

## ITS Radar Helpdesk Query: Fibre Optic Detection

Query no:	2	Query initiator	John Slip (Highways Agency)
Date:	2 <sup>nd</sup> November 2005	Compiled by:	David McGuigan – david.mcguigan@fabermaunsell.com
Query topic areas:	Fibre Optic Detection technology		
Categories and level of relevance :	Traffic Control Centres	Some relevance	
	Traffic Management Technology	Some relevance	
	Traffic & Travel Information	Very relevant	
	Pilots	Some relevance	
	Monitoring	Very relevant	
	Technology Solutions	Very relevant	
Transferability to Highways Agency :	Meets Policy Objectives	Yes	
	Cost/Benefits Information	Not available	
	Development status	Pilot	
	Innovative	Yes	
	UK legal issues	None	
Summary:	<p>The Highways Agency appears to be at the cutting edge of research into the use of fibre optics for traffic detection, especially longitudinal detection. We have found little literature available regarding research conducted into the use of fibre optics for vehicle detection other than that carried out by the Highways Agency.</p> <p>There are several commercial applications available in the marketplace with respect to fibre-optic detection technology reported in this note. These however do not offer the cost advantages that the longitudinal fibre optic detection system the HA is piloting would offer.</p> <p>In addition to the existing HA research, there may be merit in considering whether the same fibre optic detector or detector array could be used both for traffic detection, pavement condition monitoring, structure (bridge/viaduct) monitoring and atmospheric condition monitoring.</p>		

### Introduction

This document is provided in response to the above query regarding the development of fibre optic detection.

### Fibre Optic Detection – Lateral and Longitudinal – i2TERN Euro-Regional Conference – David Hill

The Highways Agency is very keen to collect traffic data in order to better inform stakeholders. Flow data is largely collected with permanent inductive loops, which are a well proven technology, but have several disadvantages. Problems include poor reliability (meaning a full lane closure whenever maintenance or reinstallation of loops is required), the level of calibration necessary and the associated high life-cycle costs.

Fibre optics are one of the detection technologies being investigated to replace induction loops to improve the MIDAS system and allow the installation of this system on sections of the network where loops cannot be installed. The two types being considered are:

- Lateral fibre optic detection – providing coverage at intervals along the length of the carriageway and being investigated to demonstrate ability to measure headway, axle count, etc.

- Longitudinal fibre optic detection (FOLD) – providing continuous coverage along the length of the carriageway.

The primary benefits of fibre optic detection are the potential for higher reliability and a lower requirement on the amount of kerb-side equipment over that required by inductive loops.

HA research conducted by QinetiQ started in 2002 specifically for the Highways Agency. Contacts are David Hill and Roger Crickmore.

Contact: Dave Hill on: [djhill@qinetiq.com](mailto:djhill@qinetiq.com) t:01305212782 or Roger Crickmore t:01305212419

## **Optical Fibre Intelligent Linear Heat Detection for Tunnels – Roger Hampson, Sensa**

The use of optical fibre technology to perform Distributed Temperature Sensing (DTS) has been established since 1986 and has been used in a number of other safety critical applications, such as temperature profiling of power cables, subsurface temperature monitoring of oil production wells and advanced linear heat detection for tunnels.

Fibre optic detection systems have a number of benefits over conventional heat detection systems as they can provide real-time temperature profiles, have programmable functions, have break detection and recovery, and can be remotely interrogated.

An example of a fibre optic fire detection system has been installed at the Britomart Station in Auckland, a vital transport hub that operates as an interchange between train, bus and ferry services. Fibre optics were installed throughout the platform areas, the station box and within the tunnel section approaching the station. The system was configured to map cable zones to physical zones allowing appropriate staged alarm levels for early warnings of temperature rises. Zone temperatures are monitored on a constant basis, the details of which are communicated to a central system that controls the emergency response scenarios and is directly interfaced with such systems.

## **Fibre-Optic Traffic Sensors for Axle Detection – Road Traffic Technology**

Sensor Line GmbH has developed fibre optic load sensors for use in road, railroad and airport traffic situations. The technology developed enables axel detection for any vehicle type at any speed, and is not dependant on a specific installation layout as they can be placed in slots, frames or on the road surface. The use of fibre optic detection also allows the length of time a vehicle is stationary to be determined as signal strength does not diminish over time.

Sensor Line's fibre optic systems do not use the same type of multiplexing that has been researched as part of the FOND project meaning there will be similar number of road side cabinets to a conventional induction loop system.

Further information on the products developed by Sensor line can be found at <http://www.sensorline.de>.

## **Fibre-Optic Magnetic Field Sensors – US Naval Research Laboratory, United States Military**

The United States Naval Research Laboratory has developed fibre-optic sensors for measuring magnetic fields. These sensors use optical fibre interferometer technology and a material property known as magnetostriction. The sensors can be incorporated into a number of different fibre-optic systems to form multiple sensor arrays and can also detect signals over a wide range of frequencies and amplitudes.

---

The magnetic field sensors can be used in a number of different situations, such as vehicle tracking, vehicle identification, the monitoring of ambient magnetic conditions, and port, runway and roadside traffic control.

Contact details for licensing and technical information are provided on their website (check references section).

### **Fibre-Optic Implementation of a Cumulative Momentum Model for Natural Urban Intersection Traffic Management – C. Yu & S. Muir**

A system has been proposed by academics in North Carolina that is claimed will provide an agile and cost-effective urban intersection traffic management model based on the use of an in-ground fibre optic load sensor system. The system is aimed at addressing problems associated with congestion, bus and truck signal priority and the prevention of drivers running red lights by using a process that determines the competitive cumulative momentum of vehicles.

The use of in-ground fibre optic detectors is to establish various factors such as vehicle size and speed of traffic flows approaching crossroads or intersections. This information is then fed to a central computing unit which runs an algorithm to determine cumulative momentum of traffic before assigning it a value, referred to as a 'Green Score'. The 'Green Score' for each opposing traffic set are then compared, with the highest score commanding a green light for that particular traffic flow. As the cumulative momentum in the traffic flow falls as a result of the green light, the 'Green Score' also falls. Once the 'Green Score' has fallen below the value for the opposite traffic flow the lights change to reflect this. The system constantly monitors the situation on the road and keeps similar vehicle composition and numbers on opposing sides of the road through using the competitive process.

### **Industrial and Structural Uses**

Fibre optic detection technology is also used in the oil and gas industry as an alternative to electronic transducers as they can survive extreme conditions for extended periods of time. Fibre optic sensors can detect (air) pressure, temperature and acoustics.

Fibres can also be set inside concrete members and used as strain gauges. This is used in the structures industry to measure the structural response to events such as unusual loadings, but it could equally be used on a bridge to measure axels where the surface material thin and maintenance closures too costly to use induction loops.

Some research has also been undertaken to attach fibres to rails to monitor rail track stresses in order to remotely monitor condition and watch for signs of deterioration.

### **Conclusion**

The FOND and FOLD research appear to be 'state of the art' in terms of using fibre optic detection technology for measuring traffic parameters and replacing inductive loops. However, fibre optics can also be used to measure a number of other parameters such as vehicle weight, ambient temperature and pavement stress.

## References

1. Fibre Optic Detection – Lateral and Longitudinal – David Hill, i2TERN Euro-Regional Conference, Dublin 19/09/05
2. Optical Fibre Intelligent Linear Heat Detection for Road and Rail Tunnels – Roger D. Hampson, Sensa ([http://www.sensa.org/pdfs/CS-BRITO\\_Iss01d.pdf](http://www.sensa.org/pdfs/CS-BRITO_Iss01d.pdf))
3. Fibre Optic Traffic Sensors for Axle Detection – Road Traffic Technology, [http://www.roadtraffic-technology.com/contractors/detection/sensor\\_line/](http://www.roadtraffic-technology.com/contractors/detection/sensor_line/)
4. Fibre Optic Magnetic Field Sensors – United States Naval Research, United States Military, [http://www.nrl.navy.mil/techtransfer/fs.php?fs\\_id=S10](http://www.nrl.navy.mil/techtransfer/fs.php?fs_id=S10)
5. Fibre Optic Implementation of a Cumulative Momentum Model for Natural Urban Intersection Traffic Management – Chung Yu & Sheldon Muir, ECE Department & Urban Transit Institute, North Carolina A & T State University, Greensboro <http://www.ctre.iastate.edu/pubs/midcon2003/YuFiber.pdf>