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Guideway Instrusion Detection Systems for Rail Transit APTA Rail Baltimore 2017

delivering a better world

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Contents

Guideway Intrusion Detection Systems – Purpose and Standards

- Guideway Intrusion Detection Systems used to support the public and operational safety of the System
- Primarily at the platform edge where Platform Screen Doors are not used:
  - Not generally used for Manual or Semi-automatic Train Operations (GOA1 or GOA2) although some agencies now considering for supporting drivers (London, NYCT)
  - No known examples on GOA3, Driverless Train Operation – e.g. London Docklands
  - Most often used on GOA4, Unmanned Train Operation – e.g. Vancouver SkyTrain
- Intrusion detection systems also deployed at other potential access points to the guideway:
  - Tunnel Portals
  - Level Crossings
  - Facilities such as power substations, yards
- Standards:
  - German Standard VDV 399; Requirements for Facilities Ensuring the Passengers' Safety at Stations with Driverless Operation - Test object shall be a 300 mm sphere
  - ASCE 21.3 (2008), Automated People Mover Standards Part 3, Section 10.2.3: Test object shall be minimum 300 mm(12") sphere weighing 9kg (20lbs) or more.

Example GID Systems

Guideway Intrusion Detection Systems - Existing

No active detection

London Docklands Light Rail

London Docklands Light Rail

Driverless Train Operation (DTO / GOA3) – Train Captain onboard train but may not be in front car to view platform edge.

No intrusion detection systems

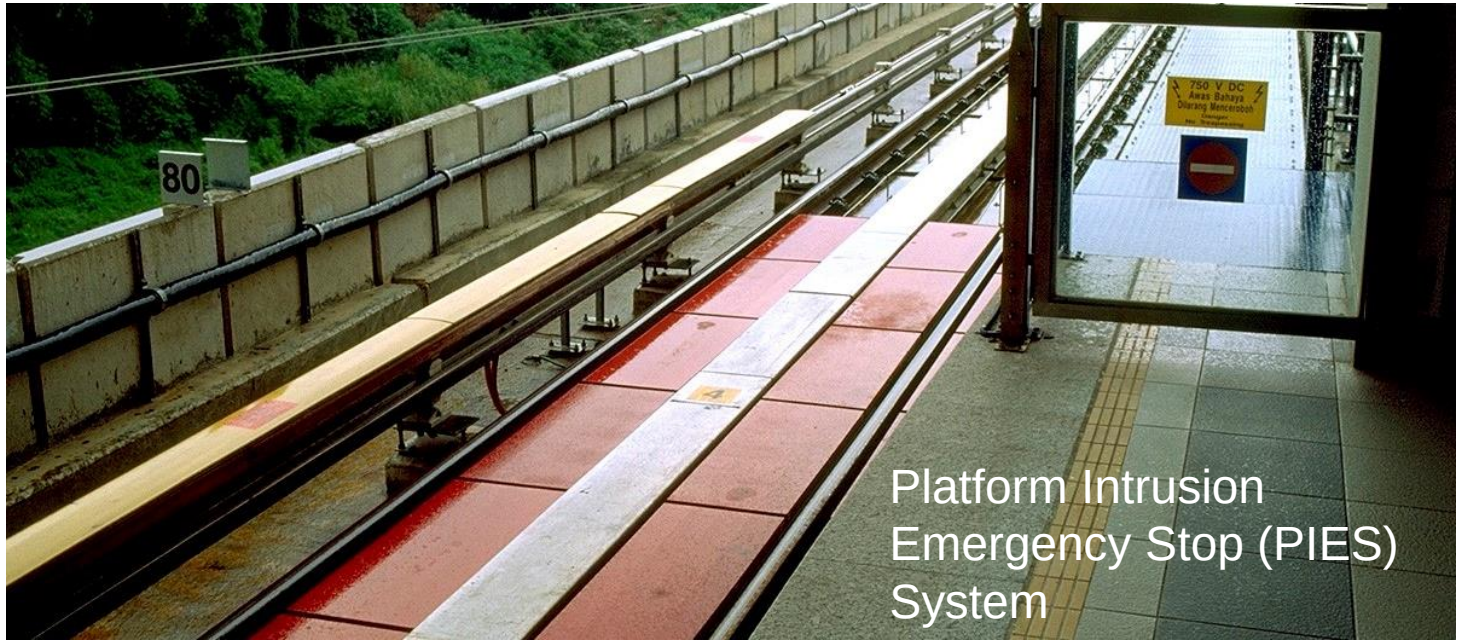
CCTV monitoring of platforms

Operations staff may be at busy platforms

No plans or perceived need for GIDS

Guideway Intrusion Detection Systems - Existing

Platform Intrusion Emergency Stop (PIES) System



Kuala Lumpur Kelana Jaya Line

Vancouver SkyTrain – Expo Line and Kuala Lumpur Kelana Jaya Lin

Unmanned Train Operation (UTO / GOA4)

Motion/mass detection system - Monitored by CBTC system to stop train

CCTV monitoring of platforms

Roving Attendants

Detection based on:

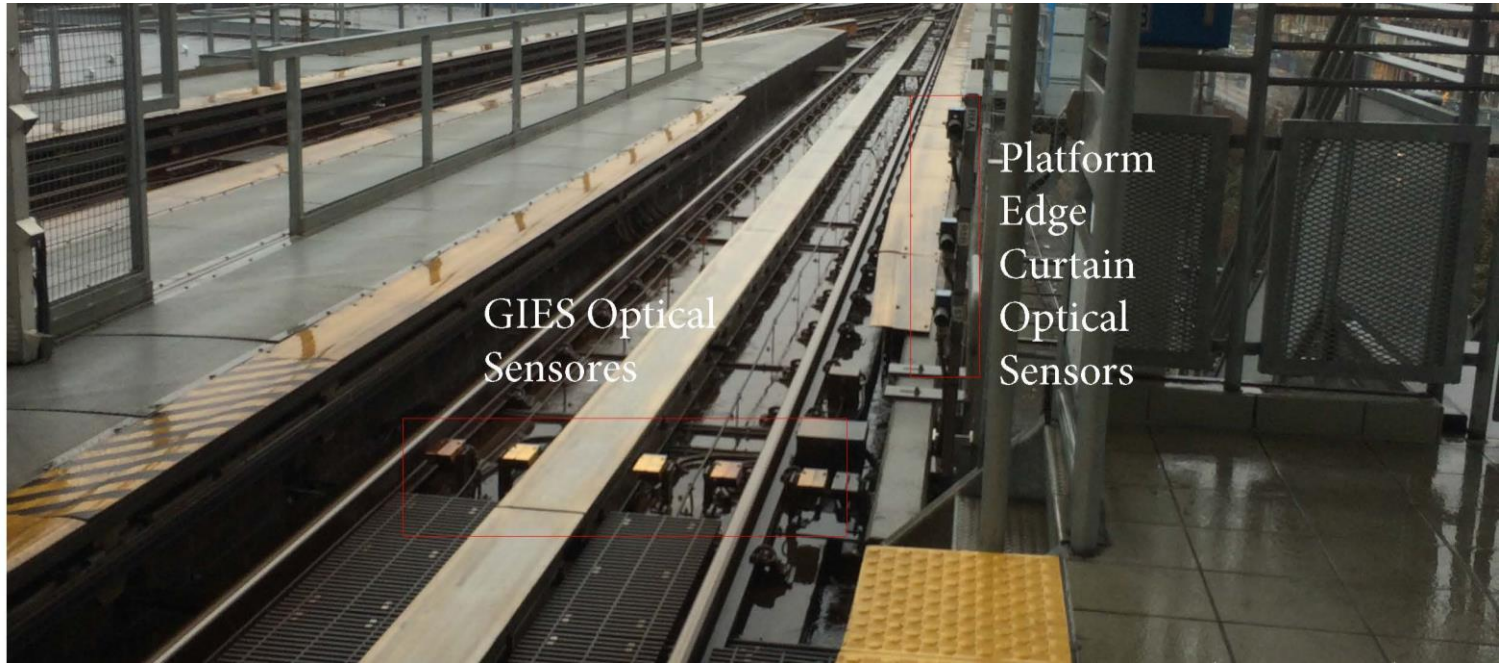
- Mass dropped
- Person walking

False positives

- Garbage, Skateboards…
- Shock/vibration/EMI

Guideway Intrusion Detection Systems - Existing

Optical Sensors



Any GIES obstruction of 1 second AND platform edge curtain trigger = Intrusion
GIES obstruction of > 10 seconds = Intrusion
Monitored by CBTC system to stop train

Vancouver SkyTrain – Millennium Line

Unmanned Train Operation (UTO / GOA4))

Optical intrusion detection systems

CCTV monitoring of platforms

Roving Attendants

Similar system on **Canada Line,** downtown to Airport and Richmond

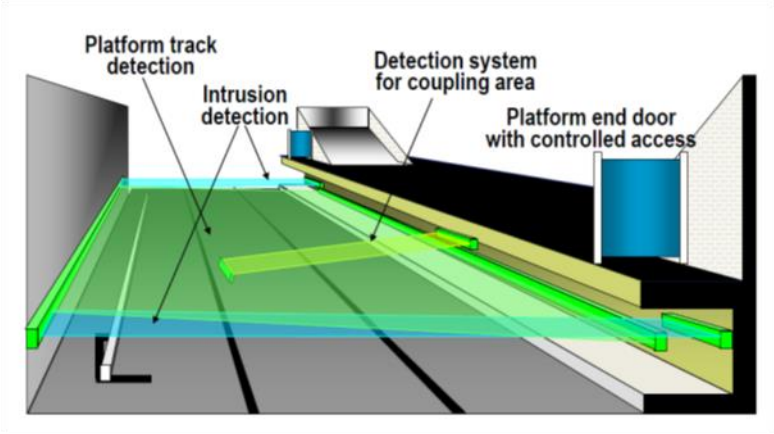
False positives or nuisance alarms:

- Birds, animals
- Garbage, plastic bags, etc.

Guideway Intrusion Detection Systems - Existing

Optical and RF Sensors

Nuremberg U-Bahn



Nuremburg U-Bahn Radar Detection

Unmanned Train Operation (UTO / GOA4)

Laser light barriers / Honeywell RF Barriers

CCTV monitoring of platforms

Guideway Intrusion Detection Systems

World Wide UTO and DTO Transit Systems – Existing and Planned

EUROPE	
Copenhagen Metro	DPM / Light Metro
Barcelona Metro Line 9	APM (L9 South) / Metro (L9 North)
Barcelona Metro Line 10	DPM / Light Metro
Turin Metro Line M1	Metro System
Rome Metro Line C	DPM
Milan Metro Line 5	Light Metro
Brescia Metro	Metro System
London Gatwick Airport	APM
London Stansted Airport	APM
Paris Metro Line 14	Metro System
Paris Metro Line 15	Metro System
Paris Metro Line 1	Metro System
Orly VAL (Orly Airport)	APM
CDG VAL (Charles de Gaulle Airport)	APM
Rennes Metro	Light Metro
Toulouse Metro	Light Metro
Lille Metro	Light Metro
Lyon Metro Line D	Light Metro
Nuremberg U-Bahn	Metro System
Lausanne Metro Line 2	Metro System
Budapest Metro – Line 4	Metro System

SOUTH AMERICA	
São Paulo Metro – Line 4	Transit System
São Paulo Metro – Future Line 6	Transit System
São Paulo Metro – Line 15	Monorail
São Paulo Metro – Future Line 17	Monorail
Lima Metro Line 2	Transit System

NORTH AMERICA	
O'Hare Airport (ATS)	APM
San Francisco Airport (AirTrain)	APM
Detroit People Mover	DPM
Jacksonville Skyway	Monorail
Tampa Airport (TPA Monorail)	Monorail
Detroit Metropolitan Wayne County Airport – Express Tram	APM
JFK AirTrain	APM
Washington Dulles International Airport - AeroTrain	APM
Hartsfield–Jackson Atlanta International Airport - ATL Skytrain	APM
Hartsfield–Jackson Atlanta International Airport. - The Plane Train	APM
Miami Metromover	DPM
Morgantown Personal Rapid Transit	PRT
Las Vegas Monorail	Monorail
Denver International Airport Automated Guideway Transit System	APM
Seattle-Tacoma International Airport - Satellite Transit System	APM
Vancouver SkyTrain	Light Rapid Transit
Vancouver Canada Line	Light Rapid Transit
Pearson Airport - LINK Train	APM

ASIA	
Disneyland Resort Line – Hong Kong	Heavy Rail MTR
Delhi – Pink Line (Delhi Metro)	Transit System
Delhi – Magenta Line (Delhi Metro)	Transit System
Kuala Lumpur – Kelana Jaya Line	Light Rapid Transit
Kuala Lumpur – Aerotrain (KLIA)	APM
Kuala Lumpur – MRT Sungai Buloh-Kajang Line	Metro System
Kuala Lumpur – MRT Sungai Buloh-Serdang-Putrajaya Line	Metro System
Kuala Lumpur – Bandar Utama-Klang Line	Light Rapid Transit
Kuala Lumpur – MRT Circle Line	Metro System
Manila Light Rail Transit System Line 2	Metro Rapid Transit
Bukit Panjang LRT Line	Light Rapid Transit
Sengkang LRT Line	Light Rapid Transit
Punggol LRT Line	Light Rapid Transit
Changi Airport SkyTrain	APM
North East MRT Line (Singapore)	Metro System
Circle MRT Line (Singapore)	Metro System
Downtown MRT Line (Singapore)	Metro System

ASIA	
Dubai Metro	Metro System
Busan–Gimhae Light Rail Transit	Light Rapid Transit
Busan Metro Line 4	Metro System
Daegu Metro Line 3	Monorail
Incheon Airport Maglev	Transit System (Maglev)
Sin-Bundang Line (Seoul)	Subway
U Line (Uijeongbu, Seoul)	Light Rapid Transit
Yongin Everline	Light Rapid Transit
Tokyo Yurikamome	Transit System
Tokyo Nippori-Toneri Liner	Transit System
Yohohama Kanazawa Seaside Line	Monorail
Nagoya Linimo	Light Rapid Transit
Osaka Nankō Port Town Line	Light Rapid Transit
Kobe New Transit	Light Rapid Transit
Hiroshima Skyrail Midorizaka Line	Monorail
Taipei Metro Brown Line (Neihu/Mucha)	Light Rapid Transit
Line 10, Shanghai Metro	Metro System
Yanfang Line, Beijing Subway	Subway

Guideway Intrusion Detection Systems - Existing

- Apart from Platform Screen Doors, the prevalent types of alternative technologies are limited to:
  - Motion sensitive panels in the guideway (e.g. PIES) – Vancouver and Kuala Lumpur;
  - Optical sensors in the guideway (e.g. GIES)– Vancouver's SkyTrain System and Canada Line, and Lyon Line D;
  - Platform edge detection systems (e.g. GIDS) – YongIn and Jacksonville;
  - Radar detection in the guideway – Nuremburg and Budapest.
- None of the alternatives to platform doors are implemented as layered technologies, e.g. radar plus video analytics. All have CCTV but this is not for any automated response but to assist central control to respond to the intrusion alarm
- Cannot be compared to Platform Screen Doors which:
  - Prevent intrusion into the guideway at station platforms
  - May also be used to control platform environment
- Issues:
  - False positives – nuisance trips, birds, garbage
  - False negatives – real intrusion not detected

Emerging Technologies

Guideway Intrusion Detection Systems – Emerging Technologies

- Other Agency Trials have been conducted (London and NYCT) with following three different technologies:
  - Radar;
  - Video Analytics;
  - LIDAR (Laser Imaging Detection and Ranging).
- No single technology found to be perfect:
  - If detection area is above top of rail (TOR), elimination of valid train movements is an issue, requires interface with signalling system - problematic if intrusion occurs while train is entering the platform area
  - video analytics suffered greatly from changing lighting effects

Guideway Intrusion Detection Systems – Emerging Technologies

- Number of false negatives caused by:
  - Target not in field of view for sufficient time for detection (<1.5s)
  - Target (child dummy or sphere) rolled or positioned partially under nosing in refuge
  - Tolerance errors – e.g. failure to detect 310mm sphere
- Number of false positives; e.g. garbage
  - Using multiple cameras at different angles improved results dramatically
  - A camera system would almost certainly need something like a ‘multicam’ solution to give a 3D analysis
- A consistent recommendation from trials and various studies is to consider use of complementary technologies in a layered approach to both:
  - Ensure detection of real intrusions or objects of interest,
  - Set-up must be on a station by station basis, cannot just rely on experience from one station used as trial
  - Eliminate as far as possible nuisance trips, but not possible to completely avoid

Guideway Intrusion Detection Systems – Emerging Technologies

Onboard Detection

- Some railroads are now experimenting with video and radar technology to support tram cars operating with automobiles*:
  - Bosch Engineering have a system based on solutions from the automotive sector using cameras and radar. A camera is used to detect the rails and the radar to detect objects between the rails and the distance to the object. Software evaluates whether a significant collision is likely and alerts the driver. Failure of the driver to respond or override causes an EB application.
  - Bombardier have a stereo camera system using in-cab cameras scanning for objects greater than 40cm in size, in a 16-60m area in front of the train. A three dimensional view is presented to the driver and a certain response time is provided before the system causes an EB application.
- Some pros and cons but with advance of Artificial Intelligence and sensor technology there is the potential for such technology to "learn" the environment in which it operates and respond safely to significant objects of interest

*International Railway Journal, Sept. 2016.

Guideway Intrusion Detection Systems – Conclusion

- At this point in time there is no single technology that can provide effective intrusion detection that is not also susceptible to false positives or nuisance trips
- A multi-layered approach is likely the best solution
- Most UTO systems surveyed use Platform Screen Doors
- Platform Screen Doors do have pros and cons:
  - High Cost – capital and life-cycle, **but absolute safety**
  - Impacts on availability – but may outweigh nuisance trips
  - May have impacts on dwell time (increased open/close times)
  - May not support various train configurations (door alignment)
  - Retrofit of Platform Screen Doors very expensive and disruptive on an operating system, so do as part of initial construction