Clearview Traffic
Safety, Technology and Data Solutions

Clearview Traffic Group Ltd.
A4 Telford Road
Bicester
Oxfordshire OX26 4LD
United Kingdom
T: +44 (0)1869 362800
F: +44 (0)1869 246858
E: info@clearviewtraffic.com
www.clearviewtraffic.com

Promoting safer cycling and efficiencies at signalised junctions with cost effective and reliable wireless bicycle detection

Graham R Muspratt
Group Product Manager
Clearview Traffic Group Limited
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Many local authorities are increasingly promoting cycling as part of their sustainable travel plans, which in turn creates its own set of issues and needs particularly around the safety of cyclists at signalised junctions. This paper reviews some of the key findings from recent studies by the Department for Transport and Transport for London for increasing cycling safety at traffic signalised junctions. These studies suggest a number of alternative signal control options and measures; this paper discusses the need to be able to maintain the efficiency of the junction for all junction users via the use of reliable and accurate bicycle detection. This paper also introduces the latest wireless bicycle radar detector and the result of the initial trial and verifications that have taken place prior to its launch.

Cycling statistics

The popularity of cycling has generally increased as a mode of transport of choice both for leisure and as a method of commuting to and from work. For example, London in particular has seen a 173% increase since 2001 and is expected to double again in the next 10 years[1]. In addition to promotion and support of cycling as part of the sustainable travel plans of many Local Authorities, this increase can also possibly be attributed to the success and profile of British cycling personalities at the 2012 Olympics.

It is therefore not surprising that as more and more of us take to our bicycles conflicts with other road users are likely to increase. According to the latest available Department for Transport accident statistics, for 2012[2], fatalities involving cyclists increased by 10% over the 2011 figures, to 118 fatalities, that more than reverses the 4% drop seen between the 2010 and 2011 figures. There has also been a further 4% increase in reported serious injury casualties rising to 3,222. Which although a smaller increase than the 12% rise seen between 2010 and 2011 continues the well-established upward trend in pedal cyclist casualties. This is the eighth consecutive year that the number of seriously injured cyclist casualties has increased. It also worth noting that accidents involving cyclists are generally accepted by the police and road authorities as being under reported.

Fatalities involving cyclists increased by 10% over the 2011 figures

Such figures and the fears generated are given as reasons for a number of non-cyclists from taking up cycling. The results from a recent Department for Transport Social Attitudes Survey[3] showed that 65% of non-cyclists believe it is too dangerous for them to cycle on the roads, whilst 48% of those already cycling think that conditions are too dangerous.

65% of non-cyclists believe it is too dangerous to cycle on the roads

It is a generally acknowledged that 75% of all cycling serious accidents occur on or near junctions and that whilst HGVs form only 5% of traffic they are involved in 20% of all cyclist fatalities.

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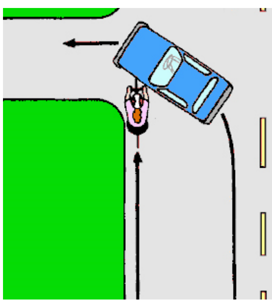
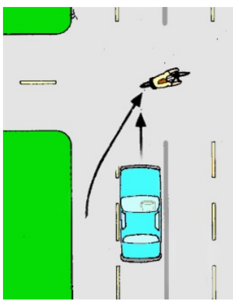
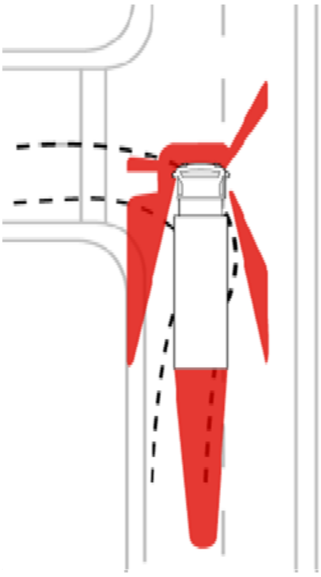
HGVs only 5% of traffic but involved in 20% of all Cyclist fatalities.





The majority of the incidents involving accidents at junctions are related to crossing paths between cyclists and vehicles, such as: vehicle turning whilst cyclist going straight ahead or the cyclist turning whilst vehicle going straight ahead. This is mainly due to poor awareness of other road users by potentially both parties.

[1] Transport for London, The Mayor's vision for cycling in London: March 2013
[2] Department for Transport, Reported Road Casualties in Great Britain: Main Results 2012 27 June 2013
[3] Department for Transport, British Social Attitudes Survey 2012:attitudes to transport: July 2013



One major issue is that HGVs in particular have a larger number of blind spots as shown in the red shaded areas on the diagram. In many incidents that occur, cyclists are either unaware of or choose not to respect these blind spots.

Whilst a number of systems exist to alert an HGV driver of a cyclist near the vehicle, using a form of radio tag and receiver technology, these are not currently interoperable, and require both cyclist and HGV to be utilising the same system. It also requires a will amongst all road users to adopt such a system, and by nature it is often the most vulnerable who are the least likely to adopt and or pay for such a device. Unless there is a clear benefit whereby such a system instantly makes them more visible to all HGVs and other road users, why would you invest in such a system?

Current cycle proximity alert systems are not interoperable

Due to the lack of reliable and accurate bicycle detection at junctions, cyclists are often frustrated in off peak times when no other vehicles are present on their leg of the junction to initiate detection. This can result in longer red phase periods that encourage them to jump the lights, which in turn whilst of course illegal starts to become second nature and gives rise to a bad reputation amongst other road users.

Lack of detection and prolonged red phases encourages cyclists to jump red lights

In most cities, junctions have not historically been designed or controlled to maximise safety for cyclists. However, where space permits, that is beginning to change and some junctions are starting to be reengineered to provide alternative safer bicycle routing. This in itself is a balancing act between catering for the needs of all road users and maintaining junction efficiencies.

Advance Stop Lines have been in place for some time now to encourage cyclists to stop in a more visible location and encourage other road users to give them suitable time to manoeuvre through the junction. There has also been an increase in dedicated cycle approach lanes to enable cyclists to reach the Advance Stop Lines safely.

Trixi mirrors have been deployed at many junctions to enable HGV drivers to see more clearly any cyclists that would otherwise be in their blind spots. The Department for Transport have made it easier for a Local Authority to deploy such mirrors by removing the need to apply for permission each time.

Transport for London, for example, is supporting cyclists and to date more than 50 junctions seen improvements for cyclists. They are deploying / considering a mix of innovative traffic signals, segregated cycle lanes, widened junctions and more 'Trixi' safety mirrors to be installed at key locations across London. An initial review of 500 locations has now been completed, which has allowed TfL to identify a priority list of 100 junctions that need improvement, based on a range of measures such as user feedback, cyclist numbers and collision data.

TfL has already improved 50 junctions for cyclists and prioritised 100 more.

The Department for Transport commissioned the Transport Research Laboratory (TRL) to conduct a study into 'Options for Traffic Management Techniques for Cyclists at Signalised Junctions in the Urban Environment'[4]. This project was tasked to identify issues relating to movement of cyclists at the approaches to and through signalised junctions and develop proposals in light of any issues identified and recommend solutions to identified problems.

The study identified, reviewed and scored 48 different techniques involving the use of new technology and practices from around the world. Of the 48 different techniques identified within the study, 19 showed greatest promises for further development, trialling and possible implementation.
Six of the 19 shortlisted techniques require, or are relevant to the actual detection of cyclists.

Cycle detection is core to six of the shortlisted techniques.

1) Extending Intergreens when a cyclist is detected using the junction – This reduces the potential for conflict between cyclists and other vehicles as clearance time is held until cyclists have left the junction. Efficiency of the junction is maintained for other road users when no cyclist is present as the Intergreen is only extended when required.

2) Providing separate bicycle phases with bicycle signal aspects – This reduces the potential for conflict between cyclist and other vehicles as separate bicycle phases are provided separate to vehicular traffic. This also requires dedicated cycle lanes on the approach to the junction and is not compatible with the use of Advance Stop Lines.

3) The use of pre signals for cyclists for early start (green bicycle aspect only) – by providing cyclists a head start via a green bicycle aspect whilst general traffic lanes are held on red, the potential for conflict is reduced. After a short period of time the vehicle lanes are then given a green signal.

4) The use of pre signals for cyclists for early start with separate red-amber-green signal head – as per item 3 above but with full separate signal head.

5) Coordination of signals for cyclists' progression "green wave" - adjusted offset times between successive green periods is set to the progression speed of cyclists. This does potentially affect other roads users more than other methods being discussed as they have a faster progression speed. Such a scheme can also be linked to inroad LED road studs that strobe to display the "green wave" progression speed.

6) The use of road marking to highlight detector positions – providing a new on road bicycle symbol to alert cyclists to the bicycle detection zone and encourage them to pass through or stop within the zone to ensure they are detected.

[4] Transport Research Laboratory, Traffic Management Techniques for cyclists, CPR1035; October 2011

The report also highlights the currently bicycle detection technologies available to traffic signal engineers as being the traditional inductive loop and video detection.

Both of these technologies have limitations:
The inductive loop requires very fine tuning and is only able to detect ferrous materials. In addition to that mentioned in the report, over the last few years the use alternative non-ferrous materials such as lightweight aluminium and carbon fibre have become more common place and therefore the accuracy and ability of the inductive loop to correctly detect a bicycle has reduced significantly. Also other road vehicles encroaching over the inductive loop will be falsely detected as a bicycle.
Video detection, as the report highlights, is prone to false detections due to shadows and poor accuracy in low light levels.

Inductive loop detection accuracy is falling due to increase in bicycles built from non-ferrous materials.

Transport for London has also commissioned the Transport Research Laboratory to conduct a similar study concentrating on the issues particular to London. Unsurprisingly many of the outcomes are very similar to that of the DfT report. They have also commissioned additional research into other potential measures such as 'early start' signals, low level signal heads and radical redesigns of roundabouts / junctions.

It is necessary to include accurate detection as an integral part of the solution to ensure that the efficiency of the junction can be maintained. In the Netherlands for example bicycle phases are operated without detection on a timed basis that therefore reduces the efficiency of the junction when no cyclists are present. Within a city equipped with Adaptive Traffic Signal control, such as SCOOT, journey times for vehicles could be improved tomorrow at a stroke, by reportedly up to 25%, if other users such as cyclists and pedestrians are totally ignored but in today's multi modal society this is obviously not a realistic option. As either existing phases are amended to, for example, extend the Intergreen period or additional bicycle phases or pre signals are added the overall efficiency of the junction for traditional vehicle users will be impacted.

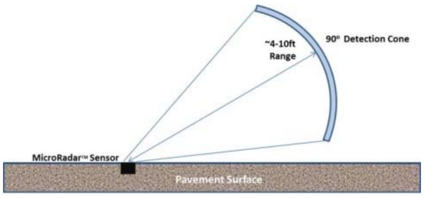
Accuracy detection of cycles necessary to ensure junction efficiencies can be maintained.

M100BR Bicycle Radar Detector from Golden River Traffic

To meet the demand for bicycle detection and more importantly accurate detection Golden River Traffic are extending the successful and cost effective M100 wireless vehicle detection range with the addition of a new bicycle radar sensor the M100BR.

This product uses the same secure wireless communications as the rest of the M100 range and can used in conjunction and integrated with the M100 magnetometer detectors already widely deployed across over 500 junctions in the UK.

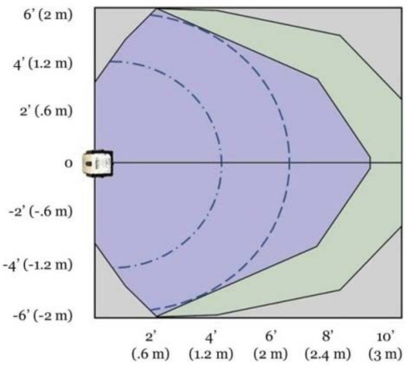
The compact in-ground sensor works using the same principle as any other radar. High frequency RF pulses are transmitted, in the 6.3GHz band, bounced off a target object, and the return pulses are measured by a time-gated RF mixer. RF reflections are analysed to produce presence, distance, and motion measurements.



Like the M100 magnetometer wireless vehicle detector the M100BR bicycle radar sensor is small in size being only 74mm x 74mm x 58mm deep and is quickly and easily installed in the carriageway surface.

The M100BR is compact in size and quick and easy to install and has user configurable detection zone sizes

M100BR sensors have a configurable detection range between 1m (3’) and 3m (10’). The width of a detection zone is approximately 90 degrees and the default range is 2m (6’).



The purple area depicts the sensor detection zone for all vehicles including bicycles. The green area depicts the sensor detection zone for large vehicles. The 1.2m and 2m arcs represent the alternative detection distance settings.

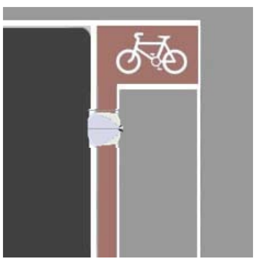
The M100BR sensor can be used in a range of locations where bicycle detection is required such as cycle lane approaches to junctions or Advance Stop Lines and differentiate between a vehicle and a bicycle. The basic method to differentiate bicycles from vehicles is based on measuring the breadth of the returned RF signal. Bicycles yield relatively small breadth values while vehicles generate both small and large values depending on the location of the vehicle.

The M100BR can differentiate between cycles and others vehicles

As well as detecting and differentiating between bicycles and other vehicles, the M100BR sensor can be configured provide independent outputs for both bicycles and other vehicles or a combination of the two. This feature enables to M100BR to be located in shared road space. Like the standard M100 magnetometer sensor, the M100BR Bicycle Radar unit has a self-contained primary cell battery with a 10 year life.

The M100BR can provide outputs for bicycles and other vehicles or a combination of the two

The two most typical detection locations are shown below:



Firstly: the M100BR sensor is installed to detect bicycles within a cycle approach lane with its detection zone facing the kerb. In this configuration other vehicles passing in the main approach lane will not be detected. It should be noted that even if another vehicle enters the cycle lane the detector will differentiate between this and a bicycle and will not give a bicycle detect output.

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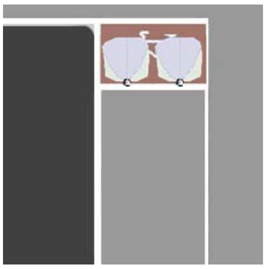

Secondly: two M100BR sensors are installed and OR'd together to detect bicycles arriving and stationary within the Advance Stop Line. The traffic signal controller would be configured to only take account of the detection input from the sensors during the red signal phase. Any other vehicle encroaching the Advance Stop Line during this red phase would not give a bicycle detect output.

Verified performance - Cycle lane approach detection

Bournemouth Borough Council recently upgraded a busy 'T' junction where Wimborne Road joins the A347 Whitelegg Way to include a dedicated cycle approach lane and Advance Stop Line on Wimborne Road. To ensure cyclists were not held too long at red when vehicle flows on Wimborne road were low an M100BR bicycle detector has been installed within the cycle approach lane to give a demand to the traffic signal controller.

Using our own video verification software that overlays time stamped output information from the systems M120 interface contact closure card in the traffic signal controller onto a video of the location verification of the accuracy of the detector can be established.

Video verification showed the M100BR to be 98% accurate for cycle approach lane detection

Total Number of Detects	149
Number of Bicycle passes	146
Number of False detects	5
Number of missed Bicycle passes	2 (on these occasions the cyclists was actually outside the bicycle lane and therefore the detection zone)

The 5 false detects were caused by 4 buses that passed through the junction and entered the cycle lane to give more room to conduct a right turn. One bus caused both a detect as it arrived at the stop and a second detect as it pulled away. The common factor in each of the false alerts was that they occurred when the bus encroached into the cycle approach lane. There were a number of occasions when other vehicles also encroached the cycle lane but these were correctly not detected.

This video verification demonstrated an overall accuracy for the M100BR in this cycle approach lane application of 98%.

Verified performance – Advanced Stop Line detection

North Somerset Council upgraded the Junction of Walliscote Road and Clevedon Road in Weston-super-Mare to MOVA and utilised M100 magnetometer detection on one approach including the installation of two M100BR sensors to detect bicycles within the entire width of the Advance Stop Line. This site is successfully detecting cycles within the Advanced Stop Line and at the time of writing video verification is in the process of being arranged.

Transport for London trials

Transport for London is conducting its own trials for alternative bicycle detection including installing five M100 BR sensors in August this year. One M100BR sensor was installed to detect cyclists approaching a signalised junction on a dedicated cycle lane forming part of one of the Barclays Cycle Superhighways and four sensors are installed within normal mixed traffic lanes. Transport for London are utilising their own in house Alternative Detector Analysis and Performance Tester (ADAPT) hardware and software platform to compare the alternative detectors against each other and video ground truth. These trials and the verification data collection and analysis are currently on-going.

Conclusion

With the number of cyclists continuing to increase, as encouraged and promoted by local authorities as being a sustainable travel choice, the bespoke set of challenges that this brings, especially with regard to safety practically on or near junctions, needs to be addressed.

Taking the needs of cyclists into account specifically at traffic signalised junctions is key to this and therefore accurate and reliable detection of bicycles is required to ensure that the overall efficiency of the junction for all road users is maintained. The Golden River M100BR Bicycle Radar Detector has been designed to uniquely detect the presence of a bicycle within a defined zone and differentiate it from other forms of traffic. The M100BR works in conjunction with the Golden River M100 wireless vehicle detection system.

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About the Clearview Traffic Group

Clearview Traffic brings together over 50 years of combined road safety and traffic data collection expertise in our multi-award winning brands: Astucia and Golden River. Astucia is the market innovator for intelligent road studs, with a focus on reducing road accidents and road casualties. Golden River is well established in the field of vehicle detection, automated traffic counting, vehicle classifying and intelligent transport systems.

Our brands are known and respected worldwide as pioneers and leaders in the field of Intelligent Transportation Systems (ITS), delivering innovative solutions that help reduce casualties on the world's roads, alleviate congestion and safely increase the capacity and effectiveness of road networks.

Since December 2007 there have been over 500 installations of the M100 wireless magnetometer system in the UK and Ireland including an increasingly large number of junctions so equipped by Transport for London for their expanding SCOOT programme. Whilst inductive loops clearly have a place in specific applications and we remain a key player in this market, Clearview Traffic Group Ltd have continually demonstrated that the M100 offers a high performing, robust alternative that dramatically lowers the total cost of ownership as well as extending the overall operating life of traffic signal installations. As a leading wireless vehicle detection technology, it is a key strand of our on-going strategy and has a number of applications that we will continue to develop and explore over the coming years.