof of Concept

**BOSCH & ESCRYPT Demonstration**

**V2X Use Cases:**
1. V2I – Red Light Warning
2. V2I – Pedestrian Detection and Warning
3. V2I – Bicycle Detection and Warning
4. V2I – No Left Hand Turn Warning
5. V2X – Disabled Roadside Vehicle Warning
6. V2X Security Credential Management System
7. V2X Application Software/Vehicle User Interface

**Camera Use Cases:**
1. Pedestrian in Cross-Walk detection
2. Traffic Classification (Car, Truck, Bicycle, Motorcycle)
3. Traffic Counting, speed, trajectory detection

**V2X Application Software:**
BOSCH and eTrans
(integrated into dashboard and/or Smartphone/Tablet)

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**V2X Security:** escrypt

**Traffic Intersection**

**Camera:**
BOSCH

**Road Sign**
Orange traffic

**Vehicle:**
BOSCH GM Escalade

**Second Vehicle:**
BOSCH Ford F-150
Video as a sensor

MIC Installations
Video as a sensor
Not Only a Great ITS Camera

Snowy owl in Montreal loves the MIC