

In the incidence of incidents ...

Video detection in road tunnels

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Wide use of video detection systems and development of new features call for new ways of managing tunnels worldwide. The closed environment of a tunnel makes it both tricky to monitor and difficult to access in case of incident. It therefore requires careful attention in order to spot incidents quickly and react accordingly

The human eye has been replaced in the tunnel by video cameras, allowing operators to monitor the situation from the outside. However, there are some cases where the screens cannot be manned 24 hours a day or where the high number of cameras makes it difficult to handle all the information received.

In these cases, assistance can be provided by video detection systems. By scanning the frames for you, they only draw your attention, when necessary, to specific incidents.

The advantages of video detection systems over more conventional detection systems has already been demonstrated in tunnels. The fact that the

newly reopened Mont Blanc tunnel has adopted this technology is a good sign of its maturity.

Improving safety

The primary focus of video incident detection systems is that they can rapidly spot a number of situations before an accident happens. By drawing the operator's attention early, the system allows a quick reaction to any abnormal event.

These systems can automatically detect the following incidents, on every lane type (traveling lane, emergency lane, ramp) and under any traffic configuration (fluid, congestion, stop and go, etc):

- Vehicles stopped;
- Traffic congestion;
- Slow vehicles;
- Pedestrian;
- Wrong way vehicle;
- Debris.

Fire

The point of this system is that thanks to some of its features, it will be able to draw the operator's attention even before the consequences of a fire are detected by other means:

- Vehicle stop: a vehicle that catches fire is often a stopped vehicle. The detection of the vehicle stop will take place even if the vehicle is isolated;
- Poor visibility inside the tunnel because of smoke;
- Light scatter generated by flames on the pavement and on the sides of the tube.

Video detection systems also generate alarms for traffic measurements exceeding specific thresholds, thus providing information about how the tunnel users are behaving, such as:

- Queue length exceeding threshold;
- Vehicles' speed exceeding threshold;
- Gap exceeding threshold.

All thresholds are set at system installation and adjusted to fit the traffic situation.

Legislation and procedures

In Europe, growing concerns for an ever-improved safety level in tunnels has led governments to adapt the law.

Video detection has been widely recognised as the leading technology for incident detection in tunnels, for example new legislation issued by French transportation state agencies calls for the equipment to be installed in all tunnels longer than 300m.

Vehicle headway has been recognised as a major factor for safety improvement in tunnels. Tracking techniques enable state-of-the-art video detection systems to perform a dynamic measurement of vehicle headway on each and every video camera.

Measurements are used for statistics – to understand tunnel users' behaviour – as well as for information delivery via dynamic message signs automatically triggered by the video detection system.

Improving efficiency

The quality of video detection systems is assessed by looking at its ability to detect every incident as well as having a low false alarm rate. The detection algorithm can therefore be considered as the heart of the system and the main focus of research. However, with its coming to maturity, tools to operate the system

immediately display the sequence before and after the incident to evaluate the cause and the phase following the incident.

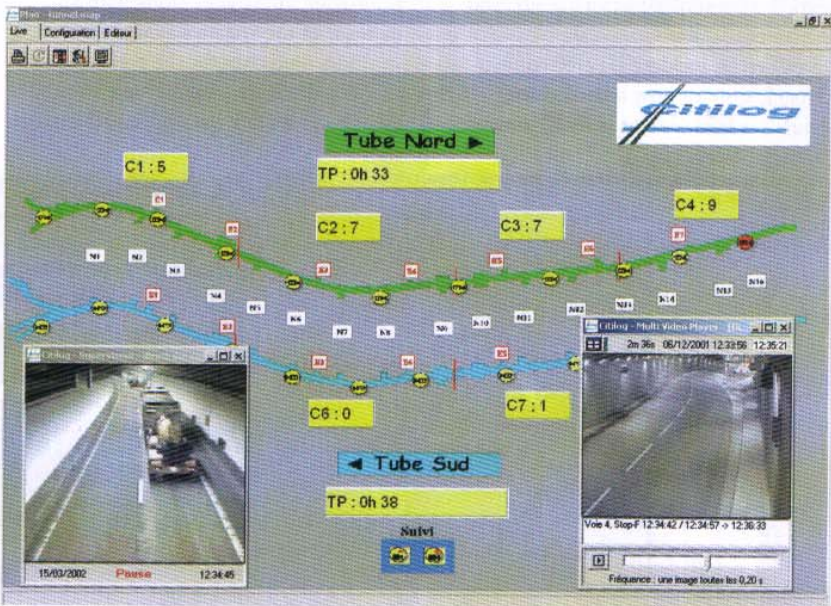
This function is a powerful tool to quickly understand events (incidents, accidents) occurring on the road either as soon as the alarm is triggered, in order to assess the type of rescue teams to be called, or after the event for a deeper analysis of the incident (official inquiry, behaviour of road travellers during and after the incident).

The resulting video sequences can be stored into incident databases and communicated to third parties for analysis.

Long recording

This feature provides the operator with a permanent digital recording of the images from all the cameras of the system.

Unlike the incident sequence recording,



Video detection system

and manage this new type of alarm became necessary.

Keeping record

For each camera analysed by the video detection system, the analyser keeps the digital video sequence in a buffer for some time after the incident.

If an incident occurs, the video sequence is kept and extended:

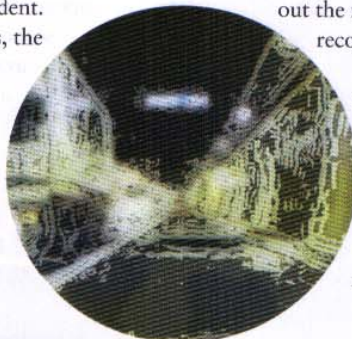
- Either for a given time after the incident;
- Until the end of the incident.

The operator can then

this recording is not associated to any incident. It is, however, kept for a few days in a circular buffer.

This allows an operator to manually retrieve the digital recording of any moment within the previous days without the need for additional digital recorders.

The two main points are that when there is an incident in the tunnel, rather than having an operator take the decision to extend the incident sequence recording, he will be



able, days after, to isolate the exact length of recording that is of interest: from the cause of the incident until all the emergency people have left the tunnel. Therefore, at the same time as avoiding this recording extension procedure in case of specific incidents, this feature provides police or security officers with the recording matching the exact incident duration. This gives the client the possibility to measure the efficiency of the detection system provided that any incident not detected would still be recorded on the hard disks of the system.

Manual recording

At any time the operator can manually activate or stop the video recording on a camera and view and archive the corresponding video sequence in the database. This enables the operator to record interesting situations apart from incidents.

When an incident is detected on a camera, systems now record video sequences from one or several cameras

decisions is the number of vehicles in the tunnel and their position. Operators need to know how many vehicles are driving toward an incident scene.

State-of-the-art video detection systems use tracking techniques. Algorithms enable detection and follow the trajectory of vehicles.

The video detection system can then identify in real time the number of vehicles in any area. The system will then display on demand (or automatically upon alarm) a graphical representation of the tunnel including the number of vehicles in any section.

The ability of the video detection system to reset automatically sections devoid of vehicles avoids any accumulation of error over a long period of time.

Global system availability

Improving safety goes along with an increase of the system's availability.

High objectives for the performances of video detection systems have stressed the need to rethink the system architecture.

viewing of a potential incident from two different points of view. A cross field-of-view camera pattern also calls for further integration of video detection and video surveillance systems.

The newly-reopened Mont-Blanc tunnel for example is monitored by a 260 redundant video detection system provided by Citilog.

Long tunnels

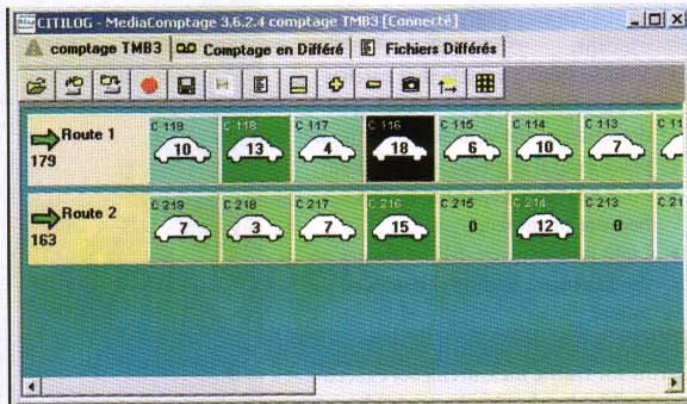
In long road-tunnels, safety issues call for specific management procedures. A number of factors are generally associated with long tunnels: small width of traffic lanes, large truck traffic, etc.

A characteristic of most long tunnels worldwide is the management of the traffic across two different locations, generally at both ends of the tunnel. This is particularly true for cross-border tunnels. In that case, bilingual man-machine interfaces allow flexibility and efficiency in crisis management situations.

Moreover, information must be available to a number of professionals able to



Multiple view display



Vehicle log

positioned before or after the camera on alarm.

This function enables a better understanding of the causes of the incident.

Sequence recording upon external alarm

It is possible to record digital video sequences from one or several cameras in case of an alarm supplied by any other system (fire extinguisher, refuge door, emergency call and so on).

Vehicle counting and positioning

In crisis situations, a key piece of information to take adequate



Going a step further than the usual self-diagnosis features, is the implementation of a true redundancy to the system architecture.

Each video input is connected to two redundant video detection systems, the video detection process stays active and operational under any circumstances. Information remains available to the operators at any time.

Cameras can also be installed in patterns enabling any location to be monitored by two different cameras. They also enable the

respond efficiently to any incident occurring in the tunnel including initially operators but also the police department, fire squads, etc. This calls for systems able to provide redundant information at several spots.

In long tunnels, vehicle counting and positioning is crucial for incident management. One example is the Somport tunnel between Spain and France that will open with a state-of-the-art video detection system addressing these issues.

Urban tunnels

These tunnels are more subject to heavy congestion than motorway tunnels. They

are mostly used by working commuters and are therefore affected by morning and evening peak rush hours. At these times, any incident resulting in a vehicle stop will increase the level of congestion dramatically.

An early detection is therefore necessary to react quickly, whether to intervene and salvage the car or to redirect the traffic to alternative routes by activating variable message signs.

As urban tunnels are faced with an inflow in the morning and an outflow in the evening, one or more lanes are often used by tunnel operators to offer extra capacity to the main flow. Allocating lanes to the main flow of traffic requires all the equipment to be bi-directional. Video detection systems are now able to cope with these changes without the need for heavy parameter modifications. Several sets of parameters are saved and applied according to the traffic conditions, whether on a time basis or an operator's request. The system is then able to operate all the preset detections

- Upon specific traffic condition identified by the system.

Level of service and statistics

The MediaTunnel system provides real-time traffic measurements for each lane of traffic, with:

- Flow rate;
- Speed;
- Occupancy rate;
- Headway;
- Queue length.

Every measurement is available for each lane of traffic or for a group of lanes. The duration for aggregating data is programmable (standard: 15 seconds, one minute or six minutes).

The traffic measurements are centralized and stored in Excel®-compatible files. They can be supplied to a traffic management centre.

For example, calculation of travel

needs for a complete understanding of the situation inside the tunnel, i.e. to:

- Easily identify the camera under alarm and display it in real time;
- Immediately play the video sequence of the minutes before the incident associated with the current alarm;
- Check the number and position of vehicles inside the tunnel in order to perform a real follow-up of the incident;
- Display the traffic measurements inside the tunnel;
- Monitor and control video sequences upon incident and permanent recording;
- Control PTZ cameras outside the tunnel;
- Perform a dynamic tracking of vehicles inside the tunnel.



Tunnel view

and traffic measurements taking into account the new direction of traffic.

By providing reliable travel time through the tunnel, video detection systems can be used as a tool to help road users plan their route efficiently. The communication of this data at strategic locations will give them enough notice to understand whether the current level of congestion allows them a fast crossing or not.

Alternate lanes

According to an hourly/daily commute it is possible to create several sets of parameters to apply to a set of cameras according to the traffic conditions. These sets of parameters can be applied:

- Upon operator request;
- By a timer;

time in Prado-Carénage Tunnel, Marseille is confirmed within 10 seconds, whatever the traffic conditions are.

Pertinent pictures

Traditionally, video detection systems interface with CCTV system in order to switch cameras to dedicated monitors.

This enables the attention of the operator to be drawn automatically to the right camera among tens of monitors. Operators can then look for additional information on the incident by switching to the video detection system graphical interface.

Current trends in video detection and CCTV system design is to integrate these applications under one single man-machine interface able to provide the operator with all the information he

In the Prado-Carénage urban tunnel in Marseille, drawing the attention of the operators from the many video monitors to the Citilog Video Detection graphical interface has led to a better understanding of tunnel users' behaviour.

Conclusion

The contribution of video detection is no longer limited to strictly providing alarms upon incidents.

Priority is today given to intelligent systems able to provide the operator only with the pertinent information, and additional information which conventional systems cannot provide.

A new generation of tools contributes to a better understanding of the monitored sites.

Tunnels like Somport (8.6km between Spain and France), Mont-Blanc (12km between Italy and France) or Grand St Bernardo (6km between Italy and Switzerland) have focused on vehicle gap monitoring and vehicle numbering and positioning.

Urban tunnels like the Prado-Carénage, Petuelring (Munich, Germany), Yan'an (Shanghai, China) or Melbourne (Australia) concentrate on availability, traffic status or travel time. These new systems take into account the specifics of each tunnel to provide adequate information and contribute to a safer environment in tunnels worldwide. ■