MediaTunnel

A real-time Traffic Incident Detection System

MediaTunnel, a real-time traffic incident detection system introduced a few months ago, was recently installed for the first time outside Europe – in the Reboucas tunnel of Rio de Janeiro, Brazil. A real-time traffic detection system enables efficient dispatching of emergency services and rescue teams, and facilitates in reducing the response time to traffic incidents and accidents. Results of MediaTunnel’s functioning in the city’s longest tunnel have been impressive.

Real-time Traffic Incident Detection is an important part of any modern traffic management system. Conventional traffic incident detection which is passive, detects an incident only after it has taken place. MediaTunnel from Paris-based Citilog Inc is a real-time traffic incident detection system for road tunnels which enables traffic operators to detect incidents by triggering an alarm within a few moments of occurrence of an incident. Operators can initiate appropriate action much before the incident can be detected by a conventional loop-based detection system, i.e., before the actual consequences of the incidents manifest. They can assess the type of rescue teams that need to be called in.
The system also facilitates official inquiries of incidents and allows for a deeper analysis of incidents such as observing the behaviour of road users before and after an incident. It also warns road users of traffic hazards due to the incident, thus reducing the risk of secondary accidents. Another advantage is it avoids the need for closing lanes during installation and maintenance work, closures which can cause quite a bit of losses to the economy. Also, it eliminates the problems of degradation of road surface and rapid wear and tear due to frequent digging. MediaTunnel has recently been installed in the Reboucas tunnel — the longest tunnel in Rio de Janeiro in Brazil linking Lagoa and Rio Comprido areas, two prominent work and residential zones in the city. Every day about 190,000 vehicles use the tunnel.

Pierre Champsavin, Business Development Engineer, CitiLog Inc. Says, “The current algorithm used in the software of MediaTunnel is an evolution of the first incident detection system developed in the early 90s. The first consideration in the development of the software was to define what an incident was, in order to be able to detect it. The INRETS researchers figured the best way to know that there is an incident is to detect all superfluous vehicle stoppages which are not incidents. The second consideration was to develop an algorithm for comparing captured images, and to provide the quickest possible detection with the highest reliability. The system has to be accurate too in the face of light variations and differences of video stream quality.”

The system is capable of detecting a wide variety of incidents on normal traffic lanes as well as on road shoulders and access ramps, under traffic conditions varying from smooth-flowing to congestion to stop-and-go traffic. Incidents detected include stopped vehicles, traffic slow down, traffic congestion, movement of pedestrians on the road, loss of visibility and debris on the roads.

Pierre Champsavin

Rubens Rodrigues, Head – Traffic Management, CET Rio (the company which manages the Reboucas tunnel) says, “Earlier, when any incident happened we were not able to detect it for a long time, and traffic in the tunnel used to remain blocked. Therefore, we decided to install an automatic incident detection system to reduce our response time to traffic incidents and to minimise the impact of incidents on the traffic flow. We decided to install IP cameras in the tunnel as they provide a very good flexibility for installation and management of videos. So we needed an Incident Detection System with good capabilities with IP streams and MediaTunnel is good at this. The redundancy features of the system added another level of safety. Plus, the ability of MediaTunnel to say if the incident has occurred in fluid or congested traffic is important for traffic operators. We also found the number of traffic operators needed to monitor the traffic inside the tunnel has decreased, and most of the incident alarms given off by MediaTunnel have been reliable.”

System Architecture

The system consists of CCTV cameras monitoring the tunnel, a set of analysers, a server and workstations.

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All system components are connected together using a local Ethernet network that uses the TCP/IP protocol. Each analyser, which is a high-grade industrial computer, consists of a computation unit, the image processing software, a video signal digitisation system and a video storage unit connected to a local network. Each analyser acquires, decodes and samples the IP video signals from the CCTV cameras, and acquires and digitises analogue video signals as well. It also records video sequences captured using the cameras on a periodic basis, a periodicity which can be set by the user. The server stores all the incident alarms, incident video clips and other relevant traffic data in a centralised database. It is connected to workstations and in some cases, to a SCADA (Supervisory Control and Data Acquisition) system in a Traffic Management Centre (TMC). Each workstation has the MediaTunnel monitoring software installed on it which can be periodically updated through the server, thus maintaining it up-to-date. The workstation displays incident alarms and other relevant traffic data.

At system start up, the system algorithm builds up a reference image of the background of the monitored area, the image being continuously updated as the system receives new information. The algorithm works by extracting information of objects in the various video images captured by CCTV cameras. The area monitored by the CCTV cameras can be easily defined by the operator. Objects within the images could be vehicles and pedestrians, or simply artefacts such as shadows which could generate false alarms by the system. The algorithm avoids false alarms by using a double comparison method to detect vehicles within each image. The use of morphological filters that assign a distinct marker to each object in motion enables the system to separate vehicles from other objects in motion such as pedestrians. The algorithm also uses trajectory analysis of the objects in motion to rule out potential events that do not correspond to true traffic incidents. This is done by tracking the object by analysing the movement of its marker throughout the sequence of images to build up a time and space trajectory of the object. During periods of traffic congestion, vehicles are often occluded, and the cameras find difficulty in tracking them. In these situations an active occlusion management mechanism preserves the tracking markers, and the system resumes normal tracking when visibility is restored. This tracking and system analysis forms the basis of the traffic incident detection capabilities of the system.

The analyser stores in its buffer recorded digital video clips of a certain time duration preceding the incident. This duration can be adjusted. When an incident occurs, the video clip is extended either until the end of the incident or for a given time after the incident. The operator can then immediately display the video clips of the time periods before and after the incident which helps in evaluating the cause of the incident. The resulting video sequence of the incident is stored in the MediaMonitor database on the MediaTunnel Server, after being time and date stamped. MediaMonitor software, the operations interface of the system, is installed on both the server and...
One of the problems in automatic traffic incident detection is the high rate of false alarms due to environmental factors such as heavy rain, falling snow at the entrance of the tunnel, and shadows on the road. To reduce the false alarm rate, besides tracking and trajectory analysis, the MediaTunnel algorithm uses techniques of superposition to analyse movement patterns and shapes. It also uses dynamic shaping of the reference background image to identify permanent shadows and other obstacles or events which hamper incident detection. It also applies dynamic filters upon environmental conditions such as rain, and snow which interfere with the incident detection.

Says Rodrigues, “The most significant and impressive improvement in the process is the period of response to an incident. We can now detect an incident in about 20 seconds, see how critical the incident is, and then send appropriate rescue team with the proper equipment. The impact of the incident on the traffic flow is minimised. A few months ago we had a mini-van incident on the central lane during the afternoon rush hour. After the incident was detected and analysed, we saw that no person was seriously injured. We blocked the central lane and sent in a rescue team which cleared the lane in about ten minutes.”

Rajmohan Kurup