Having Good Control over a Tunnel's Operation

Traffic Monitoring, Automatic Incident Detection and Incident Management among Essentials

*By Husam Musharbash **

Increasing demand for road infrastructure upgrades is among the ordeals urban planners cope with in fast developing countries. Grade separated intersections with flyovers and tunnels have been replacing ordinary signalized intersections to better manage growing volumes and mix of vehicles. These increasingly complex transportation networks are requiring even greater deal of attention in traffic operations and safety management, an area where intelligent transportation systems (ITS) professionals come into picture.

In traffic congested urban areas, road tunnels are built to overcome space constraints, especially at intersections with existing bridges. Complexities in tunnel design though, necessitate the need for optimized ITS solutions. In particular, highly automatic traffic monitoring, management and control, as well as an effective incident management system, seem mandatory to comply with tunnel operation safety standards. A wide selection of advanced ITS components in the market makes all these possible. However, one may overlook the importance of customizing overall system's design to achieve true integration between ITS components and tunnel infrastructure subsystems, into one platform. In addition, the system's management software must incorporate well planned emergency system configurations that will activate necessary settings of all tunnel components to manage pre-defined emergency scenarios. A balance in operator intervention during incident management should also be regarded.

True Integration

Let's take a closer look at how incidents are monitored, detected and managed by an efficient tunnel management system.
For instance, a stalled vehicle is in the middle of a tunnel. Incident detection cameras will detect this vehicle, triggering a system alarm in the tunnel's control room. A video workstation, equipped with a graphical user interface (GUI), will display an alarm layout with live feeds from pan-tilt-zoom cameras installed inside the tunnel, allowing the tunnel's operator to verify the incident. The system's management software will then give the operator pre-defined options to select such as; decrease speed limits, close a tunnel lane, totally close the tunnel, or to reset the scenario. The selected option will display necessary information on all the variable message and speed limit signs, at the approach and inside the tunnel. Depending on the option selected, the system will advise approaching vehicles to slow down, will manage lane speeds and merging, and/or will direct traffic to alternative routes as necessary. To ensure that the incident is fully attended, the operator must complete incident steps, flagged up in the control room's GUI, until the incident is resolved. Making a call to alert emergency response teams, such as ambulance or police, is among the incident steps that must be completed.
Too good to be true? Well here's another one. A fire breaks out triggering the tunnel's fire alarm, which then sends off a signal to the control room. Automatically, the tunnel will be closed and all the variable message and speed limit signs will activate to its alternative route, speed reduction, and lane merging mode. At the tunnel's control room, the system will advise the operator of the incident, and all incident steps must be completed including sending an alert to the fire department. Simultaneously, the fire alarm will also trigger the tunnel's ventilation system to increase its speed to reduce fume build up in the tunnel. As part of a complete tunnel management system, fire extinguishers, emergency telephones, and emergency exits are all accessible and illuminated inside the tunnel.

Ideal Design

All aspects in a tunnel operation must be considered in deciding what systems to be integrated. This includes control of vehicle height entering the tunnel, speed limits at the approach and inside the tunnel, lane merging, alternate routes in case of tunnel closure, incident detection and management, illumination, tunnel air quality, flood control, and emergency facilities.
The approach towards the tunnel must be equipped with variable message signs that display tunnel condition, directions, lane speed limits, and lane merging information. Advance notification of a tunnel's condition enables drivers to reduce their speed or to look out for alternate routes if necessary. Individual lane speed limits and lane control signs on the other hand facilitate lane merging and lane management of vehicles to the tunnel or to alternate routes. It is also important to equip the tunnel entry with speed detection that will detect and warn over-speeding vehicles, either by sound alarm or by visual warning, for them to slow down and adhere to speed limits inside the tunnel.

An over-height vehicle detection system (OVDS) must be installed before the tunnel approach to restrict entry of vehicles that are over the tunnel's allowable height. In addition, if an over-height vehicle is detected, the system's variable message signs should direct the over-height vehicle to an alternative route.

Inside the tunnel, an incident detection camera system is a must have. It can be programmed to trigger a system alarm when slow traffic movement, traffic flow in the wrong direction, close vehicle gaps, high speed differential, or unidentified objects on the road, are detected. Additional pan-tilt-zoom cameras can also be installed for continuous real time video surveillance. Video recordings from these cameras can also be used to review incident causes, a vital factor that aides a tunnel operator in managing incidents.

The tunnel's lighting system must be equipped with optical sensors that provide input to the tunnel management system (TMS). Based on the tunnels lighting condition, the TMS will control the lighting system to adjust its power as necessary to maintain adequate illumination in the tunnel. In addition, the pavement can be equipped with lane light LED road markers to enhance lane visibility especially in curved areas of the tunnel. All emergency facilities must also be illuminated including directional signs to emergency exits, emergency roadside telephones, and firefighting equipment.

Full Control

Most importantly, all ITS and tunnel subsystems including emergency telephones, fire alarm system, illumination, flood control system and ventilation system must be integrated, centrally controlled, monitored and operated at the tunnel's control room. The system's management software must be programmed to propose planned tunnel emergency strategies whenever system alarms are triggered. Through surveillance cameras, the operator can verify incidents in the tunnel and select a preprogrammed strategy that will eventually manage all the ITS and tunnel components of the system.

In conclusion, full control over a tunnel's operation and efficient incident management can only be achieved with a truly integrated tunnel management system.

Coordinated Efforts

The successful implementation of the tunnel management system (TMS) at the newly constructed Ras Abu Aboud Tunnel in Qatar was a demonstration of distinct collaboration among the project's stake holders.

The tunnel, built as part of a US$200 million road network expansion project that will link the country's capital to the New Doha International Airport (NDIA), is equipped with highly advanced traffic management & ITS infrastructure, fire alarm system, flood control, ventilation control, and emergency roadside telephone system. All these are fully integrated into one platform, managed and controlled via Telegra's TopXview software. The New Doha International Airport Steering Committee has administered the execution of the new airport's master plan, including the construction of the tunnel. As a project that will form part of the airport's road infrastructure, the project's supply chain, from component suppliers to the consultant, were expected to build the tunnel, together with a highly efficient TMS, to support complex traffic demand once the airport opens.

The contractor, Midmac-Yuksel JV, was open to TMS design ideas proposed during the project's conceptualization. Traffic Tech (Gulf) on the other hand came up with design proposals that integrate necessary technologies to achieve global safety standards. The consultant, Cansult Maunsell (AECOM), added value to the whole supply chain with their professional advice on design issues encountered. Last but not least, the NDIA Steering Committee was keen to implement a state-of-the-art TMS for the tunnel.With the TMS design concept finalized in July 2009 and the opening aimed in December the same year, Traffic Tech executed the whole project in a span of five months, from design, to installation and commissioning, through efficient coordination with Telegra and the rest of the TMS component suppliers. ■

** Husam Musharbash, Traffic Tech Group, www.traffic-tech.com*

يشكّل الطّلب المتزايد على تحسين ورفع مستوى البنية التّحتية للطّرقات إحدى المحن الّتي تواجه مخططي المدن في البلدان السّريعة النمو. و قد حلّت تقاطعات الطّرق المجهّزة بجسور علويّة وأنفاق مكان التّقاطعات العاديّة بهدف التّعامل بشكل أفضل مع الكميّات المتزايدة من المركبات المختلفة. وتتطلّب شبكات النّقل المتزايدة التّعقيد هذه، والّتي يدخل في تصميمها أخصّائيون بأنظمة النّقل الذّكيّة، الكثير من الإهتمام والحذر في التّعامل مع عمليّات المرور وإدارة السّلامة. يتوجّب على هؤلاء الأخصّائيين مراعاة كافّة الجوانب المتعلّقة بعمليات الأنفاق من أجل تحديد الأنظمة الّتي تدخل في تصميمها كتحديد الإرتفاع الأقصى المسموح به للمركبات والسّرعة المطلوبة لدى الإقتراب من النّفق ولدى دخوله وتحديد الطّرق البديلة في حال إغلاق النّفق ورصد الحوادث وإدارتها و التّحكّم بالإضاءة و نوعية الهواء داخل النّفق والسّيطرة على الفيضانات وتزويد النّفق بمرافق للطوارئ وغيرها.

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