CHAPTER 8: VEHICLE-RESPONSIVE CONTROL

8.1 INTRODUCTION

1 Vehicle-responsive control at isolated junctions utilises a self-optimising strategy in which green periods are adjusted based on the calculation of a control function or performance index. The objective is to establish signal settings that optimise the performance index. This performance index could either be delay, or a combined function of delay and number stops. Traffic is counted by means of loop detectors, and traffic models are used to calculate the performance index for alternative signal settings.

2 The control strategy used in vehicle-responsive control differs from that used in vehicle-actuated control. A relatively simple strategy is used in vehicle-actuated control that would just allow the longest queue to pass through a junction on green. Actuated control, however, has a number of shortcomings that result in less than optimum control. This strategy is relatively successful when traffic flows are low, but actuated control tends to run to maximum when flows are high, resulting in less efficient or even oversaturated operations. Vehicle-responsive control would be able to optimise signal settings under both low and high traffic volumes.

3 The method of control described below is the one used in the MOVA (Microprocessor Optimised Vehicle Actuation) controller developed by the Transport Research Laboratory (TRL) in the United Kingdom. The method combines both vehicle-actuated and traffic responsive strategies and utilises the advantages of both strategies in one system. Traffic responsive control requires relative accurate measurements of traffic volumes. An accumulation of small errors in traffic counts can result in less than optimum operations. This problem can be addressed by combining the vehicle-actuated and traffic responsive control strategies.

4 MOVA is claimed to reduce vehicular delay significantly in comparison with vehicle-actuated control, and that it addresses many of the shortcomings of vehicle-actuated-control. An advantage of the system is that a microprocessor-based module has been developed which can be added to many existing traffic signal controllers. Consequently, it is not necessary to replace existing controllers.

8.2 CONTROL PRINCIPLES

1 The MOVA system uses detectors located in each lane at typically 100 m and 40 m from the stop line as shown Figure 8.1. The detector located at 100 m from the stop line is defined as the IN-detector. The detector at 40 m is defined as the X-detector.

2 Different forms of control strategies are implemented depending on traffic flow conditions. The duration of the green interval is determined by making a number of sequential decisions based on traffic flows and queue information derived from the vehicle detectors.

3 A basic decision is made to establish whether the junction is under or oversaturated. The junction is deemed to be undersaturated if queues clear the junction each cycle. When a substantial number of vehicles remain in the queue at the end of green, the junction is oversaturated. Different control strategies are used depending on whether the junction is undersaturated or oversaturated.

4 In the undersaturated condition, the duration of the green period is determined by making a number of sequential decisions based on traffic and queue information obtained from the vehicle detectors. The following control strategies are then implemented:

(a) The green period starts with the implementation of a basic **vehicle-actuated** control strategy in which provision is made for the following:

(i) An absolute minimum green followed by a further variable green that allows for vehicles stopped between the X-detector and the stop line. The variable green is estimated from a count of those vehicles that have crossed the X-detector during the preceding red period.

(ii) After the minimum green interval, the size of the "gap" between successive vehicles is measured at the X-detectors to determine if traffic is discharging at measurably less than the saturation rate. As soon as *one* lane of an approach is judged to be discharging at less than full rate, then the entire approach is judged to have reached the "end of saturation" condition. When *all* relevant approaches have individually reached end of saturation then the end of saturation is deemed to be reached.

(b) Once end of saturation has been reached and queues have departed, a **traffic responsive control** strategy is implemented in which provision is made for the following:

(i) A traffic model is used which is updated from IN- and X-detector counts. This model is used to calculate the benefit or disbenefit of extending the current green period. The benefit or disbenefit is determined as the saving in the performance index.

(ii) A check is maintained of all vehicles that will benefit and disbenefit from extending the green. The vehicles that will benefit are those that are receiving green, while vehicles that will disbenefit are those that are queuing at red signals around the junction. Traffic that is expected to arrive in the short-term future is also taken into account.

(iii) If the performance index falls to zero or below, the decision is made to change the signals. If the performance index is positive, the current green is extended.

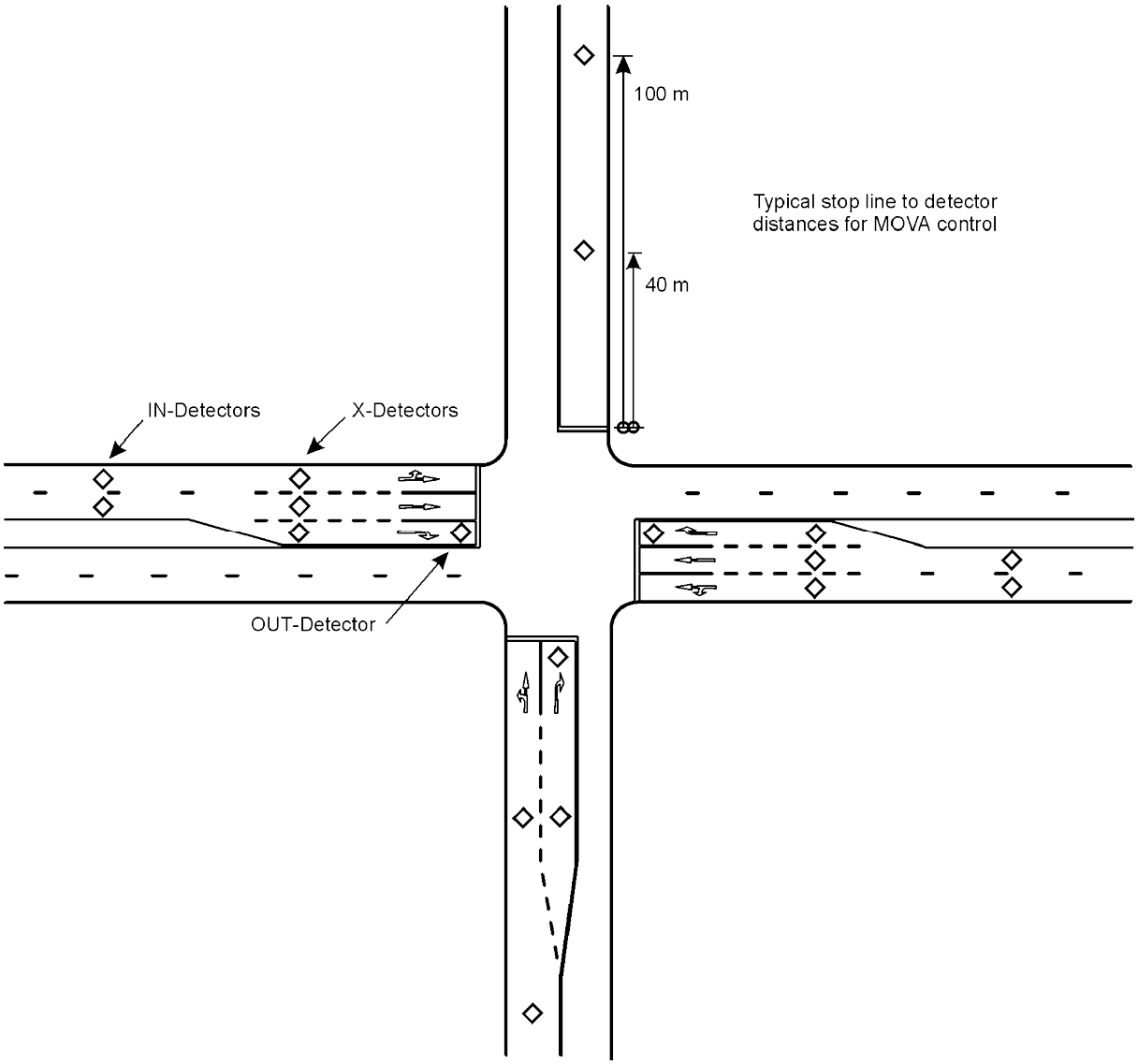

Figure 8.1: Typical layout of detectors

5 In the oversaturated condition, a control strategy is implemented which attempts to maximise capacity on congested (oversaturated) approaches. Green is maintained on oversaturated approaches provided that discharge continues at full saturation up to pre-set maximum greens. The junction will then operate on long cycles; thus minimising lost time.

6 Provision is also made for deciding whether or not an exclusive right-turn phase is required. If this facility is to be used an additional detector is required in advance of the stop line. This is referred to as the OUT-detector (see Figure 8.1). Traffic counts are used from both the OUT- and X-detectors. Should this number exceed a pre-set minimum, the exclusive right-turn phase is provided.

7 The combination of the various control strategies makes this an effective method of control. Although obviously more costly than fixed time control, the benefits to traffic and not having to update signal timings regularly, outweighs the cost substantially.

8.3 BIBLIOGRAPHY

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