Arizona State University

Traffic Simulator Technical Specification

Team 8

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Equations

1 Traffic Flow Rate

In order to realistically model the flow rate of cars through an intersection, a hyperbolic function was used, with additional variables added to control the flow rate for different scenarios and events. The equation is shown below:

(1) $$f(t) = \mathrm{R}(\mathrm{M}(\tanh(Dt - \pi) + RM))$$

Where:

t = time (in seconds) since green light cycle began
D = a scalar, determined by a selected scenario, to alter the time for cars to reach max flow rate
M = a scalar, set by the user, to alter the maximum flow rate
R = a scalar, determined by a selected scenario, to alter the maximum flow rate

Variables *D*, *M*, and *R* are inputs directly or indirectly inputted by the user. *M* is a direct input from the user that determines that max flow rate of cars when there are no other factors (such as bad weather) affecting the intersection. *R* and *D* are scalars used to both slow down the max flow and the length of time it takes for cars to reach the max flow rate. These values are determined based on the selected scenario the user chooses. For example, the user may choose “Construction”, “Rainy Weather”, or “Accident” which will alter the scalars accordingly. Additionally, the “time of day” and “day of the week” user inputs will affect the scalar values.

The number of cars that have left the intersection at any given time *t* can be determined by taking the integral of the function. In the traffic simulator application, the number of cars in and out of the intersection is modeled in real-time, so the flow rate is added to the totals after each second.

2 Cars Per Lane

Each leg in the intersection has a left turn lane, a straight lane, and a right turn lane. Users can input lane percentages which will indicate the percentage of cars waiting in that direction that proceed through the specified lane. The equation for the number of cars at a given lane is shown below:

(2) $$g(f(t)) = \Big(\big(f(t)\big) + C\Big)P$$

Where:

t = time (in seconds) since green light cycle began
f(t) = traffic flow rate equation (equation #1)
C = number of cars waiting in intersection currently
P = a scalar ratio, set by the user, which gives the ratio of the total cars that are in that lane (ex. 0.7)

3 Maximum Flow Rate

When starting at point (-π, -1) in a standard hyperbolic tangent function ('tanh(x)'), the maximum height of the curve is 2. For this reason, the default flow rate is set to 2 in the traffic simulator. However, since the standard height of the curve is 2 and the user can input the maximum flow rate, the inputted value needs to be divided by 2. Thus, the following equation gives the formula for determining *M* for equation 1:

(3) $$M = U/2$$

Where:

U = a value, set by the user, to choose the maximum flow rate