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Integration of Pedestrian Traffic Signal Control within SCOOT-UTC Systems

INTRODUCTION

SCOOT[1,2,3] (Split Cycle and Offset Optimisation Technique) is an adaptive method of controlling signal-controlled junctions and stand-alone crossings which responds automatically to traffic fluctuations. This leaflet describes the new facilities developed recently and provides general advice on how to operate UTC systems to help pedestrians. It should be read in conjunction with Traffic Advisory Leaflet (TAL) 5/05[4] Pedestrian Facilities at Signal-Controlled Junctions and Puffin Good Practice Guide[5]. Other relevant documents are Improved Control of Pedestrian Crossings in SCOOT[3] and TAL 7/99[2] The 'SCOOT' Urban Traffic Control System. This leaflet is aimed at engineers and those working in traffic management.

RECENT DEVELOPMENTS

The Department commissioned the Transport Research Laboratory (TRL) to investigate ways to improve the control of pedestrian crossings within SCOOT UTC systems (UG476[3], Improvement to Puffin Control within SCOOT UTC systems). When signal-controlled installations are controlled by a SCOOT UTC system, nodes in the same region are all constrained to operate at the same cycle time. Where capacity allows or where a specific strategy is adopted, installations may operate twice (double cycle) within the cycle time set for the region, effectively operating at half the region cycle time. In some cases triple or quadruple cycling is used.

The pedestrian stage is called at the same fixed position in the stage order with its start time dependent on vehicle demand and region coordination. One consequence can be that pedestrians have to wait longer for an invitation to cross than they would if the crossing or junction was operating independently.

The main outcomes of project UG476[3] were an improvement to the modelling of Puffin facilities within SCOOT and the development of facilities to allow greater priority to be given to pedestrians at crossings under SCOOT control.

MODELLING OF PUFFIN AND PELICAN CROSSINGS

Puffin and pelican stand-alone crossings operate in different ways. At Puffins, pedestrians are presented with near-side indicators and vehicle movements are controlled using conventional three aspect signals and the same light sequence as at junctions. The length of time vehicles are held at red is variable as a result of pedestrian detection on the crossing.

Pelican crossings use far-side pedestrian signals and do not positively control all vehicle movements: during the flashing vehicle amber it is individual drivers who decide whether to proceed or not. The rules are clear, that drivers must give priority to pedestrians, but the drivers are not held at a red signal.

Until now, Puffins have had to be modelled as pelicans within SCOOT. When SCOOT is controlling a pelican crossing, the feedback logic assumes (correctly) that the pedestrian stage is a fixed length. SCOOT also makes the same assumption when controlling Puffin crossings. However, with Puffin crossings the length of time that vehicles are stopped due to pedestrians is not fixed, because of pedestrian detection and the variable intergreen following the pedestrian stage.

The SCOOT kernel software has now been modified to correctly model the variable intergreen period that follows the pedestrian stage, rather than assuming it runs for a fixed length. As a consequence SCOOT MC3[6] and later versions now accurately model the on-street behaviour of stand-alone Puffins and variable pedestrian intergreens at junctions, thus providing improved control and reductions in delay to vehicles.

NEW SCOOT PEDESTRIAN PRIORITY STRATEGIES

UG476[3] also looked at developing pedestrian priority strategies to reduce pedestrian waiting times at Puffin crossings compared with existing SCOOT control. These strategies are available in SCOOT MC3[6] Service Pack 1[7,8] and are also applicable at Pelican crossings.

The pedestrian priority strategies work by reducing the time before the next pedestrian stage can be initiated on the street. Within SCOOT, the offset optimiser seeks the optimum time in the cycle such that the pedestrian stage can run when it will cause minimum delay to vehicles. When a strategy is in operation, the start time of the pedestrian stage can be advanced from the optimum time for vehicles to reduce waiting time for pedestrians.

When operating under normal UTC control, the system sends out a control bit which inhibits the pedestrian stage from starting. The sending of this control bit is released at a fixed point in the cycle for a short period. This, in effect, provides a short window (normally 1–2 seconds) during which the pedestrian stage can start. If the pedestrian stage has been demanded, it will then begin.

With the new strategies in operation, UTC can release the control bit earlier and hold it until the fixed point in the cycle. In effect, the window of opportunity is enlarged. If there is already a pedestrian demand then the pedestrian stage starts early, at the beginning of the window. If there is a pedestrian demand during the window then the pedestrian stage starts immediately the demand is registered.

Under normal use, the priority strategy will give the longer window for registering a pedestrian demand once per cycle. It is particularly useful during off-peak periods when there will be greater opportunities for the pedestrian stage to be established.

The advantage of the priority strategy does reduce as pedestrian demands increase, especially when there is pedestrian demand every cycle. At that point the pedestrian stage would always start at the beginning of the earlier window time. The time between each pedestrian stage would therefore be the same. Consequently, there would be no benefit for pedestrians, who would have to wait the same time between the pedestrian stages and potentially longer delays to drivers as the priority strategy works below the optimum for vehicles.

To counter this disadvantage, the strategy monitors the preceding cycles and introduces a balance to the changes, as the frequency of pedestrian stage demand increases.

The strategy therefore can provide the traffic manager with control over the balance of priority between pedestrians and drivers. During the development, several control parameters were investigated. In the recommended strategy, the level of priority to pedestrians is governed by two factors: the degree of saturation of vehicles and the waiting time of pedestrians at the crossing. The highest level of priority to pedestrians is given when the vehicular degree of saturation is low and when pedestrians have been waiting a long time. The extent to which the degree of saturation and the pedestrian wait time affect the priority is controlled by user-variable parameters.

This strategy will provide useful reductions in pedestrian waiting times without risk of large increases in vehicle delays. Reductions approaching 20% were obtained at the test sites, but the benefits to pedestrians will be limited when the vehicle flows are high.

LONG CYCLE TIMES

At some Puffin and pelican crossings it may be necessary to operate them with long cycle times at peak periods. The priority strategy might then have the unintended effect of allowing the pedestrian stage to occur twice in the same cycle. This can greatly increase delay to traffic, and if double-cycling in this way is undesirable, it is recommended that it be prevented by setting the flag provided for this purpose.

SCOOT PARAMETERS

It is important that the various SCOOT parameters controlling the operation of junctions and pedestrian crossings are set correctly to achieve the intended effect. In particular, when using the pedestrian priority strategies, the ability of the strategy to start the pedestrian stage early is limited by the minimum stage length in the SCOOT database. The minimum should be set to a value appropriate for a VA pelican or Puffin, not one operating in fixed time mode. Other important parameters are the maximum region cycle time and the force double cycling status of Puffins and pelicans.

GENERAL CONSIDERATIONS

Double cycling

Pedestrian waiting times for any control strategy are directly related to cycle time. Puffin and pelican stand-alone crossings are normally considerably less saturated than junctions in the same region; they have only two stages and the pedestrian stage is not as long as many

vehicle stages. Therefore, when giving priority to pedestrians, the first action recommended both under fixed time and SCOOT UTC control is to double cycle all Puffin and pelican crossings, unless the consequential extra vehicle delay will be prohibitive at a particular crossing (see **Long cycle times**).

TRANSYT 13 also allows nodes to be triple or quadruple cycled and this should be considered when parameters at signal-controlled junctions in the region determine higher cycle times.

Gap Out

Another strategy that has been used to reduce wait time of pedestrians at UTC controlled pedestrian crossings is to allow the pedestrian stage to come in early when a gap is detected in the approaching traffic. Known as 'Gap Out', it can be inhibited until the vehicle stage has run for a preset time. It can be used at both Fixed Time and SCOOT UTC controlled crossings, however it requires suitable Vehicle Actuated (VA) detectors on each approach, in addition to the SCOOT detectors.

The cheapest option for the VA detection is to use Microwave Vehicle Detectors (MVD). These only respond to moving traffic and so will allow gap out when there is a stationary queue on the approach.

Vehicle Actuated Control

The SCOOT pedestrian priority strategies have been designed to provide tools for traffic engineers to give a measure of priority to pedestrians without serious disruption of vehicle operations.

Minimum pedestrian delay will be achieved by dropping Puffin and pelican crossings from UTC control and operating them under VA with pre-timed maximum operation. With this method of control, a pedestrian demand will be serviced immediately once the vehicle stage has run for the pre-timed maximum period. If the period has not expired then the pedestrian stage will come in if a gap in the traffic is detected. Whilst providing a good level of service to pedestrians, this can result in an increase in vehicle delay, particularly at busy times.

In many situations, the best solution will be to run VA in the off-peak periods and to operate under UTC control, preferably SCOOT with the priority strategy, at the busy times of day. It should be noted however that VA operation will require detectors. In SCOOT UTC systems this would mean that two sets of detectors need to be installed and maintained. The cost can be reduced by using MVD for the VA detection.

Importance of coordination

When deciding whether to run a crossing on VA control, it is important to consider the importance of coordination. Crossings running VA control which are close to neighbouring junctions are likely to cause considerably more vehicle delay than those some distance away. If they are sufficiently far apart, then lack of coordination of the crossing will not cause blocking back and thus wasted capacity at the downstream junction.

In such circumstances, operating the crossing under VA to give a high level of priority to pedestrians might considerably increase delay to vehicles at the crossing. However, much of this extra delay will be a relocation of delay from the downstream junction and will not greatly increase the overall journey time of vehicles.

Where pedestrian crossings are close to junctions, good coordination is important as VA operation in busy conditions would be expected to result in a large increase in vehicle delay.

Limiting pedestrian wait time

If it is desired to set a limit on the maximum waiting time of pedestrians, this can only be achieved in UTC systems by limiting the cycle time, and under VA operation by setting the maximum vehicle stage length.

Changing from Pelican to Puffin control at stand-alone crossings

As SCOOT MC3[6] has been modified to improve control and reduce delays for vehicles, the use of the Puffin strategy at stand-alone crossings, rather than the pelican strategy, can give benefits. It should be remembered that any adjacent crossing and junction with signal-controlled facilities should also use the same strategy.

Pedestrian facilities at junctions

The modelling of the variable intergreen in SCOOT MC3[6] can give valuable benefits at junctions with Puffin type pedestrian facilities on an all-red pedestrian stage. Where the pedestrian stage is called every cycle, the benefits of the enhanced feedback are likely to be in the order of a 10% saving in delay to vehicles.

The improved modelling of the variable intergreen will, however, not be of direct benefit to pedestrians. There is no facility at present to provide priority to pedestrians at junctions. The pedestrian stage will be served once per cycle at the same point in each cycle. To reduce pedestrian waiting times at junctions it is necessary to reduce the cycle time.

A junction with a pedestrian stage will operate at least 3 stages (two vehicle stages and the pedestrian stage). Consequently, it is unlikely to be able to double cycle without causing appreciable delay to vehicles unless it is very much less heavily loaded than the busiest junctions in the region.

Therefore, the main way of limiting pedestrians' waiting times is to set the maximum region cycle time to be as low as possible. The decision on the maximum cycle time and the consequent effects on pedestrian waiting time and vehicle delay will be a local policy matter.

FUTURE DEVELOPMENTS

It is possible that future developments will provide facilities for reducing the delay to pedestrians at junctions. The aim will be to monitor the pedestrian usage and utilise the vehicle and on crossing pedestrian detection to provide greater pedestrian priority where possible, without creating excessive extra vehicle delay.

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