2013 EASTS Outstanding Transportation Project Award

Speed Map Panel in the New Territories (SMP)

April 2013

1. EXECUTIVE SUMMARY

Autotoll Limited (Autotoll) is pleased to submit our construction project of Speed Map Panels in the New Territories (SMP) for the 2013 EASTS Outstanding Transportation Project Award.

The objective of the implementation of Speed Map Panels (SMP) is to disseminate real-time traffic speed and estimated journey time information to motorists via LED displays, interactive voice response system (IVRS) and Internet Speed Map (ISM) through website and smartphone applications. The traffic speed on different road sections of major routes is represented in three colours: red for congested traffic and speed is very slow, amber for moderate traffic and green for smooth traffic under free-flow condition. And so, motorists are enabled to achieve information of the traffic conditions of the roads ahead and choose alternative routes to Kowloon, Tsuen Wan (West) or Ting Kau from the New Territories of Hong Kong to avoid the traffic congestion.

Autotoll, the Electronic Toll Collection (ETC) service provider in Hong Kong, collaborated with counterparts to lead a team of experts to undertake the project. The implementation enables the motorists shorten the driving time by choosing the less congested road segments of routes shown on SMP on real-time basis to reach destinations along the journey, alleviates the congestion on the road and aids re-distribution of traffic particular when there is an accident happened on the road ahead.

The challenges from design to commissioning of the SMP are to handle numerous sites' work, coordination with different government departments and utility service companies, construction and erection of gantries and footings, installation on main routes and expressways, and more crucially to satisfy the high accuracy level as required by the Government of HKSAR. With possessing the solid hand-on experience in implementing ITS projects, the project team not only has overcome all these challenges and delivered the project within permitted schedule and budget, but had also maintained the quality of work. (Please see Figure (1) in Section 9 – Pictures and Drawings)

2. OUTLINE OF THE PROJECT

Brief history of SMP project

Autotoll was successfully awarded the tender of the implementation of "Speed Map Panels in the New Territories" in 2009 by the Transport Department of the Government of HKSAR. SMP was an enhancement model of the Journey Time Indication System (JTIS) project that had also been completed by Autotoll in 2010. However, JTIS provides the estimated journey times on ISM, IVRS and journey time indicators (JTI) for aiding motorist to compose a plan before travelling in making route choice to cross the harbor from Kowloon Peninsula to Hong Kong Island and vice versa to avoid the traffic congestion. However, the traffic information of the major Kowloon-bound routes from New Territories was neglected. Therefore, the development of SMP was to expand the coverage of providing traffic information.

Compared with the operation of SMP, the significant enhancement is the display of real-time traffic speed with journey time estimation of the strategic road segments of major routes ahead. This further aids the motorists to decide their route

choices along the journey and go a step further to ameliorate overloading traffic on roads. (Please see Figure (2) & Figure (3) in Section 9 – Pictures and Drawings)

The scope of work of SMP project included:

1. the construction, relocation and modification of existing footings and/or gantries, supporting frames, poles, etc. for the erection of SMPs and JTIs;
2. addressing tree issue at locations of SMPs for erection of sign panels, and relocation and removal of traffic signs.
3. the installation of SMPs with LED display at five strategic locations and JTIs at 9 critical points at the major Kowloon-bound routes to provides real-time average traffic speed and journey time estimation of vehicle from the New Territories to Kowloon, Tsuen Wan (West) and Ting Kau;
4. the installation of the necessary vehicle detection equipment such as License Plate Recognition System (LPRS) devices and Video Image Processing (VIP) devices, along the major highways of Kowloon from the New Territories to collect the traffic data required for computation of the estimated journey time and traffic speed;
5. the interface design Central Control and Motoring System (CCMS) for computing traffic speed and journey time information at two-minute intervals, and for monitoring and controlling the system operation;
6. the integration of JTISHK and JTISK with SMP system, for the computation of vehicle speed and journey time estimation; and
7. the development of Interactive Voice Response System (IVRS) and computer system to disseminate traffic speed and journey time information of SMP system via telecom, internet and smartphone applications. .

The project was commenced in January 2010 and completed in October 2012, and has entered Defect Liability Period. The construction budget of the project including the provision of maintenance service was US$9 million.

3. IMPACT OF THE PROJECT

Social Impact

Hong Kong is a dynamic and prosperous city, which always come with problems on transportation. In urban area, such as Tsim Sha Tsui, the roads are usually fully clogged with vehicles in rush hours. There are many sources of this traffic congestion, for instance, underground repairs, too many buses, special events and traffic accidents. The bad traffic condition causes many problems, such as buses arriving late, delays in deliveries. It is difficult to estimate how much time Hong Kong residents waste in traffic congestion or the economic loss but the figures are definitely high. Yet, time is money. As such, SMP is an influential system not only enables to alleviate the serious traffic problem facing by the public, but can also save the economic loss. Moreover, by alleviating traffic congestion and saving the journey time, it allows for lower fuel consumption and vehicle emission, leading to the reduction of air-pollution and environmental damage by cutting down on the use of fossil fuel.

Transportation Impact

During rush hours, vehicles are usually not evenly distributed on the relevant roads due to lack of knowledge of real-time road conditions and options of roads. If motorists select the less occupied road, they can avoid jams. An advanced traveler information system such as SMP could provide these information to motorists. All motorists, not only the drivers who use this system, could travel more smoothly as jams would be eliminated because this system can help to redistribute the vehicles on the roads. The system creates an equilibrium system because more vehicles will travel on the less occupied road. This can help to avoid overloading roads while allowing drivers to select the best route to their destination.

4. METHOD/TECHNOLOGY OF CONSTRUCTION

The overall SMP system block diagram is illustrated as below. (Please see Figure (4) in Section 9 – Pictures and Drawings)

Hybrid Data Collection Method

The key and unique methodology adopted in SMP was the hybrid data collection method which provided high accuracy level in capturing the data for real time traffic speed and journey time estimation. According to the contract of the SMP project, 88 traffic monitoring stations (TMS) has to be set at the various strategic points along the major Kowloon-bound routes to capture the real-time data and traffic flow. In order to optimize the system performance, 8 more TMS were installed at roadsides, therefore a total of 96 TMS was set. TMS refers to the interface from vehicle detectors to the front-end logger components, control devices and any integrated or ancillary traffic data processing unit for acquisition of traffic data for the generation of journey time information.

Two types of traffic detectors have been adopted for collection of real-time data for traffic speed and journey time estimation in the SMP system, including link speed detector (LSD) by License Plate Recognition System (LPRS) technology and spot speed detector (SSD) by Video Image Processing (VIP) technology. LPRS and VIP raw data are captured and transmitted to computation algorithm. Finally, the sectional traffic speed and estimated journey time would be distributed to the public via SMP LED display, IVRS, ISM on website and smartphone applications. The traffic information would be updated in every two-minute interval.

On the other hand, with the intention to provide a cost effective solution, the hybrid and dual data communication network was introduced. Although the dual and fixed line network is more reliable under typhoon and black rain signals than the single path wireless network, the cost is very high. We decided to adopt hybrid and dual data communication network with maintaining the service availability at the required level based on the provision of end to end fiber and resilient network infrastructure from our network service provider. It also provides the data priority service to Autotoll to ensure the service availability of data transmission especially under the inferior situation as typhoon and black rain warning period. In addition a 7x24 technical support and 7x24 network and router management service are also provided. As such, the most cost effective approach has been operating the communication network with high security and reliability.

To maintain the high reliability and accuracy level of traffic information, it would not be enough with only using the

real-time data for the estimation of journey time and traffic speed. The errors of estimation would increase with reduction on available real-time data particularly when some of the TMS for real-time data collection were broken down. In SMP project, real-time traffic data captured from various traffic detectors together with the offline (historical) data are simultaneously considered in the journey time and traffic speed estimation algorithm.

Computation Algorithm

The solution algorithm in SMP integrates different types of available real-time traffic data and offline estimates for provision of most up-to-minute traffic information for the selected paths in New Territories and Kowloon. In addition to the use of real-time automatic vehicle identification (AVI) data collected from LPRS devices along the selected paths and VIP data for traffic speed and journey time computation, the offline database could be complementary to the real-time database as the availability of real-time data would be varied by time of day and day of the week etc. The offline database would be updated continuously with the real-time data collected by time of day and day of the week for improvement of the traffic speed and journey time estimation. Moreover, the algorithm has been enhanced to suit for complicated traffic scenario in Hong Kong. (Please see Figure (5) in Section 9 – Pictures and Drawings)

The merits of the adopted algorithm are:

- Feasible for integrating other data sources and different types of real-time traffic data for traffic speed and journey time estimation.
- Offline database is integrated into the real-time traffic speed and journey time computation system. Not only mean travel time data but also spatial covariance relationships of link travel times are adopted in the algorithm for traffic speed and journey time estimation. The covariance can indicate some correlations between link travel times and speed. This correlation is of particular help for link travel time and speed estimation based on spot speed data.
- A robust data filtering method was developed for generating stochastic valid time windows. The thresholds of valid time window are dependent on various factors at previous time intervals.

Validation Method

According to the contract requirement of the project, the accuracy level of the traffic speed and journey time estimates on each of the selected paths should reach 95% with designated error levels. To validate the traffic speed and journey time estimates, comprehensive floating car surveys were conducted in a typical weekday and a weekend respectively for collection of the observed traffic speed ranges and journey times. Each of the survey periods was scheduled with three hours from 08:00 to 11:00, 12:00 to 15:00 and 17:00 to 20:00, respectively. During the surveys, the test vehicles were driven on all the thirteen selected paths and the 68 corresponding road segments. Hence, the traffic speed and journey time measured on each of the selected paths can be considered as an observed average travel time and traffic speed ranges of the traffic stream as a whole. The results showed that SMP system successfully met the requirement of the targeted accuracy level of 95% with designated error level for all the selected paths throughout the survey periods within the two survey days.

Construction

The construction work of the project embraced civil, electrical and mechanical aspects. The layout of SMP, and LPRS

and VIP data collection were the key component of the project, therefore, the design, construction programme, installation method, workmanship of the vehicle detectors were crucial factors for the accuracy, excellent deployment and implementation of the project. The corresponding layouts of SMPs and mounting methods have been approved by the Project Engineer and Transport Department of HKSAR.

The relocation and reconstruction of existing footings, gantries and supporting frame was carried out as minimal as possible in order to minimize the construction waste and to speed up the overall construction programme. Also, design of the new gantries was conducted in compliance with the relevant codes of practice and standards as specified in the SMP contract so as to reduce the disturbance to the existing traffic and the public. Besides, almost all the modifications were conducted beforehand, to ensure a smooth installation of SMPs and JTIs.
Crane lorry and chain blocks (or other equivalent access tool/equipment) have been used to lift up the panels to proper location for installation. Also, early notification had been sent to the relevant parties to ask for the permits essential for conducting relevant work programmes, such as Temporary Traffic Management (TTM) for the installation of SMP or conducting any civil works. (Please see Figure (6) in Section 9 – Pictures and Drawings)

The modification of existing supporting structures for minimizing the construction and various methods adopted in the project, the tight quality control over the construction work enabled the project to be completed on time and within budget. In spite of various challenges encountered, such as numerous working sites up to 96, comprehensive coordination works with different Government departments and utility service companies, complicated construction programmes, risky installation on gantry on main routes and expressways and also working at height, the project was implemented with high quality control. (Please see Figure (7) in Section 9 – Pictures and Drawings)

5. FINANCING AND MANAGEMENT

The project was financed by the Hong Kong Government as it was a tender contract. The project was implemented by Autotoll who has more than 15 years' experience in ETC service operation and is a leading Intelligent Transportation Systems (ITS) service provider in Hong Kong, implemented ITS projects including Real-time Travel Information System (RTIS), Driving Route Search System (DRSS), Internet Speed Map (ISM), Journey Time Indication in Kowloon and Hong Kong (JTISK/JTISHK). Furthermore, Autotoll has a sound reputation as a responsible main contractor with a safety record far above the industrial average as proven by attaining a winning prize of "Consideration Contrators Site Award" from the Works Branch of the Development Bureau of the Government of SAR in the JTISK project in 2010. Our project team worked tightly with its strategic counterparts including university, consultancy firm, as well as operations counterparts such as subcontractors, different government departments and utility service companies, from the beginning till the completion, which was critical for the outstanding performance of the project.

6. UNIQUENESS OF THE PROJECT

The uniqueness of the SMP can be summarized as follows:

- Integration of the systems of JTISK, JTISHK and SMP enables to provide the public with a wide picture of the

traffic flow and map routing of Hong Kong. The system has already incorporated the main routes of the New Territories, Kowloon and Hong Kong Island. Moreover, the mapping system has been regularly updated by re-calibration of road segments; as such the map would be easily integrated to include road segments/routes from other territories, to ensure a smooth expansion of system on estimation of journey time and speed time with high accuracy and reliability.

- Autotoll has built up 8 more TMS equipped with LPRS devices and video detectors with the total number of 96 TMS at various strategic locations at major Kolwoon-bound routes from New Territories in order to optimize the system performance of capturing the vehicle spot speed and traffic flow. With the intention to implement the project cost-effectively, we well managed to fine-tune the viewing angle of each video capture device, enabling 1 camera to monitor upto 2 lanes of highways. With supply and installation of such massive number of vehicles detectors on various risky locations i.e. roadsides, footbridges and gantries, that has proven Autotoll's technical expertise and professionalism in implement the detectors for real-time traffic data collection.

- The Central Control and Monitoring System was enhanced with User-friendly Graphical User Interface (GUI) from client inputs in SMP project to allow efficient and fast operation. In order to achieve high reliability, resilience have been incorporated in the system in order to prevent single point if failure. The design of CCMS with using open standards and platform allows interoperability among various open standard compliant products for cost-effectively and flexible future expansion and upgrade.

- The Algorithm to be implemented in SMP project shall be adaptive in nature with dynamic features for catering of different traffic flow patterns and raw data. It calculates the real-time traffic speed and journey time estimation with high accuracy by integrating the real-time traffic data collected by LPRS and VIP technology, together with historical travel time estimation. The Algorithm has been deployed in various local ITS projects such as JTISHK, JTISK and DRSS with proven track records and remarkable reliability. Furthermore, this Algorithm is being enhanced to suit for complicated traffic scenario in Hong Kong where overseas off-the-shelf algorithm cannot achieve.

7. CONCLUSION

Meeting the challenges in implementation, operation and maintenance of the project, Autotoll, being the main contractor has contributed in achieving the SMP to be a unique ITS project that provides significant transport and social benefit to HK society, and also a successful example for future ITS project in the region.

8. POINT OF CONTACT PERSON

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9. PICTURES / DRAWINGS

Figure (1) – Image of Speed Map Panel

Figure (2) Image of Speed Map Panel

Figure (3) SMP – display average traffic speed with estimated journey time

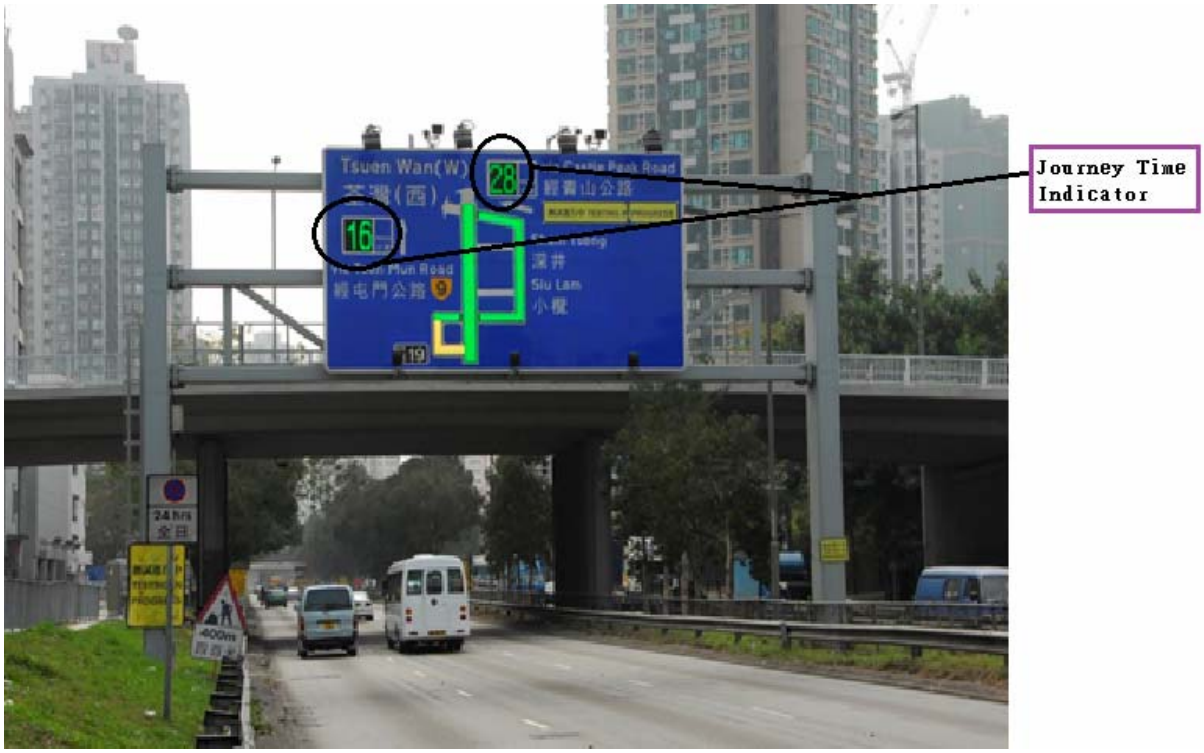


Figure 4. SMP System Block Diagram

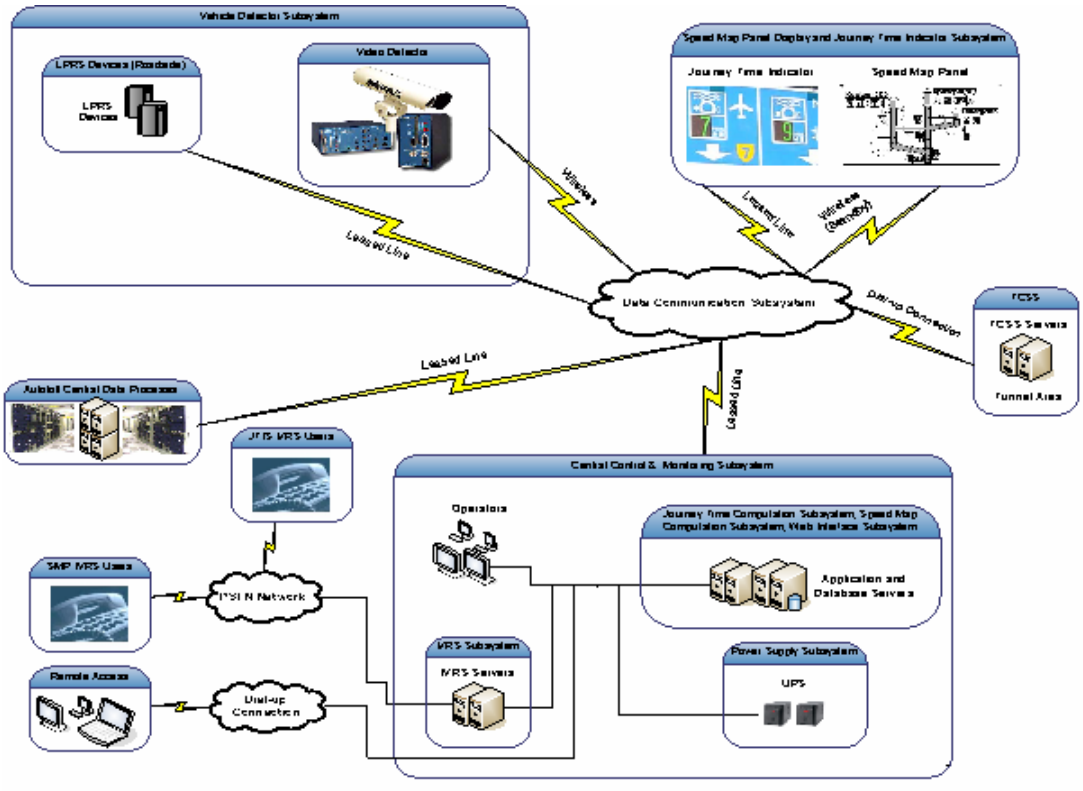


Figure 5. Adopted Algorithm for Journey Time and Traffic Speed Computation

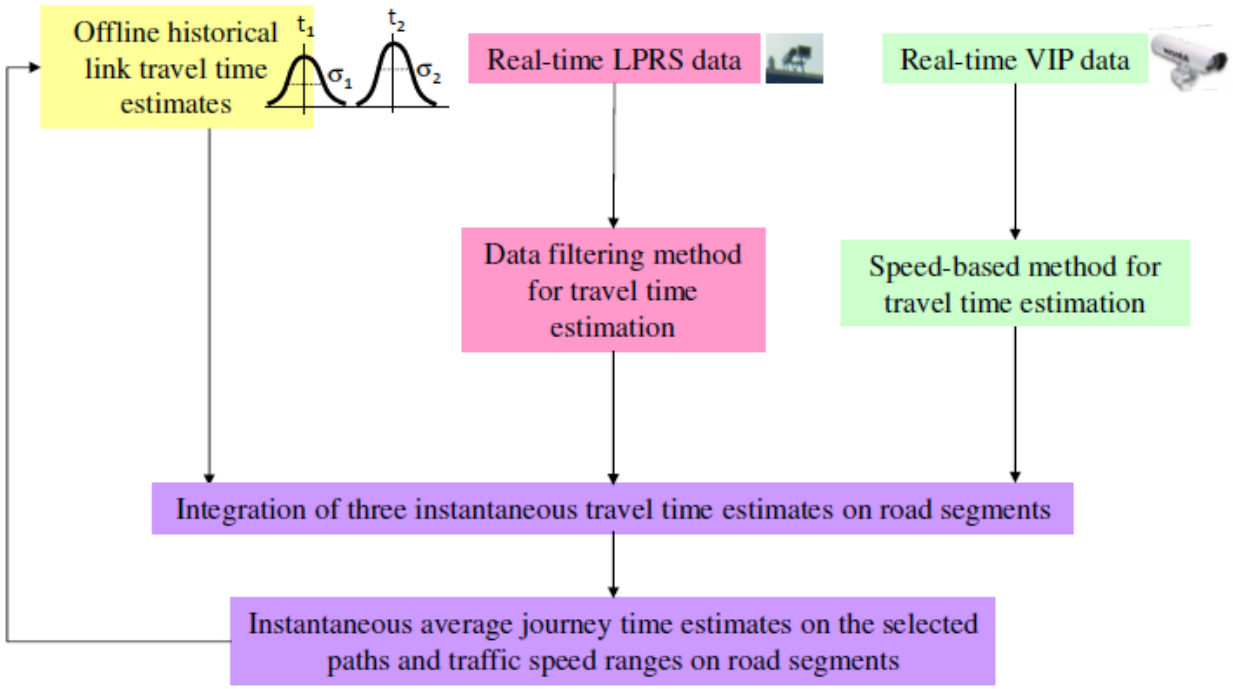


Figure 6. The layout of SMP

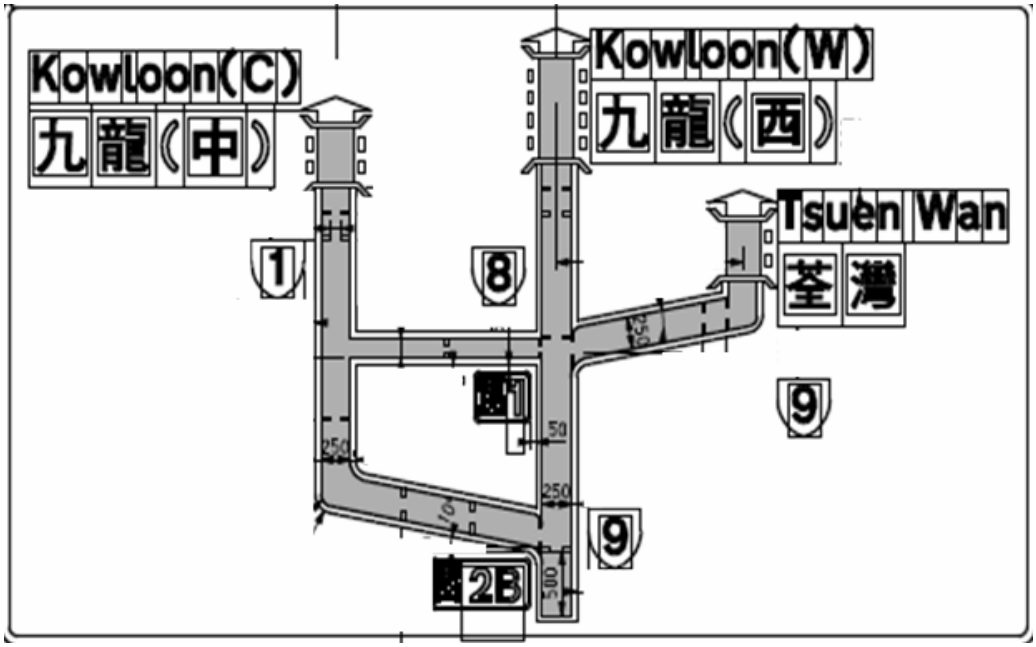
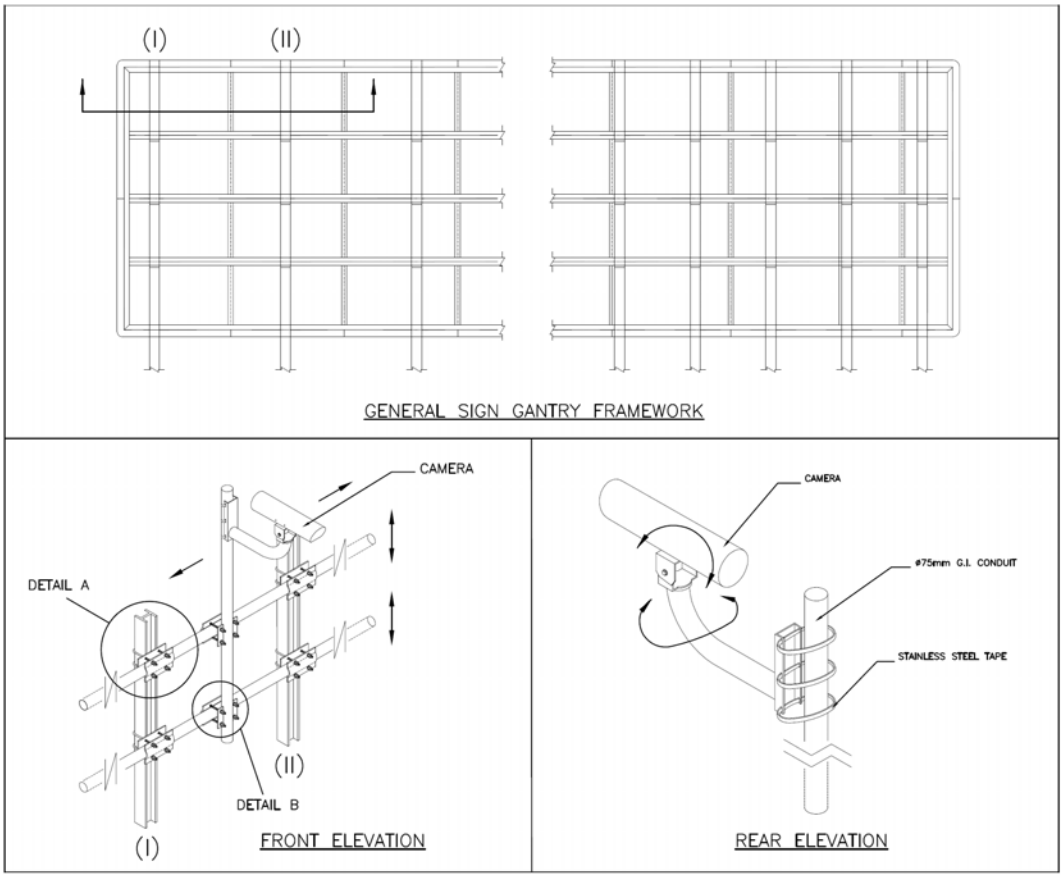
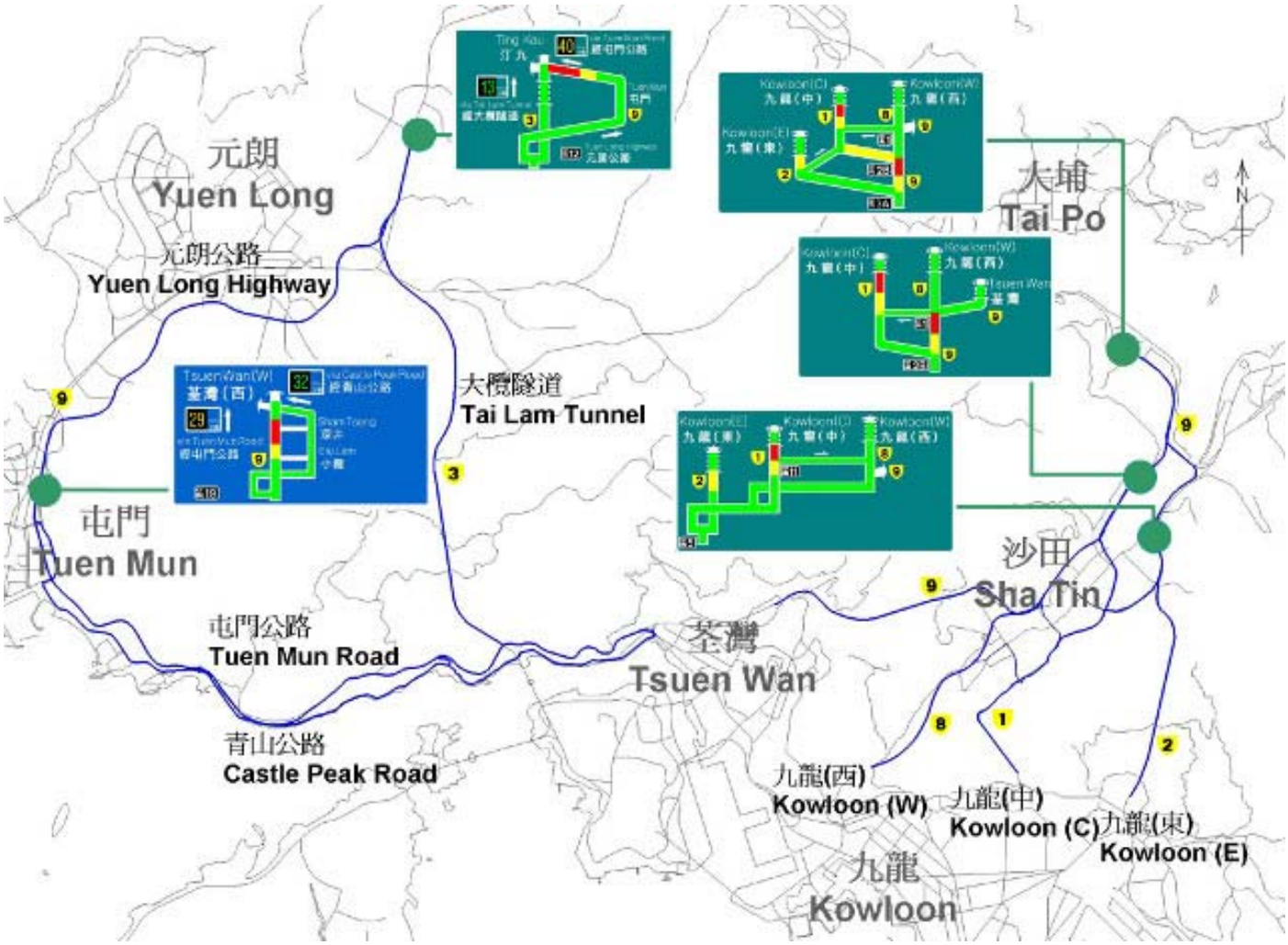


Figure 7. LPRS devices and VIP devices Installation Detail



SMP Location Map



Speed Map Panels

Civil works

Installation of SMPs and JTIs

Installation of detectors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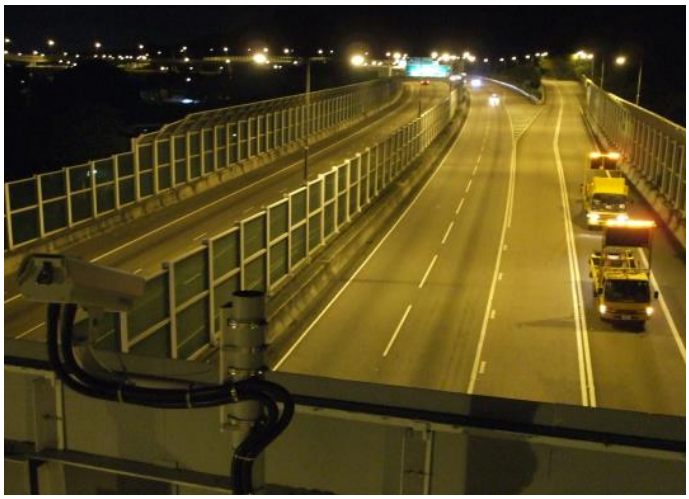
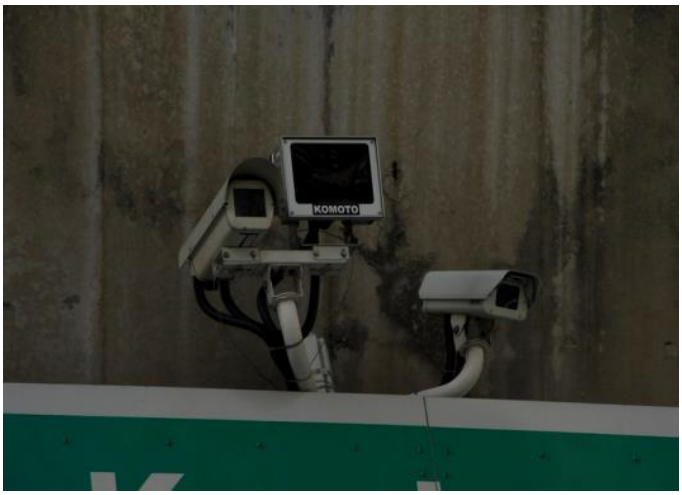
½km




KOMOTO