Harnessing computer vision to better balance pedestrian and network demands

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Introduction

For many of us the experience of crossing the road makes us feel second class to those passing in front of us in motor vehicles. Although the Highway Code now places pedestrians at the top of the road user hierarchy, many crossings are yet to be upgraded to provide adequate pedestrian priority and still largely focus on the movement of vehicles.

But how can pedestrians be given greater priority without making congestion, and air quality, significantly worse? How can the needs of bus users be balanced with those of pedestrians?

In theory, kerbside detection can be used to insert demand for pedestrian phases to offer an improved level of service to pedestrians. This is particularly helpful for those with extra accessibility requirements who may have challenges operating a push button. However, having implemented this technique at various sites, the feature has largely had to be switched off. The high number of spurious demands from conventional kerbside detection (due to shadows/tree branches etc) and pedestrian demands being inserted in response to pedestrians walking past the crossing, caused unnecessary delay to traffic and generated significant correspondence.

This report will focus on the results of a trial at two pedestrian crossings on Meadow Lane in central Leeds, where VivaCity implemented a novel methodology enabling kerbside sensors to distinguish passing pedestrians from those wishing to cross. This technology makes the use of kerbside detectors to insert pedestrian demand feasible and practical, improving the pedestrian and cycle experience without inhibiting the expeditious movement of motorised traffic.

The trials illustrate how computer vision detection is enabling authorities to squeeze greater efficiency from their signal control assets, freeing up capacity to make the network more attractive for active travel whilst minimising the impact on other transport modes.

Problem statement

Leeds City Council (LCC) are already making use of volumetric pedestrian detection to enable signals to better respond to different levels of demand at crossings. Computer vision has successfully addressed the issues related to spurious detection of pedestrians that contributed to switching off kerbside demands. However, at certain times and locations pedestrian movements close to the waiting areas can still result in demand being inserted for pedestrians who are simply passing by the crossing, with no intention to cross. Prioritising the pedestrian crossing phase unnecessarily results in delays to the network with particular concern about delay to bus services.

Prior to the work undertaken in this project, the council previously had 2 options to mitigate this problem:

- removing the kerbside demand facility, with the side effect of making the crossing less accessible for any road users who struggle to operate the push button
- impose limitations on the frequency and priority of calls to the pedestrian stage to compensate for spurious demands

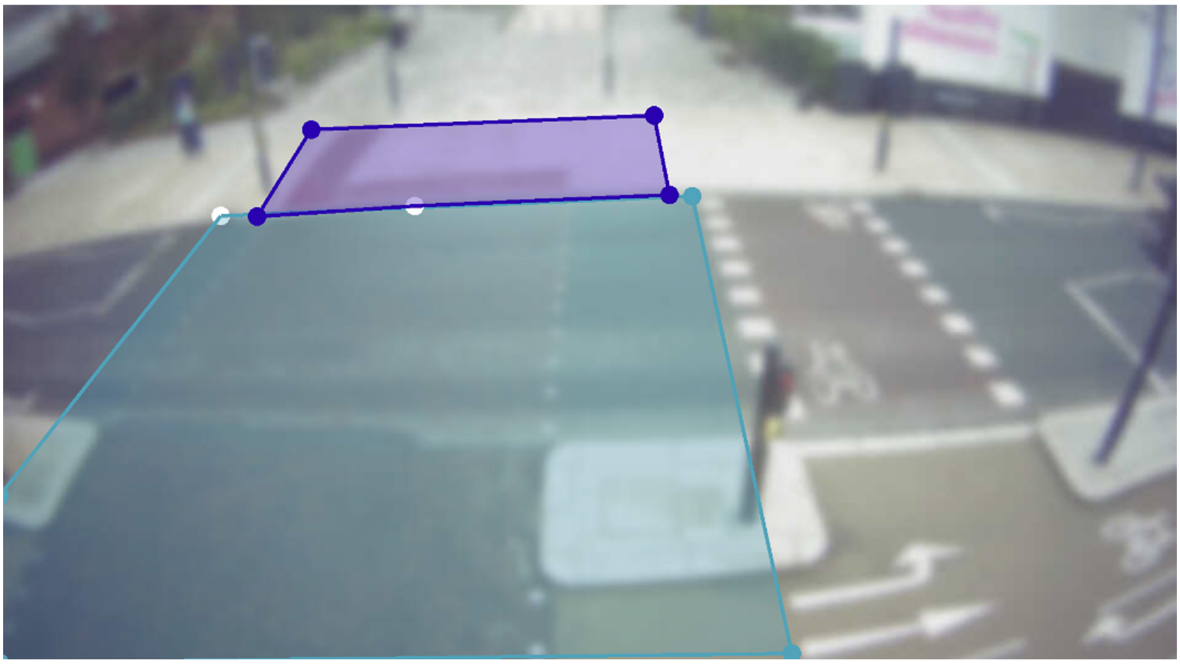
Neither of these mitigations are satisfactory as both diminish the pedestrian experience.

Solution & methodology

Detection zones for VivaCity sensors were configured to distinguish between pedestrians waiting to cross from passers-by. This was achieved by:

1. Configuring several separate zones covering the kerbside waiting areas, on-crossing area and approaching traffic lanes, to enable different rules to be set for each zone
2. Applying advanced differential directional filters on kerbside zones, to remove unnecessary demands from passers-by

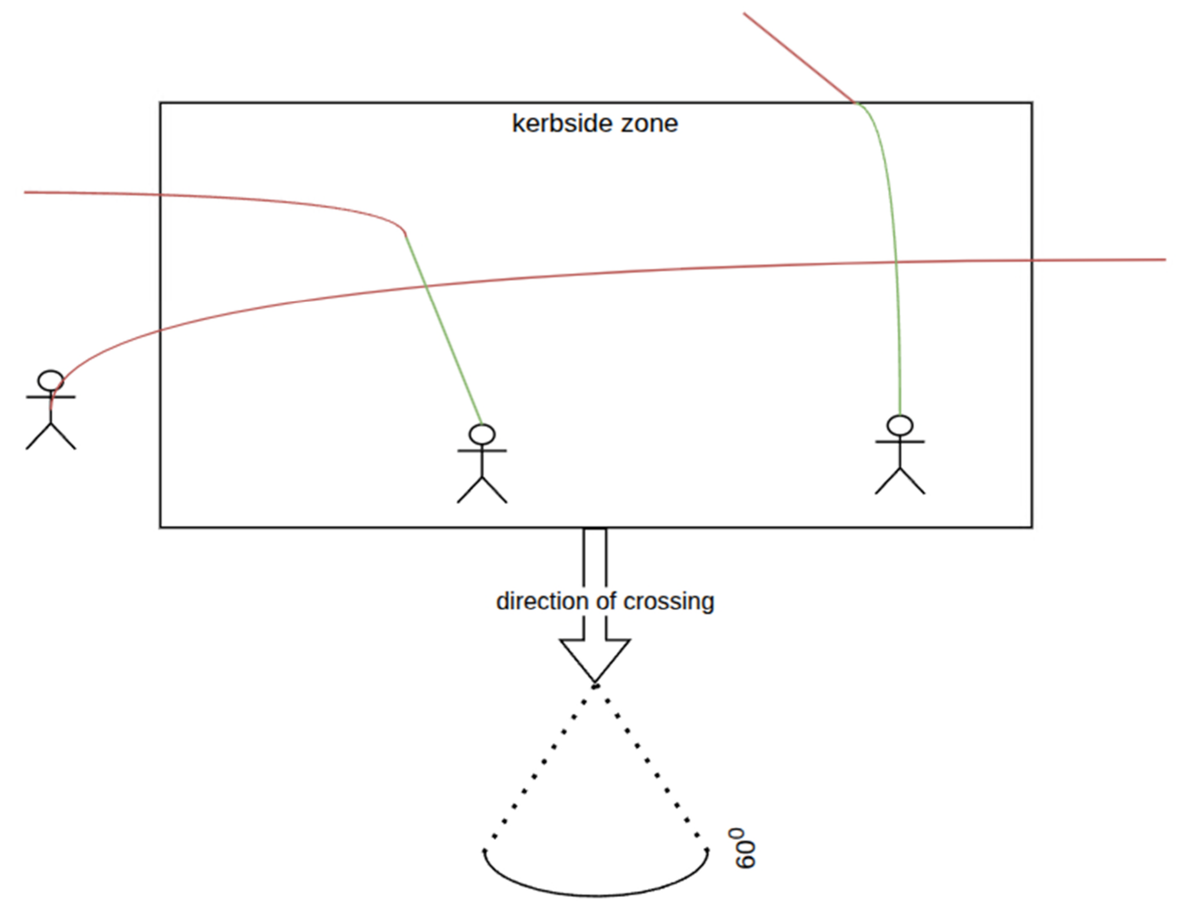
Subsequently, Swarco will then update the config of the controllers to introduce logic to reduce pedestrian waiting times (See final presentation for the full impact).



Configuration of a VivaCity sensor at one of the trial crossings. The dark blue zone is configured as a kerbside detector and pedestrian directional filtering is applied to filter out

pedestrians who do not intend to use the crossing

The desired behaviour was that pedestrians moving towards the crossing, or stopped waiting at the crossing, would lead to a pedestrian demand being inserted in the controller whilst pedestrians walking through the zone parallel to the carriageway are excluded. This was verified through visual inspection and as expected led to a reduction in pedestrian stage calls. The total duration of vehicle stops and delays on the approach to the crossings was also monitored to assess the impact on other road users.



Schematic of directional filtering logic. When the angle of recent pedestrian movement direction relative to the direction of the crossing is within the configured bounds (shown here as 60^0), the pedestrian is included in the occupancy and a pedestrian demand is inserted. Green shows where along a pedestrian trail they were included in demand, and red shows parts of the trail where they were excluded from demand. Any stopped pedestrian within the zone also inserts demand.

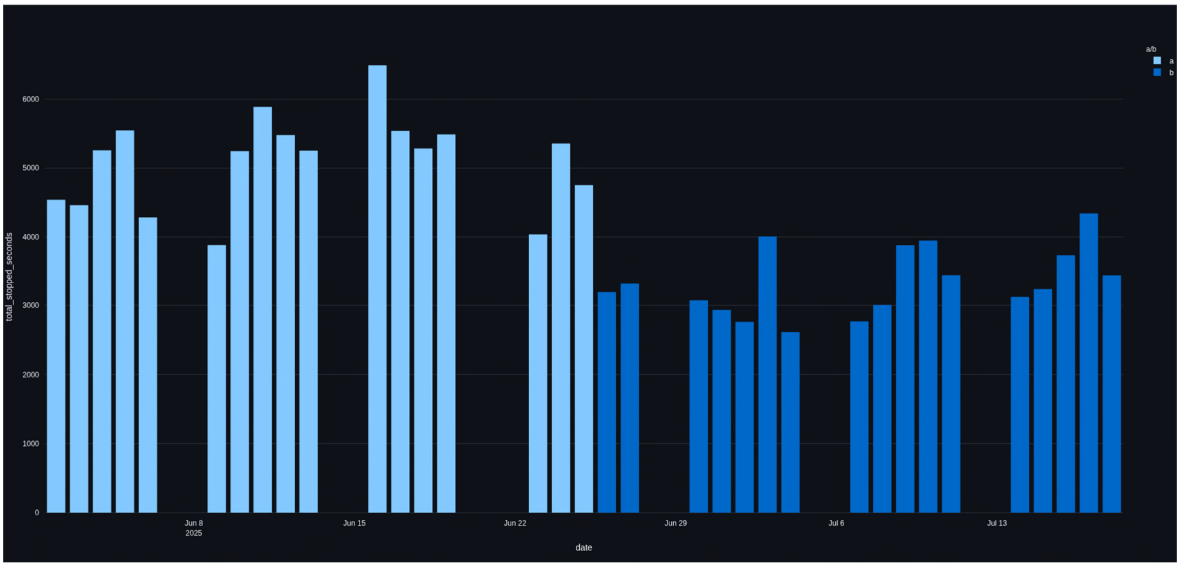
Impact

By avoiding spurious calls for the pedestrian stage, we aimed to achieve a reduction in the time general traffic and buses spent stopped on the approach to the crossings. VivaCity sensors were used to measure this, quantifying the reduction in time vehicles were stationary. It was expected the change may negatively impact pedestrians as some may have previously caught the end of a pedestrian green initiated by a spurious demand.

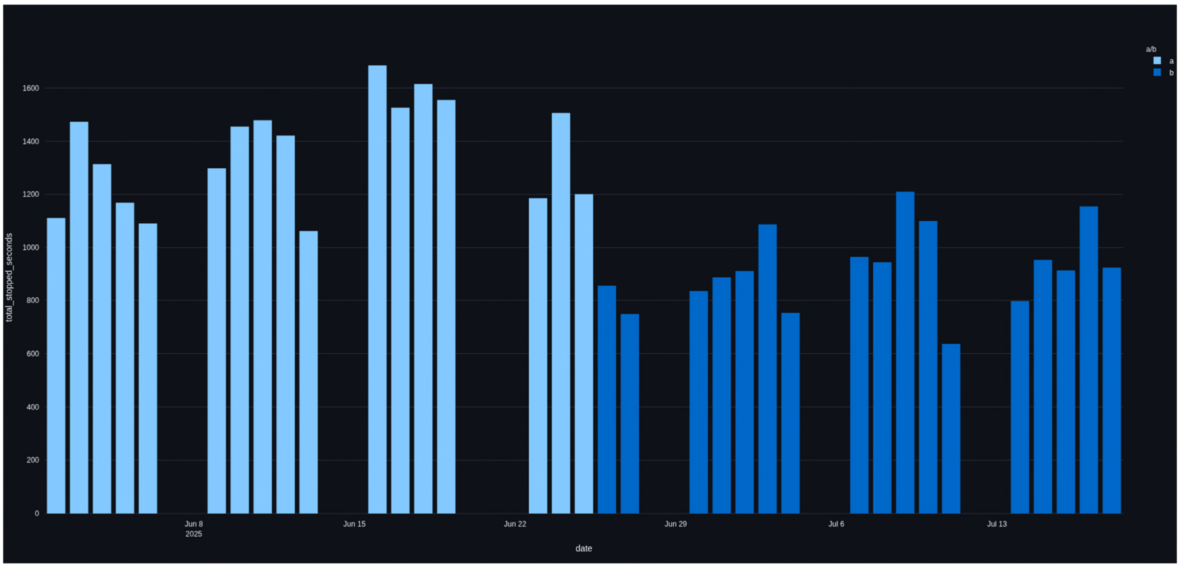
UTC logs of 3 days before and after the change showed a 17% reduction in ped stage appearances throughout the day, demonstrating the success of the methodology in preventing spurious stage demands.

Quantifying both the benefit to traffic and disbenefit to pedestrians over 3 weeks before and 3 weeks after the implementation confirmed an overall efficiency gain at the crossings. The reduction in traffic stopped time was more than double the increase in pedestrian stopped time. That efficiency gain can subsequently be reallocated between traffic and pedestrians according to LCC's Connecting Leeds Transport Policy.

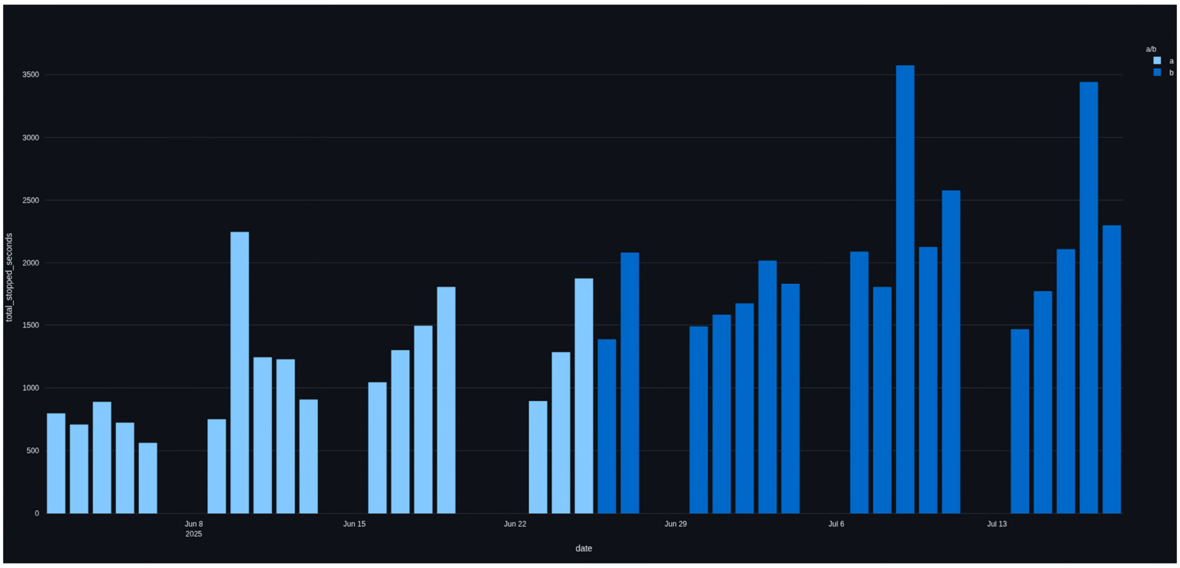
Note that one day of the A/B period (20th June 2025) is excluded from the analysis due to an external incident causing disruption in the trial network. Including the data from this day in the "before" dataset would skew the results to exaggerate the benefits of our approach.



The total time general traffic spent stopped on the approaches to the crossings fell by an average of 1764 seconds per day after the change was implemented



The total time buses spent stopped on the approaches to the crossings fell by an average of 439 seconds per day after the change was implemented



The total time pedestrians spent stopped on the approaches to the crossings increased by an average of 916 seconds per day after the change was implemented

As a consequence of removing spurious demands, the pedestrian experience can be improved by implementing a version of Pre-Timed Max (PTM) within the controller configuration. PTM is standard at all new and refurbished standalone (or ‘mid-block’) crossings in Leeds and reduces pedestrian waiting times by ‘pre-timing’ the vehicle maximum green as though a pedestrian demand has already been placed at the start of the vehicle green. When a pedestrian demand is *actually* placed, the demand can be served more quickly. In Leeds, the maximum vehicle green for standard PTM is 25 seconds. The

PTM logic will make use of the VivaCity object classification to suspend PTM if a bus is present to minimise delay.

Once the new configurations are in we will have additional data to analyse through August and early September for a comparison for the JCT presentation.

Next steps

1. Productionise the feature
    a. VivaCity will take learnings from the trial and make it quick and easy to configure directional filtering at kerbside zones.

2. Refining pre-timed max
    a. LCC will take learnings from the trial to optimise the pre-timed max (PTM) configuration to improve the pedestrian level of service. LCC already operate an enhanced version of PTM using MOVA at other sites on the network whereby the maximum vehicle green is further reduced unless oversaturation is present. A version of this logic will be trialled within the controller logic using VivaCity zonal occupancy information for sites with no MOVA.

3. Rollout across Leeds
    a. After verification of improved performance at this trial location we will be rolling out this approach to a range of different locations in Leeds.