ITS Radar Helpdesk Query: Radar and Video Based Incident Detection

Query no:	24	Query initiator:	Amanda Wilson (WSP)
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Query topic areas:	Incident detection systems. Traffic monitoring sensors.		
Categories and level of relevance:		Traffic Control Centres	Very relevant
		Monitoring	Very relevant
		Safety	Very relevant
Transferability to Highways Agency:		Meets Policy Objectives	N/A
		Cost/Benefits Information	Little
		Development status	Deployed
		Innovative	Yes
		UK legal issues	N/A
Summary:	The M4 requires traffic monitoring and incident detection equipment between junctions 1 and 3. This detection may be by video or by radar. Of these two technologies video offers the greatest flexibility and other value added benefits, but may be more difficult to position and may be more expensive.		

Introduction

This document is provided in response to a query from WSP requesting information on incident detection systems that could be installed on raised sections of the M4 in London. We have examined 3 radar implementations and 3 video based systems and an alternative induction based system. These implementations are reviewed and their merits and drawbacks are recorded.

It should be noted that all technologies have their advantages and disadvantages. Video based systems for instance can have difficulties in poor weather conditions or poor lighting, induction based systems have issues with slow and stationary vehicles. The specific configuration issues and limitations of each product is beyond the scope of this document.

The Site

The site is on the M4 from the start of the motorway at J1 and continues approximately 3.5km along an elevated section to just beyond J2 where the elevated section ends and the bus lane begins. There is no hard shoulder along this section.

The section is very busy and prone to both congestion and incidents and some form of Automatic Incident Detection (AID)[i] is required. The elevated sections make the road unsuitable for installing induction loops, so alternative solutions are being sought. There are a number of gantries that are currently used for signage; these may be suitable for mounting equipment on.

Induction based systems

Induction loops (as used by the MIDAS incident detection and queue protection system) are used in the majority of traffic monitoring and incident detection systems in the UK. Loop based systems have been around a long time and have traditionally been cheap to procure and are relatively reliable. However, loops have a number of disadvantages that may prevent them from being used in certain locations:

- traffic management costs – loops require cutting into the carriageway during installation which takes time. The traffic management issues surrounding this can be prohibitive.
- surface depth required – loops need to be buried into the carriageway to a reasonable depth (approximately 100mm) to prevent damage. This depth is not always available.
- immanent resurfacing work - re-surfacing a carriageway often requires loops to be removed and re-laid.

Sensys Wireless Vehicle Detection System

The Sensys system uses magnetic induction, much like normal loops and is marketed as a direct replacement to standard induction loops. The Sensys detectors claim to be much quicker and easier to install and more robust than standard loops[ii]. Installation requires drilling a 100mm diameter hole in the carriageway with a minimum depth of 51mm, which is less than loops. The small puck-like device is simply dropped into the hole and epoxy resin is poured over the top to fill in the hole. The installation of each device is advertised as taking as little as five minutes. An array of devices used for monitoring several lanes then communicates wirelessly with a roadside access-point. Batteries for each sensor are expected to last at least 10 years.

Radar Systems

There are a number of Radar systems available that may be used for traffic monitoring purposes. Three of these radar systems are covered below.

Navtech I800 Highways Monitoring system, M42 England

Navtech produce a millimetric radar system that purports to be able to pick out stationary vehicles in slow moving traffic[iii]. This system has recently been trialled on the M42 near Birmingham and the review is being undertaken; Phase 1 results are available[iv] but the trials are not yet complete.

Millimetric radar refers to a radar system using waves in the millimetre band. This allows much greater precision in the location of objects than would normally be achievable by RADAR. This allows the system to detect debris on the road as well as vehicles and was originally developed to spot debris on airport runways. In general, RADAR systems have an advantage over Video systems as they can work in almost any weather without impairment of function. The Navtech system is also advertised on its ability to interface with a CCTV system so that live images can be brought to a control centre. The installation requirements of a radar system such as this may also be more limited than for other radar systems, but only because it is capable of covering multiple lanes of traffic from each detector.

Intelligent Road Studs, M8 Scotland

Intelligent road studs (IRS) are widely seen as an alternative to cat's-eyes and fulfil the dual roles or traffic monitoring and intervention. IRS have been deployed across the world, sometimes more in the role of signals than as detectors. Astucia have produced numerous different models of studs and have installed them across the world. The M8 in Scotland is an example of one of these installations.

Over 50,000 vehicles use the M8 between Edinburgh and Glasgow where IRS are installed on an average day. IRS fitted with LEDs mark the inside lane and hard shoulder. Detector studs using radar technology are sited 500m apart in the centre lane. These studs collect data on traffic speeds which can be used to identify incidents and potential hazards on the road. Some functions of the equipment are automated; appropriate strings of lighting studs flash to give a warning to traffic approaching stationary vehicles.

A preliminary evaluation of this scheme has shown that the studs do help to improve safety[v]. Speeds drop and lane changes are cut down when the studs are active. The results show that there was a small decrease in speed (3%), 13% change in headway and a 65% drop in lane changing – including an 81% drop in dangerous lane change manoeuvres.

The studs themselves are hardwired and set into the surface of the road, which *may* cause the same issues as cutting loops. Surface depth requirements would need to be investigated further.

Companion

The Companion System is a roadside incident detection system that also uses radar. Radar detectors are mounted by the side of the road and detect slow moving or stationary traffic. The detectors do not provide coverage for a specific lane, but are a relatively reliable method of spotting stationary vehicles. The system was designed to be a low-cost and low impact automatic incident detection system.

The Companion system has been used in a number of locations across Europe for example the A92 near Munich, the A4 near Verona and the M90 near Edinburgh.

Like IRS, Companion is also a hazard warning system. There are a series of beacons that run down the side of the road that are capable of flashing red, yellow or orange. The system uses streams of illuminated beacons at the side of the carriageway to warn traffic about any incidents up ahead. Test results from Scotland have shown reductions of speeds of up to 20% when the system is active[vi].

Italian test results show a similar trend[vii]. The TEMPO report evaluated the scheme on a number of criteria: safety; efficiency; environment; accessibility; integration and impact on users. Integration and Impact on users were not expected to be of interest. There was a decrease in stop start traffic which was seen as an Environmental benefit. The efficiency benefit was met by a 7.1% increase in speed in winter and a 23.6% increase in speed in summer. Traffic volumes increased by 7.5% in winter and 8.0% in summer. Safety is a major benefit to this scheme. The TEMPO report describes a drop in the average density of vehicles of 31% in the winter and of 41.1% in the summer. There is also a trend towards more evenly spaced vehicles. Most tellingly from a safety perspective there has been a reduction of accidents by 54.4%. This is based on a total of 2360 accidents during this time.

The TABASCO Review[viii] which is focused on German and Scottish results gives similar findings; there has been a mean speed reduction of 20% with Companion in operation and the scheme has been well received in these countries.

Further trials of Companion are expected on the English network over the coming year.

Video Image Processing (VIP) systems

There are broadly two types of VIP systems:

- Systems that process video to simulate in-surface detectors and produce virtual loop data. These have been around and in reliable use for in excess of a decade. They use basic pattern matching to spot when a pre-configured piece of road is occupied or not, and use this to count vehicles. These systems tend to offer a similar quality of data to loops, but are easily reconfigured, don't wear out and don't require the carriageway to

be cut. However, it is sometimes difficult to find locations were the cameras can be mounted. For incident detection, these 'virtual loop' systems have the same disadvantages of traditional loop-based systems; they require the queue to occupy the loop before an alarm is triggered.

- Machine vision systems, sometimes referred to as direct recognition systems, identify and track multiple objects such as vehicles in their field of view. This can be used to spot stationary vehicles amongst moving vehicles. This system requires frequent cameras as it cannot infer the occurrence of an incident on any part of the road network not covered by cameras. Machine vision systems are a much more recent development due to the level of processing required in the algorithms. Newer systems have few issues coping with shadows or changing lighting conditions, providing the cameras are set up correctly. Machine vision systems are capable of directly spotting slow or stationary vehicles, so the time to trigger alarms is normally short[ix].

VIP systems have two potential disadvantages: their performance is reduced in poor weather conditions and they need regular maintenance (typically every 3 – 6 months).

Autoscope

Autoscope produce a range of systems including both 'virtual loop' systems and vision recognition systems, mainly focused on urban areas. Recently Norwalk, Connecticut, has had Autoscope systems installed for urban traffic management applications. Similar systems have been successfully used around the world (Louisiana and South Korea)[x] and were installed in Athens for the Olympics. Autoscope tools have also been used for detection in tunnels and are frequently connected to CCTV systems. This offers the benefit of being able to look back and see recorded images to investigate incidents.

Traficon

Traficon systems appear to be similar to Autoscope, but are more focused on tunnel management. There are also more examples of use on faster highways[xi], including Ngauranga (Gorge) Active Traffic Management System[xii,xiii] and Antwerp ring road. It appears that the majority of Traficon systems are built around their ability to behave as virtual loop detectors. An added facility is to be able to spot stationary vehicles, or vehicles making illegal movements such as travelling in the hard shoulder or travelling in the wrong direction. Traficon claim that they are able to detect incidents by spotting stationary vehicles within 10 seconds of the incident occurring[xiv].

Citilog

Citilog are a French provider of video based detection systems. Although they offer several products[xv], their highway systems have been developed as part of safety systems for tunnels. Their largest system to date is the Paris outer ring A86, a large section of which is in tunnels. 350 Citilog's cameras monitor the tunnels to identify incidents using a machine vision system. They claim to be able to identify congestion, stationary vehicles, vehicles off-carriageway and act as vehicle detectors.

ISDS

ISDS have developed machine vision type systems which 'self learn' – i.e. learning normal behaviour and then creating alerts for unusual behaviour.

ISDS Ltd have been contacted for information. We are awaiting replies. ISDS are believed to be involved in the early stages of a trial of their equipment on the M4 near London.

ANPR Video systems

Other video based sensing techniques utilise Automatic Number Plate Recognition (ANPR). ANPR systems use pairs of cameras. They recognise vehicle number-plates and compare the time taken to travel between the camera pairs to measure a vehicle's speed. When traffic flows take longer than a preset amount of time to traverse a section, the system can trigger an incident alert. ANPR systems are useful as they can provide traffic information and journey time measurements between points on the network and can provide an alert if the rate of detection drops. However, as it takes time for vehicles to travel between camera pairs, there is an inherent time delay before incidents are identified. Additionally, the further apart cameras are, the harder it is to spot delays caused by smaller incidents until the queues are quite significant. Specialised ANPR cameras are required for 24 hour operations, and like VIP systems, regular maintenance is required.

References

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