Incident Detection Systems in Motorway Tunnels
Overview

Incidents

Delayed incident detection

Performance criteria for incident detection systems

Available incident detection systems in tunnels

Areas of development
Incidents

Are “an event or issue (both planned and unplanned) that has or may have an adverse impact on the traffic flow of the road network or to road user safety, requiring a response from motorway traffic operations staff.”

Source: Time Line of Traffic Incident Management (AUSTROADS AP-R304-07)
Delayed Incident Detection

Prolonged incident flow, delayed clearance, longer recovery.

Source: Cambridge Systematics (1990)

Incident Management
Performance Criteria

Detection rate
• Percentage of incidents detected (relative to number of actual incidents)
• Higher is better

Time to detect
• Time required to detect an incident
• Lower is better.

False alarm rate
• Percentage of false alarms raised (relative to number of actual incidents)
• Lower is better.
Performance Criteria

Parameters are linked

- Increasing detection rate may increase false alarm rate
- Reducing time to detect may increase false alarm rate
- Reducing false alarm rate may decrease detection rate or increase time to detect.

Performance criteria should be set to meet operational requirements

However recognise limitations of the available technology / solutions
Available Incident Detection Systems

CCTV Surveillance

Traffic Incident Detection Systems

Automatic Video Incident Detection

Over Height Vehicles

Emergency Bays

Dangerous Goods Carrying Vehicles

Smokey Vehicles
CCTV Surveillance

Cameras providing redundant coverage of the entire tunnel

Cameras are either fixed-view or pan-tilt-zoom (PTZ)

Camera images are displayed on operator workstations and video wall displays
• May also be remotely accessed by other control centres or personnel off site.

Camera viewing can be automated
• Tours on video wall displays
• Automatic camera switching in response to detected events / alarms.
CCTV Surveillance

Cross City Tunnel

M5 East
CCTV Surveillance across NSW tunnels

<table>
<thead>
<tr>
<th>Tunnel</th>
<th>Tunnel Length (metres)</th>
<th>Cameras</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross City Tunnel</td>
<td>2100</td>
<td>154</td>
</tr>
<tr>
<td>Eastern Distributor</td>
<td>1700</td>
<td>150</td>
</tr>
<tr>
<td>Lane Cove Tunnel</td>
<td>3600</td>
<td>256</td>
</tr>
<tr>
<td>M5 East</td>
<td>4000</td>
<td>225</td>
</tr>
<tr>
<td>St Helena Tunnel</td>
<td>430</td>
<td>~50</td>
</tr>
<tr>
<td>Sydney Harbour Tunnel</td>
<td>1400</td>
<td>~100</td>
</tr>
<tr>
<td>NorthConnex</td>
<td>9000</td>
<td>~650</td>
</tr>
<tr>
<td>WestConnex – M4 East</td>
<td>5500</td>
<td>~475</td>
</tr>
<tr>
<td>WestConnex – New M5</td>
<td>9000</td>
<td>~766</td>
</tr>
</tbody>
</table>
Traffic Incident Detection Systems

Traffic data is generated at 10-30 second intervals and then sent to the incident detection algorithms for processing.

The most common incident detection algorithms deployed are:
- High-occupancy algorithm (HIOCC)
- California algorithms
- All Purpose Incident Detection (APID)
- McMaster

Time to detect incidents is typically up to 120 seconds.
- Other systems (eg AVIDS) are faster
Automatic Video Incident Detection Systems

AVIDS monitors CCTV video inputs through video analytics / algorithms

Video analytics / algorithms perform a frame by frame comparison for different incidents

Source: Citilog
Automatic Video Incident Detection Systems

Traffic Incidents

• stopped vehicles on the carriageway
• wrong way vehicle – opposite direction of travel
• speed drop – sudden step change in average vehicle speed
• traffic congestion – queue length measurement
• under speed and over speed (single vehicle)
• vehicle presence (e.g. in emergency bay)

Non-traffic Incidents

• smoke and fire detection
• pedestrians and cyclists
• fallen or random objects, cargo, debris or animals
Automatic Video Incident Detection Systems

Pedestrian Detected
Source: Clem Jones Tunnel (CLEM7) / FLIR

Stopped Vehicle
Source: M5 East
Automatic Video Incident Detection Systems

Stopped Vehicle
Source: Clem Jones Tunnel (CLEM7) / FLIR

Fallen Object
Source: FLIR
AVIDS deployment across NSW tunnels

<table>
<thead>
<tr>
<th>Tunnel</th>
<th>AVIDS capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross City Tunnel</td>
<td>No</td>
</tr>
<tr>
<td>Eastern Distributor</td>
<td>Yes</td>
</tr>
<tr>
<td>Lane Cove Tunnel</td>
<td>Yes</td>
</tr>
<tr>
<td>M2 Norfolk Tunnel</td>
<td>Yes</td>
</tr>
<tr>
<td>M5 East</td>
<td>Yes</td>
</tr>
<tr>
<td>St Helena Tunnel</td>
<td>Yes</td>
</tr>
<tr>
<td>Sydney Harbour Tunnel</td>
<td>Smoke detection only</td>
</tr>
<tr>
<td>NorthConnex</td>
<td>Yes</td>
</tr>
<tr>
<td>WestConnex – M4 East</td>
<td>Yes</td>
</tr>
<tr>
<td>WestConnex – New M5</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Over-height vehicles

Tunnel trouble

- **January 30** A Mack truck hits roof of Eastern Distributor tunnel with its tray raised.

- **November 14** Truck with tray open wedged in M5 East, causing $250,000 in damage (right). Two overheight trucks stopped by warning systems at Harbour Tunnel, closing tunnel briefly.

- **October** Three truck drivers have licences suspended for breaching tunnel height restrictions – two closing the Harbour Tunnel, and one damaging the Eastern Distributor tunnel.

Source: SMH (2014) Traffic: Tunnel debate hits new heights after snarls
Over-height vehicles

Over-height vehicles represent a risk to the tunnel infrastructure and need to be detoured away from tunnel entrances

Over height vehicle sensors calibrated to the tunnel configuration are generally deployed at two points:
• Prior to last exit to allow for diversion
• After last exit to trigger tunnel closure.
Over-height vehicles

Legend

- OR: Over-height restriction static signs
- OD: Over-height vehicle detector
- VMS: VMS for over-height vehicle warning
- Tunnel portal
- ISLUS at Tunnel Portal
- OP: Over-height vehicle protection barrier

Tunnel closure control
Traffic signals, boom gates, stop line

Median opening
Portion portal
Tunnel portal
Emergency Bays

Detection of stopped vehicles in emergency (or break-down) bays in tunnels
Drivers are notified via other tunnel signage that the bay is occupied
Detection may be video based or via dedicated sensor (loop, radar, IR etc)
Dangerous goods carrying vehicles

In NSW, vehicles are prohibited from entering tunnels whilst carrying dangerous goods
Signage deployed at tunnel approaches / entrances advertising this
Ongoing investigations into automatically detecting and diverting such vehicles
Smoky vehicles

Smoky Vehicle Camera Systems must comply with “Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales” by the Department of Environment and Conservation (DEC).

These systems perform digital image capturing of vehicle registration number plate and video recording to satisfy the requirements of TM31.
Questions