Embedded/Networked Final Project – Traffic Light Intersection Modelling

<https://ops.fhwa.dot.gov/trafficanalysistools/tat_vol4/app_f.htm#:~:text=In%20fully%2Dactuated%20mode%2C%20detection,%2C%20left%2Dturn%20movements>).

System Design Description/Requirements

* The traffic intersection is a 4-way intersection
* (Colin I’m modelling this one after the one near my apartment)
* The intersection consists of a 2-way “main” road intersecting a secondary 2-way road with lower priority
* The intersection is situated near a railroad crossing which crosses over the main road.
* The intersection should support interrupts for the detection of emergency vehicles.
* The intersection should switch operating modes at night to accommodate lighter traffic.

There are various kinds of traffic light control systems which target specific requirements of intersections. In this case we will consider “fully actuated” control, where sensors are used at every approach to the intersection to determine the phase of traffic. Other systems include fixed time control traffic lights, where traffic phases are on a predetermined cycle length, and semi actuated traffic lights, where sensors are only used to allow cars to pass through the minor road of an intersection.

From “Appendix F: Actuated Signal Control”, US Department of Transportation Federal Highway Administration

A diagram of a barrier and barrier

Description automatically generated

Here, a diagram shows street-movements for a 4-way intersection. The diagram is read left-to-right, with columns of phases happening concurrently. The numbers 1, 2, 5, and 6 denote phases for the “main street”, meaning the road with higher traffic. The numbers 3, 7, 4, and 8 denote phases for the “side street”, or the road with more sparse traffic. This diagram has “leading left turns” for both streets; other configurations for traffic phases are feasible as well.

There are various types of detectors that influence when to move onto the next phase. Extension and count detectors in “presence mode” placed at the stop bar will ask the controller to service their phase. In our case, we may have count detectors on the side roads which ask the controller to move on to the next phase. These same detectors operating in “passage mode” can extend the green phase so that more traffic can be moved during the phase. In our case, we may have passage mode detectors on the main road to extend the green light for the highest volume of traffic.

There are two time-intervals that determine the length of a phase (i.e. green light). The first is the initial interval, which is the minimum time that a green light must be active. This can be a fixed time or can be computed based on the volume of traffic determined by presence mode sensors. The second interval is the extendable interval, which may extend the green light signal if there is demand. The extendable interval also has a maximum length; after the interval times out, the phase must terminate. The extendable interval may terminate early if there is demand for another phase.