Clearview Traffic
Safety, Technology and Data Solutions

Saving money on vehicle detection

Reducing lifetime costs for SCOOT and MOVA via smart vehicle detection

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Cost effective, reliable and simple to install magnetometer sensors with wireless communications

It is not just the initial cost of deployment of vehicle detection that should be considered when choosing the type and technology of vehicle detection to be used for traffic signal control systems. In the current economic climate with both capital and maintenance expenditure being reduced, it is therefore not surprising that a number of Authorities are looking to alternative vehicle detection technologies to provide a increased value for money solution including taking overall lifetime costs into account.
Indeed some alternative technologies can reduce the initial capital expenditure involved especially where advanced detection for the likes of MOVA and SCOOT is required, however performance, reliability and therefore lifetime costs should also be considered.
This paper looks at one such alternative; the Golden River M100 magnetometer wireless vehicle detector and its deployment of the system by Aberdeen City Council to reduce their ongoing lifetime costs of maintaining vehicle detectors.

Traditional vehicle detection issues

The traditional method of vehicle detection for the majority of traffic signal applications is usually the customary inductive loop. Whilst the inductive loop is accepted to be generally reliable in many applications and locations, as Aberdeen City Council, like most Local Authorities, experienced it does have some inherent potential risks and problem areas.
Generally they were finding that within the city the life of the inductive loop could be as little as three to five years. The primary causes of failure were identified as typically being: damage from road works, such as by the utility and or communication installation companies cutting through them as they install or maintain their own services; or degradation of aging road surfaces.
Aberdeen also advised: depending on how the inductive loop is repaired can also create lifespan issues for them. If the loop is jointed (no more than three joints per loop as per specification) they then tend to have on-going intermittent failures from the time that they are jointed. If the loop is fully re-cut this can then cause issues with the slots being cut close to the old loop that can further result in a weaker road surface that is likely to cause premature failure of the newly installed loops and therefore the cycle continues.
The costs of the expensive and time consuming traffic management of road or lane closures to repair and or replace the inductive loops further increases lifetime costs This also of course results in disruption to traffic flows both during the period of the detection failure affecting the traffic signal

control sequencing and also when the traffic management is required during the repair and or replacement of the loop.

Although well maintained inductive loops establish the benchmark for vehicle detection accuracy, they can for the reasons above be notoriously unreliable. For example, during analysis by California Transport they found that 8,800 (36%) of their 24,000 monitored inductive loops on freeways were inoperative, either permanently or intermittently. These are also typical of figures reported elsewhere. Given these results, and the use of SCOOT and MOVA in mainly high traffic areas it is apparent that these types of detection systems have high maintenance costs in such environments.

Detection for both SCOOT and MOVA traffic signal control applications require detection either on the exit of a junction or well in advance of a stop line. As a result of these desired locations any ducting or trenching already in place in conjunction with existing Vehicle Activated (VA) detection on the junction approaches is not sufficient to be solely utilised and therefore additional extended ducting will need to be installed for use with inductive loops. In many cases the expense of such ducting is increased due to the urban environment necessitating in hand dug trenching due to the sheer mass of utilities pipe work and cabling already underground. Even where 'stop line' SCOOT detection is being deployed, which would require little new if any ducting, considerations need to be made for the reliability of the induction loop in such heavily trafficked areas and the costs of future replacements or repairs.

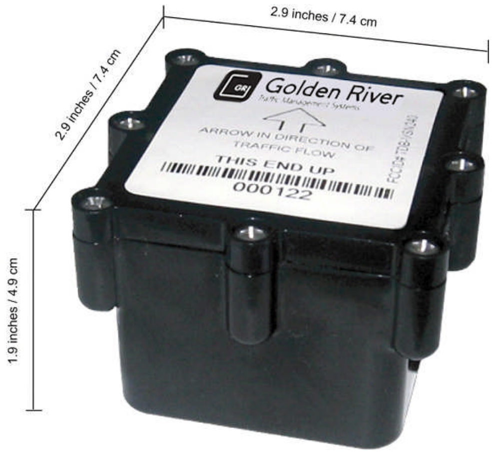
Alternative vehicle detection technologies

To try and overcome some of the issues highlighted above a range of alternative technologies for vehicle detection have been developed and employed. As with most things in life many of these replacements have their own strengths and weaknesses, when compared to loops which of course themselves are neither 100% accurate nor 100% reliable all of the time. These other technologies have been improving significantly in recent years to become a realistic alternative to the inductive loop for many applications.

One such technology is the magnetometer based vehicle detection system. Its basic principle uses three magnetic detection sensors to measure the X, Y and Z axis of the earth's natural magnetic field. When no vehicles are present the sensor will calibrate itself by measuring the values of the background magnetic field and establishing a reference value. The passage and presence of vehicles are detected by measuring deviations from that reference value. Each sensor automatically self calibrates to the specific installation site and to any long term variations of the local magnetic field by allowing this reference value to change over time.
This ensures that operation accuracy is maintained despite external factors such as movement of the sensor due to road surface wear, tear and it shifting over time.
It is this ability to calibrate to the local environment that also gives flexibility of installation allowing the sensors to be located close to any existing ironwork and also within carriageway surfaces containing reinforcing bar.

The in road magnetometer sensor also compares very favourably with other detection technologies. Unlike most radar based detection systems, the M100 magnetometer sensors are not especially sensitive to variations in traffic flow. An M100 sensor can maintain practically the same high level of accuracy regardless of whether traffic is free flowing or stop and go and bumper to bumper. Even the inductive stop line loop in some instances such as at the change from the red to green phase where the first few queuing vehicles tend to move off as one might register the vehicles as one whereas in the general the magnetometer sensor correctly identifies each individual vehicle. It has also been found that radar detectors can also sometimes count pedestrians crossing the road through the detection zone giving the impression of higher congestion rates.

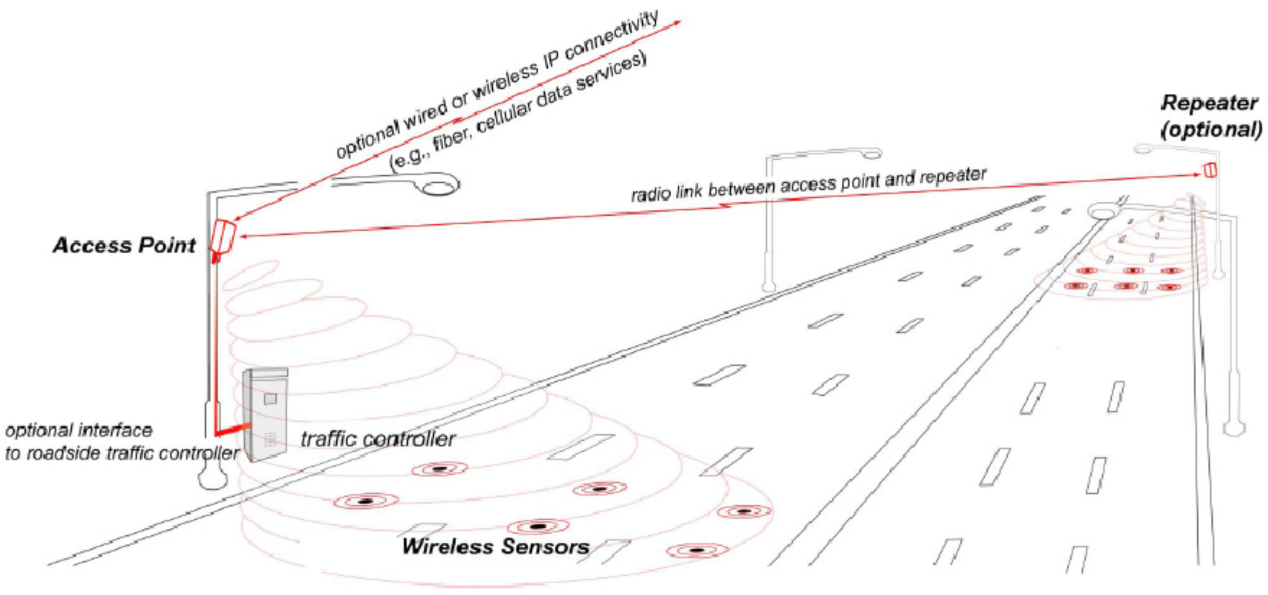
With respect to most video detection methods the magnetometer is not susceptible to environmental conditions. With such systems, fog and snow can completely prevent detection whilst other conditions such as rain, glare, reflections and even low light levels can cause either missed or false detections.



Sensys Networks Inc., the technology partner of UK based Golden River Traffic, that was born out research carried out at Berkeley University in San Francisco, have taken the development, use and acceptance of the magnetometer detectors a huge step forward by developing extremely low powered two way radio communications that has enabled the detector stud to be of such a small size, being only 74mm x 74mm x 49mm deep, including a battery with an operational life in excess of ten years.

Mechanically the sensors are designed to survive being embedded within a road, operating over a temperature range of -40 degrees C to +85 degrees C. They are constructed to withstand more than the full weight of passing traffic should they drive directly over it, however, to some extent the sensors compact size and how it is typically used generally installed in the middle of a lane also helps to further prolong its operational life.

The in road sensor communicates wirelessly using a low power, highly secure and unique radio protocol, to send time stamped detection data to the M110 Access Point, within an approximate range of 30m away, that forms the heart and communications hub of the system.



The Access Points are usually mounted on top of a suitably positioned signal head. The Repeater Units, where needed, are battery powered, with either two or seven year replaceable battery options available. Each repeater can support up to 10 sensors, also within a 30m range, relaying the detection data back to Access Point and extends the range of an Access Point by up to 300m.

The wireless radio communication is two way and any signal from the sensor is acknowledged back from the Access Point, and buffered within the sensor and resent until the acknowledgement is received ensuring continuity and completeness of the detection data.

The Access Point is capable of collecting data from up to 48 sensors and via up to 15 Repeater Units.

Finally for traffic signal control the Golden River M120 contact closure card is located within the traffic light controller and is linked to the Access Point by an external grade Cat 5 cable, this carries both power to the Access Point from the card and also the communications. The interface card is a direct replacement for a typical, 3U rack size, loop pack card and is therefore traffic light controller manufacturer independent to ensure compatibility with all systems currently in use. The card simply replicates traditional loop inputs and has four detection output channels per card. Multiple cards can be daisy chained together to provide the required number of output closure channels (in fact up to 16 cards can be so linked together should it be required).

The detector sensor is simply and quickly installed in a small 100mm x 50mm deep hole and requires no specialist slot cutting and more importantly no ducting or trenching, it sits approximately 4 to 6mm below the surface of the road and in the centre of the carriageway or lane. A durable two pack epoxy resin is used to complete the installation. This means that typically a sensor can be installed in only 15-20 minutes, including the resin cure time, resulting in greater productivity when installing the sensors compared with inductive loops and also reducing the amount of disruption to road users and the duration and expense of traffic management required.

Magnetometer vehicle detection wireless system deployment in Aberdeen

As described above, and in common with many Local Authorities, Aberdeen City Council have been experiencing typical issues of poor inductive loop life at a number of locations. With limited and reduced budgets they looked for a more costs effective detection method that would significantly reduce the ongoing lifetime costs associated with inductive loop replacement.

At the time of writing eight installations, seven being full traffic signalised intersections and one Toucan pedestrian crossing, have been upgraded utilising Golden River M100 magnetometers for SCOOT detection, a total to date of 52 detectors. Eight detectors are in use for stop line SCOOT detection with the remaining on advanced entry and exit detection.

Reducing the life time costs was the primary driver for the use of the Golden River M100 wireless detection system and 70% of the installed detectors were replacing faulty inductive loops. The remaining 30% were for new additional detection with the furthest advanced detection from a stop line being 160m. With such advance detection, further cost savings have been realised against the installation of inductive loops requiring expensive ducting and trenching. In many cases the expense of such ducting would have been further increased due to the urban environment, necessitating hand dug trenching to avoid the shear mass of utilities pipe work and cabling already underground.

Neale Burrows, Technical Officer of Aberdeen City Council's Intelligent Transport Systems Unit advised: "The installation of the M100 sensor is much quicker than cutting new loops, which is important to us given the high profile and busy urban locations of the junctions involved. Traffic disruption is minimal and traffic management costs and duration are significantly reduced." Neale Burrows further advised: "The simple installation of the M100 sensors allows us to use in-house personnel, making the programme of works simpler and more cost effective as several junctions can be done in one day."

Further deployment examples

Like Aberdeen City Council other Authorities have also benefitted from considerable cost savings from the deployment of the M100 system. One such is Slough Borough Council whom in conjunction with their traffic signal consultant partners Atkins have installed over one hundred sensors on the busy A4 arterial route. The project included new SCOOT detector locations on both the main A4 dual carriageway and also a number of intersecting side roads at eleven separate junctions. Following the success of the initial installation for SCOOT detection many exiting VA detection loops have also subsequently been replaced, either due to their failure or re-surfacing works, with the M100 magnetometer detectors. Since these initial installations a further 10 junctions have been specified, realising costs savings with the use of the M100 system and will be installed in the coming months including the high profile 'Heart of Slough' development.

Blackburn with Darwen Borough Council via their partners Capita Symonds made savings in excess of £60,000 across three busy junctions in Blackburn that were upgraded to MOVA control.
These junctions are located on main routes in to and around the town and located in densely populated urban areas. Due to the problematic nature of providing ducting in the service-congested footways in these urban areas the costs in this instance would have been well in excess of £100 per metre therefore the substantial savings were made by eliminating such ducting whilst at the same minimising the disruption to traffic and local residents during the installation phase. A total of seven junctions within Blackburn have now been upgraded to MOVA utilising the M100 magnetometer sensors.

Since the launch of the fully type approved Golden River M100 magnetometer system in the United Kingdom just over two ago over 150 installations have already returned significant costs benefits to their respective road authorities.

Other applications

The Golden River M100 wireless magnetometer range can be used for a variety of applications where traditional inductive loops have been used in the past.
In addition to MOVA and SCOOT the magnetometer system is suitable for use with all the standard traffic signal control systems including: System D / VA and SCATS. The system as a whole including the Golden River M120 contact closure card is fully type approved to the Highways Agency standard TR2512A for below ground vehicle detectors covering all of the above traffic signal control applications.

Other applications besides traffic signal control are currently being developed, such as Motorway Incident Detections and Automatic Signalling (MIDAS) and also Ramp Metering for this alternative vehicle detection technology. This will bring the advantages of many of the benefits outlined above in to other areas of the Intelligent Traffic Systems sector.

The use of wireless communications

The Golden River M100 magnetometer system communicates using 16 channels in the open access, licence free, 2.4 GHz band as specified by the 802.15.4 PHY standard. The actual communication protocol is unique to the system, therefore highly secure and can not be interfered with externally. The utilisation of the 802.15.4 frequency minimises any risk from any radio interference from 802.11b/g frequency devices such as Wi-Fi networks and Bluetooth devices, this is of particular importance in densely populated urban areas. Also any MESH4G networks are totally unaffected.

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Conclusion

The use of the Golden River M100 magnetometer system has now, including in the UK, a proven track record for providing accurate vehicle detection in all conditions. With its flexibility and ease of installation the system demonstrates a wide range of benefits and cost savings. These benefits include the reduced lifetime costs coupled with cheaper, easier and quicker installation and reduced traffic management needs. These benefits are due to the reliability of the sensor, the reduced possibly of damage from 3rd parties carrying out work on or near the carriageway and the elimination of the amount of additional ducting associated with the advance detection typically required for MOVA and SCOOT detection. The added complication in urban areas, where SCOOT is more likely to be deployed, is that due to the shear amount of other utilities etc. generally such ducting would need to be hand dug, further increasing the potential costs especially with the required locations and distances from the junction of SCOOT detectors. Additionally considerably less disruption to traffic and local residents can be achieved during installation, eliminating any potential need for night time working and long periods of traffic management as the sensors can be installed quickly and easily during the off peak daytime, even at junctions on busy main arterial routes such as within the heart of cities like Aberdeen.

Once the wireless communications infrastructure is in place future upgrades to such an equipped junctions, for example to add additional detection for switching to MOVA control during some periods, can be achieved with even greater savings on capital outlay.

In this current climate of budget reduction etc. the use of alternative detection technology such as the Golden River M100 magnetometer system creates the ability to make substantial cost savings whilst still improving the effectiveness and efficiency of the network, providing a smart and sustainable alternative for both MOVA and SCOOT detection.