Out of the loop

by Stijn Vandebuerie

Loop detectors may become a thing of the past with the introduction of Video Image Processing.

All over the world, major roads are suffering from increasing traffic density, resulting in more accidents, more vehicles involved, a larger risk of secondary accidents and long traffic jams. Fast-developing urban regions need information about traffic streams in order to take well-founded decisions regarding new road infrastructures and changes to existing infrastructures. As a consequence, increasing traffic volume and complexity have created a need for more optimised and improved Intelligent Transportation Systems (ITS) technology. Today, traffic managers across the world are looking for state-of-the-art intelligent traffic solutions for statistical purposes and safety issues.

Traditionally, basic detection systems such as loops have provided ample information to direct traffic flows and assemble statistics. However, their information is limited, and increasing traffic volume and complexity have created a need for...
more optimised systems: video detection systems. Video detection handles both traffic data collection and automatic incident detection (AID), and its incident detection shows a high detection rate, a short time to detect, fast incident verification and a low false alarm rate. These characteristics make video extremely useful for a wide range of applications such as incident management, congestion monitoring, ramp metering, etc.

Traffic Data Collection
The collection of traffic data in urban areas, on highways and in tunnels is essential in making well-informed transportation planning decisions. Until recently however, the methods for collecting traffic data were limited to fixed counting locations using inductive loop detectors, or temporary counting locations using road tubes or manual counts.

The oldest of all traffic surveillance technologies are inductive loop detectors. Loop detectors are placed in the subsurface of the roadway and can provide real-time traffic data. However, it has been noted that the cost of installation and maintenance of loop detectors can be prohibitively high. Thus the quest for a more cost-effective alternative was embarked upon, and other technologies such as video detection came to the market. These alternative technologies provide not only cost-savings, but also the ability to obtain a greater variety of traffic and incident-related data.

Video detection technology
Video detection has been commercially available for several years and is gaining acceptance as a more effective technology than the conventional inductive loop-based technology. But why?

Traffic detection using video image processing has several advantages over inductive loop-based technology. Inductive loops are only capable of gathering traffic flow data at a certain point, whereas video image technology can provide a wide range of standard traffic data and information about traffic flow, and is the fastest way to detect and verify traffic incidents.

Video image processors function by analysing the images supplied by a video camera. While video cameras and processors are typically more expensive than other surveillance mechanisms, their flexibility is an incredible strength. Video cameras can be used to obtain data about vehicle presence, speed, volume and lane changes for multiple lanes of traffic with just a single detector.

Applications
Because the Traficon video detection system is multi-functional, fast, flexible and reliable, it is the perfect traffic measurement system for a wide range of traffic applications:

- Ramp metering;
- Travel time calculation;
- Dynamic speed indication;
- Queue tail monitoring;
- Congestion monitoring;
- Tunnel access control;
- Ventilation control;
- Re-routing;
- VM S-control;
- Dynamic queue indication during road works;
- Dynamic lane opening or closing.

For example, video detection technology has proven to be very useful and reliable during road works. Road works can generate traffic jams, leading to very dangerous traffic situations. The use of video detection and VM S panels that can be mounted on a temporary basis has been proven to lower accident rates by more than 70 per cent. As an additional advantage, this system is movable – it is a modular system that is easy to install and easy to dismantle.

Case study
The Georgia ITS, dubbed Navigator, is the result of the integration of technology, information and communication, leading to easier travel, increased safety and saved time and money. The Transportation Management Center (TMC) is the headquarters and information clearing-house for Navigator.

Cameras are the primary source of real-time information, and incident management is provided through a three-phase process: the TMC monitors the roadways and collects real-time information from the video detection cameras; each incident is confirmed and analysed by identifying the problem, the cause and the effect it has on the roadway, and notifying the proper authorities; this information is communicated to travellers through changeable message signs, the Navigator Web site and media relations. The signs display two primary message types: travel time and incident messages.

Traficon’s video detection system was installed as an expansion of the Georgia...
than 50 per cent of secondary accidents occur within 10 minutes of the first incident. In many cases, they are caused by minor primary accidents and could be avoided if approaching drivers were warned in time. Third, studies show that more vehicle hours of delay result from traffic jams caused by accidents than from regular daily jams.

Traffic data and real-time images are communicated over a fibre-optic network to the TMC through the use of Trafcon’s VIEWCOM communication modules. VIEWCOM provides remote monitoring, remote set-up and also the ability to change the configurations of all VIP boards.

A complete description of the Georgia Intelligent Transportation System can be found at: www.georgianavigator.com.

Automatic Incident Detection

Next to traffic data acquisition, video detection is the best ITS technology for rapid incident detection and verification. Trafcon believes that improved ITS technology such as incident detection systems could lead to a large reduction in the frequency and cost of accidents. Some observations gathered from several studies support this point of view. First, between 20 and 30 per cent of all accidents on freeways are caused by preceding (primary) incidents. Second, more than 50 per cent of secondary accidents occur within 10 minutes of the first incident. In many cases, they are caused by minor primary accidents and could be avoided if approaching drivers were warned in time. Third, studies show that more vehicle hours of delay result from traffic jams caused by accidents than from regular daily jams.

Trafcon’s Automatic Incident Detection system shows a high detection rate, a short time to detect, fast incident verification and a low false alarm rate. These characteristics make video extremely useful for reaching incident management goals such as fast and effective intervention or secondary incident prevention.

Video detection technology

Wide area video detection for direct automatic incident detection is based on real-time analysis of the images from the cameras monitoring the road. This analysis will detect all abnormalities of traffic flow, such as stopped vehicles, inverse direction drivers, slow vehicles, fallen objects, traffic jams, etc. An average installation will have cameras installed along the road at distances of between 250 and 400m; for tunnels best results are obtained with distances of between 70 and 100m. Since there is full coverage, all incidents can be verified immediately. This detection method is mostly used in tunnels, on bridges and on roads with heavy traffic and regular traffic jams and accidents.

When direct video detection is not possible due to budgetary restrictions, a good compromise is to use indirect incident detection based on wide-area zone monitoring. The indirect approach covers zones of up to 100m, with cameras mounted every 500 to 1,000m. The parameters monitored are average space speed, variations of these speeds and zone occupancy. This data can be used to calculate the expected travel time and its evolution. Tests performed with systems based on the space speed show the detection of incidents between cameras to take less than two minutes, and a high detection rate of more than 90 per cent.

Typical installations have cameras that visually cover most of the highway that has to be monitored. An important side feature of this detection method is...
the good performance of the time to
destination or travel time measurement,
both in normal traffic and congestion sit-
suations. Indirect video incident detection
can also be used as a stand-alone installa-
tion that will directly activate VM S panels
to warn drivers of upcoming traffic jams.
This method shows very good results
for mobile installations that guard road
works, informing drivers in real time
about the situation of the road ahead
(see Figure 4).

Another advantage of this method is
that it can be combined with CCTV sys-
tems with pan, tilt and zoom, that have a
good homing system. The automatic inci-
dent detection will detect the incident
and automatically show the image of the
camera concerned to the operator, who
can then verify the incident and take
appropriate action.

Types of traffic events
Besides the normal traffic data, many
traffic management or control centres
want to be informed about certain traffic
events such as:

- Stopped vehicles;
- Departing vehicles;
- Inverse direction;
- Fallen objects on the road;
- Pedestrians on the roadway;
- Smoke (in tunnels);
- Lane changes;
- Speed drop;
- Over-speed/ under-speed;
- Queues, different levels of service.

Traffic managers are now convinced
that an AID system is indispensable,
especially in tunnels. VIP video detection
technology provides real-time aid to tunnel
operators by automatically identifying all
potentially dangerous situations. Within
seconds, the operator in the control room
sees exactly what is happening in the tun-
nel, receiving information on position
and type of incident, and is able to act.

Case study
The Isokylä Tunnel is situated near the
city of Salo, Finland, on the main Road
1 between Turku and Helsinki. The tun-
nel is constructed as two parallel motor-
way tunnels, both 430m long with two
lanes. The location close to the Baltic Sea
affects climatic conditions, occasionally
causing dense fog. Also, the design of the
tunnel (in an east/west direction with the
western part situated 15m higher) affects
visibility in the tunnel, sometimes causing
strong blinding in the tunnel during
evening hours because of the low sun.

Trafficcon’s video detection system
covers the tunnel and the tunnel entrance
and exit areas outside. It is composed of
16 VIP/I boards for the detection of
stopped vehicles, lost cargo, wrong-way
drivers and the detection of slow-moving
vehicles. The VICCOM/E module
communicates data, events and images
over TCP/IP to the local technical room
of the tunnel where Watts PC software is
installed for monitoring the system and
for database storage.

Video detection: a cure-all?
Since loops were seen as the de facto
reference, all new detection systems were
first compared with loops and the loop
characteristics, thus neglecting the real
potential of other detection systems.
Some radar and laser systems, for exam-
ple, can give better results in speed
measurements, while some ultrasonic
detectors will perform better for occu-
pancy. Video detection offers a wide
range of possibilities, and has proven to
be very reliable. However, detection tech-
nology must be used correctly and for
specific applications. The type of camera
and its position is of vital importance if a
video detection system is to fulfil customer
requirements. Different applications
require different cameras and different
camera positions.

Sometimes we can use one camera
for different purposes and thus take a
position that will work for different func-
tions. This is possible but can reduce the
quality of certain data.

So is video detection a cure-all? Much
depends on how it is used. One must not
start implementing video detection tech-
nology for traffic management and safety
without a complete understanding of the
costs and benefits associated with these
systems. If the correct guidelines and
parameters are taken into account and
implemented correctly, video detection
has proved to be very reliable and can
offer great solutions to the end user.

Conclusion
A valuable data and reports support that
using video signals for detecting traffic
data and incidents is a reliable and cost-
effective solution. While video traffic
detection and measurement is not approp-
riate for all situations, it can provide an
alternative to and improvement over
standard data collection methods in three
situations: when video detection is more
cost effective than standard methods;
when video detection can provide more
data than standard methods; and when
video detection is the only option and
other standard methods cannot be used
(e.g. Automatic Incident Detection for
tunnel applications).