Intelligent Transport Systems (ITS) in Hong Kong: Recent Development and Future Applications

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Agenda

- Background
- Four Recent ITS Applications in Hong Kong
- Potential ITS Applications
- Q & A
Hong Kong - A high density populated city

Geography of Hong Kong
Background

- Population: ~ 7 million
- Total area: 1104 km\(^2\), about 20% land developed
- Car ownership: 52 per 1000 people, about 10% of the US figure, despite a similar level of GDP
- Urban density: 34,000 persons/km\(^2\)
- In comparison: LA - 3,144;
  - Taipei – 9,650; Tokyo - 7,100; Bangkok – 1,301
- **12 million** daily trips, ~10% of car trips

- Road length = 2,076 km
- No. of licensed vehicle = 613,000
- Tag in circulation is about **250,000 tags** out of 613,000 licensed vehicles in Hong Kong in March 2011 (87,000 penetration of tags of 174,000 commercial vehicles is about 50%).

Better Use of New Technologies

Objective

“The use of new technologies will be encouraged to increase the efficiency of traffic management, improve the overall capacity of the road system, and enhance road safety.”
What are Intelligent Transport Systems (ITS)?

Deployment of advanced information and telecommunication technologies to enhance the safety, efficiency, reliability, user and environmental friendliness of the transport system

Four Recent ITS Applications in Hong Kong

1. Traffic Speed Map

2. Driving Route Search Service (DRSS)

3. Journey Time Indication System (JTIS)

4. Speed Map Panels (SMP)

1. Traffic Speed Map

**Project Information**

Client: Transport Department of HKSAR

Project Manager: Electrical & Mechanical Services
Department of HKSAR

Contractor: Autotoll Limited

Sub-contractor: Hong Kong Polytechnic University

Launch of Service: January 2007

Update: May 2010
1. Traffic Speed Map

- Launched in Hong Kong Transport Department’s website in January 2007
- Recently updated in May 2010 with use of the latest road network in Hong Kong

Real-time Traffic Information System (RTIS) Framework

**INPUT**
- Autotoll tag data
- GPS data
- VIP data
- VIP data

**Off-line estimates** obtained by a traffic flow simulator (TFS)*

**OUTPUT**

RTIS Website Portal
- Speed map and travel times for specific origin-destination pairs (updated once every 5 minutes)

Presentation Summary of Traffic Speed Map

- Accuracy level of traffic speed colour
- Validation methods
  - Test car survey on road segments without CCTV cameras
  - Observation survey based on CCTV images
- Validation results
  - Test car survey
  - Observation survey

Title: Using automatic vehicle identification data for travel time estimation in Hong Kong
Author(s): Tam Mei Lam; Lam William H. K.
Source: TRANSPORTMETRICA Volume: 4 Issue: 3 Pages: 179-194 Published: 2008

Accuracy Level of Traffic Speed Map

Under normal condition, 90% probability of observed average speed falling within the specified speed range throughout the whole day.

For example, 08:40-08:45:
On a road segment of a major route:

- Observed average speed = 28 km/h
- Estimated speed colour = Yellow ✓
- Estimated speed colour = Red ×
For example, on the 2nd road segment of a major route:
Estimated average speed at 8:40-8:45 = 2.03 km / 4.5 min = 27 km/h (Yellow)
Observed speed by test car = 2.03 km / (8:43:58 - 8:39:36) = 2.03 km / 4.37 min = 28 km/h

Validation Results of Test Car Surveys
Survey day: one typical weekday (Tue, Wed or Thu) in May 2010 for each path
Survey period: one peak and one non-peak periods (each period was 2 hours)
Survey route: 5 selected routes in urban area of Hong Kong

<table>
<thead>
<tr>
<th>Route</th>
<th>Number of observed average speeds on the segments along the path</th>
<th>Number of accurate speed color estimates</th>
<th>Accuracy</th>
<th>Achievement of targeted accuracy level</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>48</td>
<td>45</td>
<td>93.8%</td>
<td>✓</td>
</tr>
<tr>
<td>B</td>
<td>95</td>
<td>89</td>
<td>93.7%</td>
<td>✓</td>
</tr>
<tr>
<td>C</td>
<td>80</td>
<td>77</td>
<td>96.3%</td>
<td>✓</td>
</tr>
<tr>
<td>D</td>
<td>112</td>
<td>109</td>
<td>97.3%</td>
<td>✓</td>
</tr>
<tr>
<td>E</td>
<td>160</td>
<td>149</td>
<td>93.1%</td>
<td>✓</td>
</tr>
</tbody>
</table>
Observation Surveys on CCTV Images

Results of Observation Surveys

- Survey day: 14 May (Fri) - 24 May (Mon) 2010, excluding public holiday of 21 May 2010 (a total of 10 days)
- Survey period: 08:00-20:00 (12 hours)
- Frequency of checking: 10-minute interval
- Location: 30 selected locations with CCTV cameras
- Results:
  - all locations with accuracy of $\geq 90\%$
  - 29 locations (96.7%) with accuracy of $\geq 95\%$
  - 27 locations (90.0%) with accuracy of $\geq 97\%$
  - 17 locations (56.7%) with accuracy of $\geq 99\%$
2. Driving Route Search Service (DRSS)

Presentation Summary of Driving Route Search Service (DRSS)

- Project information
- Criteria of route search
  - Shortest travel time
  - Lowest toll
  - Shortest distance
- Features of DRSS
  - Incorporation of real-time traffic speed data
  - Road network information
  - Special traffic news

(http://drss.td.gov.hk/drss)
2. DRSS Project Information

Client: Transport Department of HKSAR

Project Manager: Electrical & Mechanical Services Department of HKSAR

Contractor: Autotoll Limited

Commencement: April 2008

Launch of Service: April 2010

Sub-contractor: Hong Kong Polytechnic University

Route Search

Launched in Hong Kong Transport Department’s website in April 2010

(http://drss.td.gov.hk/drss)
Incorporation of Real-time Traffic Speed Data

Peak Hour (e.g. 9:00 am) using Western Harbour Crossing

Non-peak Hour (e.g. 1:30 pm) using Cross Harbour Tunnel

Road Network Information (Parking)
Due to watermain burst, all lanes of Waterloo Road Yau Ma Tei bound near House No. 118 are closed to all traffic. Vehicles on Prince Edward Road West are prohibited to turn left onto Waterloo Road Yau Ma Tei bound. At the same time, the U-turn loop leading from Waterloo Road northbound to southbound is closed. Bus routes 113 and 208 have been diverted. Motorists are advised to use alternative route(s) such as Argyle Street.
3. Journey Time Indication System (JTIS)

Presentation Summary of Journey Time Indication System (JTIS)

- Project information
- Two different types of traffic detectors
  1. Automatic vehicle identification (AVI) detector using RFID for electron toll collection
  2. Spot speed detector (e.g. Autoscope)
- Accuracy requirement of journey time estimates
  - Within +/- 20% errors with a compliance of 95% throughout the survey periods within two survey days (a weekday and a weekend) for each selected path.
- Validation results on 13 selected paths
3. JTIS Project Information

Client: Transport Department of HKSAR

Project Manager: Electrical & Mechanical Services Department of HKSAR

Contractor: Autotoll Limited

Contract Period:
  Implementation: October 2008
  Launch of Service: May 2009 (Hong Kong Island: JHK1-3),
                  May 2010 (Kowloon and JHK11)
  Defects Liability Period: 12 months
  Operation & Maintenance (O&M): 8 years

Sub-contractor: Hong Kong Polytechnic University

Two Types of Traffic Detectors

• Automatic vehicle identification (AVI) detector

  ID: 123456  Journey time = 15 min  ID: 123456
  9:15:00am  9:30:00am

• Spot speed detector

  No. of AVI detectors  No. of spot speed detectors
  Hong Kong Island  9  16
  Kowloon Peninsula  13  19

  65km/h  58km/h  55km/h
Offline Travel Time Estimates

- Average link travel time estimates ($t_1$, $t_2$)
- Spatial variance ($\sigma_1^2$, $\sigma_2^2$) and covariance ($\sigma_1\sigma_2$) relationships of link travel times

Algorithm for Journey Time Estimation

- Historical link speed estimates
- Real-time AVI data
- Real-time VIP data
- AVI data filtering method
- Space mean speeds
- Valid AVI data
- Piecewise non-linear speed based method
- Off-line spatial variance/ covariance of link travel times
- Off-line link travel time estimates on selected paths
- Average journey time estimates on selected paths
- Spatial variance/ covariance of journey time estimates
- Average journey time estimates on road segments along selected paths

Integration of various estimates

Instantaneous journey time estimates on the selected paths at two-minute intervals
AVI Data Filtering

J3 (Waterloo Road) Gantry

Cross Harbour Tunnel (CHT) Toll-gate

Journey time of vehicle A = 20 min

Journey time of vehicle B = 50 min

AVI Data Filtering Methods

<table>
<thead>
<tr>
<th></th>
<th>JTIS</th>
<th>TransGuide</th>
<th>TranStar</th>
<th>Transmit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interval</td>
<td>2 minutes</td>
<td>2 minutes</td>
<td>30 seconds</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Thresholds of valid time window</td>
<td>Stochastic (dependent on various factors at the previous time intervals)</td>
<td>Fixed (±20% of mean journey time at the previous time interval t-1)</td>
<td>Fixed (±20% of mean journey time at interval t-1)</td>
<td>Fixed (±X% of mean journey time at interval t-1, X is defined by users)</td>
</tr>
<tr>
<td>Applications in</td>
<td>Hong Kong</td>
<td>San Antonio, USA</td>
<td>Houston, USA</td>
<td>New York/ New Jersey, USA</td>
</tr>
</tbody>
</table>

AVI Data Filtering Method for Generating Valid Time Windows using Fixed Threshold (e.g. +/-20% of mean journey times at previous time interval t-1)

J4 (Princess Margaret Road) – Cross Harbour Tunnel (Toll gate) on 5 Feb 2010 (Friday)

JTIS Data Filtering Method for Generating Stochastic Valid Time Windows

J4 (Princess Margaret Road) – Cross Harbour Tunnel (Toll gate) on 5 Feb 2010 (Friday)
Speed Data Collected by Autoscopes

Time mean speed

Space mean speed

Speed-based Method for Estimating Journey Time

- **Average speed method**

- **Piecewise linear speed based method**

- **Piecewise non-linear speed based method** (with consideration of covariance relationship of link travel times/speeds)
Integration of Different Journey Time Estimates

- Instantaneous journey time estimates
  \[ = A \times \text{journey time estimated by valid Autotoll tag data} \]
  \[ + B \times \text{journey time estimated by Autoscope data} \]
  \[ + C \times \text{offline journey time estimates} \]

- Weights of A and B are dependent on sample sizes of valid Autotoll tag and Autoscope data, respectively

- Offline estimates are the lowest priority (C=1-A-B)

Integration of Different Traffic Data

- Mainly dependent on sample sizes of AVI tag data
Automatic Vehicle Identification (AVI) Detector – Autotoll Tag Reader

Update once every 2 minutes!

Autotoll Tag Reader

Autotoll Tag

Automatic Vehicle Identification (AVI) Detector – Autotoll Tag Reader (RFID technology)

Autotoll Tag Reader

Autotoll Tag
### Autotoll Tag Data

<table>
<thead>
<tr>
<th>Journey time indicator to tunnel toll-gate</th>
<th>19:04:31</th>
<th>19:18:25</th>
<th>13 min 54 sec</th>
<th>834 sec</th>
</tr>
</thead>
</table>

Tag in circulation is about **250,000 tags** out of 613,000 licensed vehicles in Hong Kong in March 2011 (87,000 penetration of tags of 174,000 commercial vehicles is about 50%).

### Real-time Data collected by Autotoll Tag Reader

Tag in circulation is about **250,000 tags** out of 613,000 licensed vehicles in Hong Kong in March 2011 (87,000 penetration of tags of 174,000 commercial vehicles is about 50%).
Spot Speed Detector – Video Image Processing (VIP) Technology

Video detector: **Autoscope**

**Data Collected:** Traffic counts, time mean speed and space mean speed, etc.

Detected zones of **Autoscope**

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**JTIS Instantaneous Average Journey Time Estimates**

- Estimated average journey time at the road segment
- Instantaneous average journey time
- CHT (exit at HK side)
- Completed journey time

- Video detector: **Autoscope**
- Data Collected: Traffic counts, time mean speed and space mean speed, etc.

- Detection zones of **Autoscope**
Performance Criterion for Journey Time Validation

- Within +/- 20% errors with a compliance of 95% throughout the survey periods within two survey days (a weekday and a weekend) for each selected path.

For example, JHK1-CHT at 09:00:00-09:01:59 on Sunday:

- Observed instantaneous journey time = 4 min (50 km/h)
- Estimated instantaneous journey time = 5 min (40 km/h)
- Estimation error = (5-4)/4 × 100% = 25% > 20%

Validation Results

<table>
<thead>
<tr>
<th>Path No.</th>
<th>Selected path</th>
<th>No. of samples</th>
<th>Accuracy*</th>
<th>Path No.</th>
<th>Selected path</th>
<th>No. of samples</th>
<th>Accuracy*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>JHK1-CHT</td>
<td>94</td>
<td>97.9%</td>
<td>1</td>
<td>J1-CHT</td>
<td>159</td>
<td>98.1%</td>
</tr>
<tr>
<td>2</td>
<td>JHK1-EHC</td>
<td>91</td>
<td>98.9%</td>
<td>2</td>
<td>J1-WHC</td>
<td>117</td>
<td>98.3%</td>
</tr>
<tr>
<td>3</td>
<td>JHK2-CHT</td>
<td>120</td>
<td>95.0%</td>
<td>3</td>
<td>J2-CHT</td>
<td>78</td>
<td>96.2%</td>
</tr>
<tr>
<td>4</td>
<td>JHK2-EHC</td>
<td>102</td>
<td>97.1%</td>
<td>4</td>
<td>J2-EHC</td>
<td>203</td>
<td>99.0%</td>
</tr>
<tr>
<td>5</td>
<td>JHK2-WHC</td>
<td>110</td>
<td>95.5%</td>
<td>5</td>
<td>J3-CHT</td>
<td>110</td>
<td>96.4%</td>
</tr>
<tr>
<td>6</td>
<td>JHK3-CHT</td>
<td>103</td>
<td>95.1%</td>
<td>6</td>
<td>J3-EHC</td>
<td>137</td>
<td>100.0%</td>
</tr>
<tr>
<td>7</td>
<td>JHK3-WHC</td>
<td>114</td>
<td>98.3%</td>
<td>7</td>
<td>J3-WHC</td>
<td>80</td>
<td>98.8%</td>
</tr>
<tr>
<td>8</td>
<td>JHK11-CHT</td>
<td>90</td>
<td>97.8%</td>
<td>8</td>
<td>J4-CHT</td>
<td>86</td>
<td>95.3%</td>
</tr>
<tr>
<td>9</td>
<td>JHK11-EHC</td>
<td>119</td>
<td>99.2%</td>
<td>9</td>
<td>J4-WHC</td>
<td>132</td>
<td>98.5%</td>
</tr>
<tr>
<td>10</td>
<td>J5-CHT</td>
<td>187</td>
<td>97.3%</td>
<td>10</td>
<td>J5-EHC</td>
<td>184</td>
<td>98.4%</td>
</tr>
<tr>
<td>11</td>
<td>J5-EHC</td>
<td>184</td>
<td>98.4%</td>
<td>11</td>
<td>J6-CHT</td>
<td>93</td>
<td>95.7%</td>
</tr>
<tr>
<td>12</td>
<td>J6-WHC</td>
<td>114</td>
<td>96.5%</td>
<td>13</td>
<td>J6-WHC</td>
<td>114</td>
<td>96.5%</td>
</tr>
</tbody>
</table>

*Percentage of samples within ± 20% errors throughout the survey periods in the validation.
JHK1-JHK3, JHK11 and J1-J6 are the journey time indicators in Hong Kong Island and Kowloon Peninsula, respectively.
Abbreviation: CHT – Cross Harbor Tunnel; EHC – Eastern Harbor Crossing; WHC – Western Harbor Crossing.

The requirement of the targeted accuracy level is achieved.
4. Speed Map Panels (SMP) in the New Territories

SMP informs the motorists of the traffic conditions of the roads ahead by using different colors to represent different congestion levels, together with journey time information.

Presentation Summary of Speed Map Panels

- Project information
- Location and layout of SMP
- Two different types of traffic detectors
  1. Spot speed detector (e.g. Autoscope)
  2. Automatic vehicle identification (AVI) detector using Automatic license plate recognition technology

REG_NUMBER: GH5286
CONFIDENCE: 94
VESNAME: Fixed VES
VES_LOC: Gloucester Rd
NORTHING: 2466490
EASTING: 208700
SMP Project Information

Client: Transport Department of HKSAR

Project Manager: Mott MacDonald (HK) Limited

Contractor: Autotoll Limited

Contract Period:
- Implementation: January 2010
- Expected Launch of Service: June 2012
- Defects Liability Period: 12 months
- Operation & Maintenance (O&M): 8 years

Sub-contractor: Hong Kong Polytechnic University

Location of Five Speed Map Panels (SMP)

3 SMP in NT East;
2 SMP in NT West
Distance from Tuen Mun to Tsuen Wan West:
- via Tuen Mun Road = 17.5 km
- via Castle Peak Road = 18.2 km

Two Types of Traffic Detectors

Traffic detectors
- 39 link speed detectors
- 96 spot speed detectors

Link speed detector: Automatic license plate recognition technology

Spot speed detector: Video image processing technology
Two Types of Traffic Detectors

- Link speed and spot speed detectors are installed at the starting and the end points of the path segments.
  - Longest path segment = 9.4 km
  - Shortest path segment = 1.1 km
- Average spacing of spot speed detectors is not greater than 1.2 km.

<table>
<thead>
<tr>
<th>Link + spot speed detectors</th>
<th>Spot speed detector</th>
<th>Link + spot speed detectors</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>No. of vehicles (as at March 2011)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All licensed vehicles in Hong Kong</td>
</tr>
<tr>
<td>Corporate vehicles (owned by limited companies)</td>
</tr>
<tr>
<td>Corporate vehicles with Autotoll tags</td>
</tr>
</tbody>
</table>

Validation Approach for Journey Time and Traffic Speed Range Measurements

- Floating car surveys

<table>
<thead>
<tr>
<th>Day of Week:</th>
<th>1 weekday and 1 weekend (Sat or Sun)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey Period:</td>
<td>08:00-11:00; 12:00-15:00; 17:00-20:00</td>
</tr>
<tr>
<td>No. of Selected Paths:</td>
<td>13</td>
</tr>
<tr>
<td>9 (NTE) + 4 (NTW) = 11 for journey time and traffic speed range validation</td>
<td></td>
</tr>
<tr>
<td>2 (NTE) for traffic speed range validation only</td>
<td></td>
</tr>
<tr>
<td>Test Cars:</td>
<td>5-10 test cars for each selected path were estimated based on the path distance and the cycle time of test cars on each path</td>
</tr>
</tbody>
</table>
### Distance of the 13 Selected Paths in SMP

<table>
<thead>
<tr>
<th>Path No.</th>
<th>Selected Path</th>
<th>Path Distance (km)</th>
<th>Path No.</th>
<th>Selected Path</th>
<th>Path Distance (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SJ1-SMT</td>
<td>7.7</td>
<td>10</td>
<td>SJ4-TKTL</td>
<td>12.0</td>
</tr>
<tr>
<td>2</td>
<td>SJ1-TSCA</td>
<td>8.4</td>
<td>11</td>
<td>SJ4-TKTM</td>
<td><strong>26.9</strong></td>
</tr>
<tr>
<td>3</td>
<td>SJ1-LRT</td>
<td>7.5</td>
<td>12</td>
<td>SJ5-TWMT</td>
<td>16.9</td>
</tr>
<tr>
<td>4</td>
<td>SJ2-TSCA</td>
<td>9.7</td>
<td>13</td>
<td>SJ5-TWCP</td>
<td>17.3</td>
</tr>
<tr>
<td>5</td>
<td>SJ2-LRT</td>
<td>7.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>SJ2-TCT</td>
<td>5.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>SJ3-TSCA</td>
<td>11.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>SJ3-LRT</td>
<td>11.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>SJ3-TCT</td>
<td>10.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Distance of the longest selected path in JTISK (J3-EH) = 12.3km

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**Journey time surveys**

- No. of test cars were estimated based on the path distance and the cycle time of the test car
- Allocate at least one test car on each road segment of the selected path simultaneously
- Similar to take a snapshot at each road segment of the selected path at the same time
- Test cars are travelled at similar speed of surrounding traffic \( y = 0 \)
  \[
  y = \text{No. of vehicles overtaking test car} - \text{No. of vehicles passed by test car}
  \]
  
  \[
  y = q\left(\frac{v-w}{v}\right) \quad \text{where } v = \text{speed of test car}, \quad w = \text{speed of traffic stream}, \quad q = \text{flow}
  \]

  If \( y = 0 \), then \( v = w \)

- The targeted accuracy level of the journey time estimates is within +/- 20% errors with a compliance of 95% throughout the survey periods within two survey days (a weekday and a weekend) for each selected path.
Colour codes for Traffic Speed Ranges

- **Major routes:**
  - **Red:** 0-25km/h; **Amber:** 25-50km/h; **Green:** > 50km/h

- **Urban roads:**
  - **Red:** 0-15km/h; **Amber:** 15-30km/h; **Green:** > 30km/h

Performance Criterion for Traffic Speed Range

- The targeted accuracy level of the computed speed range for SMP should be fallen within +/- 20% with a compliance of 95%.

- Thus, the computed speed ranges for two types of routes become:
  - **Major Routes**
    - **Red:** 0-30km/h; **Amber:** 20-60km/h, **Green:** >40km/h
  - **Urban Roads**
    - **Red:** 0-18km/h; **Amber:** 12-36km/h, **Green:** >24km/h
Example
(Road Segments of a Major Route)

Observed Speed Range:

Computed Speed Range with allowance of +/-20% errors:

Potential ITS Applications in Hong Kong
Technologies for Incident Management

Feasibility Study on Deploying Advanced Technologies in Incident Management - Executive Summary

February 2010


Traffic Accident on Major Road

Incident Detection

<table>
<thead>
<tr>
<th>Time Interval (t)</th>
<th>Predicted Travel Speed (Y_t) (km/h)</th>
<th>Observed Travel Speed (X_t) (km/h)</th>
<th>Relative Difference of Travel Speed (Y_t - X_t)/Y_t</th>
<th>Threshold of Relative Difference of Travel Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:10-10:11</td>
<td>54.0</td>
<td>60.0</td>
<td>0.1</td>
<td>0.4</td>
</tr>
<tr>
<td>10:12-10:13 (Estimated incident occurrence time)</td>
<td>54.0</td>
<td>50.0</td>
<td>0.1 Time to detect: 4 min</td>
<td>0.4 Time to give alarm: 6 min</td>
</tr>
<tr>
<td>10:14-10:15</td>
<td>54.0</td>
<td>8.0</td>
<td>0.9</td>
<td>0.4</td>
</tr>
<tr>
<td>10:16-10:17</td>
<td>54.0</td>
<td>4.6</td>
<td>0.9</td>
<td>0.4</td>
</tr>
<tr>
<td>10:18-10:19</td>
<td>54.0</td>
<td>17.0</td>
<td>0.7</td>
<td>0.4</td>
</tr>
<tr>
<td>10:36-10:37</td>
<td>54.0</td>
<td>10.0</td>
<td>0.8</td>
<td>0.4</td>
</tr>
<tr>
<td>10:37-10:38</td>
<td>54.0</td>
<td>57.3</td>
<td>-0.1</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Notes: (1) Alarm is given when the relative difference of travel speed at two successive time intervals exceeds the threshold value. (2) Y_t is referred to the predicted travel speed at the time interval of incident occurred.

Route Guidance

- Reliable routing service with on-time arrival probability
Reliable Route Searching System

Title: Reliable shortest path finding in stochastic networks with spatial correlated link travel times
Author(s): Chen Bi Yu; Lam William H. K.; Sumalee Agachai; et al.
Source: INTERNATIONAL JOURNAL OF GEOGRAPHICAL INFORMATION SCIENCE  Volume: 26  Issue: 2  Pages: 365-386  Published: 2012

Overall System for Niche Areas ITS Project
### Intelligent Transportation System Testbed

**Title:** Bus arrival time prediction at bus stop with multiple routes  
**Author(s):** Yu Bin; Lam William H. K.; Tam Mei Lam  
**Source:** TRANSPORTATION RESEARCH PART C: EMERGING TECHNOLOGIES  
**Volume:** 19  
**Issue:** 6  
**Pages:** 1157-1170  
**Published:** DEC 2011

#### Benefits to the Community

**Real Time Traffic Information**  
**Predicted Bus Arrival Time**

### Benefits

Title: Bus arrival time prediction at bus stop with multiple routes  
Author(s): Yu Bin; Lam William H. K.; Tam Mei Lam  
Source: TRANSPORTATION RESEARCH PART C: EMERGING TECHNOLOGIES  
Volume: 19  
Issue: 6  
Pages: 1157-1170  
Published: DEC 2011
Website of ITS in Hong Kong

  - Journey Time Indication System
  - Traffic Speed Map
  - Area Traffic Control Systems
  - Traffic Control and Surveillance System
  - Closed Circuit Television Images on the Internet
  - Automatic Toll Collection System
  - Octopus
  - Electronic Parking Meters
  - Red Light Cameras and Speed Enforcement Cameras
  - Traffic Control Centre

* An integrated real-time traffic database for ITS in Hong Kong.

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-The End-

The 17th HKSTS International Conference
15-17 December, 2012, Hong Kong
http://www.hksts.org
The 5th International Symposium on Transportation Network Reliability (INSTR) 18-19 December, 2012, Hong Kong
http://www.instr2012.org