C++ Highway simulator

Changelog

Initial Version - 7 September 11:30 AM – drafted the Description of the project

Description

We want to simulate the motion of vehicles on a highway (to start) being a multi-lane one way road with specified entrances and exits.

The objective is to verify under which conditions traffic gets clogged and how to maximize the vehicular flow.

Not all the (and only) the below collected characteristics need to me implemented.

There will be signals on the road (possibly condition dependent), changes in road width and number of lanes (to simulate roadworks) plus a mandatory set of circulation rules (that may r may not be fully respected by the drivers). Physical conditions of the environment may be tweaked as well (e.g. Lightning conditions, Rain, Fog….) in location and time dependent ways.

The vehicles have a variable set of characteristics trying to model the real variability on the road. There will be motorbikes, car, trucks and heavy freights each with different dimensions, ability to maneuver and acceleration/deceleration profiles. Inheritance can have a strong role here.

Vehicles are driven by simulated drivers according to “personal” set of rules superimposed (and sometimes overriding) the stated road traffic rules. Different drivers behaviors will eventually be implemented. Driver attention on the road may not be always granted (e.g. in “low stimuli” conditions some sensory inputs may be accidentally ignored due to low attention or, after long drives, drivers ability to react may be reduced…)

As on real roads drivers have visibility of nearby vehicles behavior limited to a normal visual range.

The personal driver rules may be temporarily changed due to random events (e.g. road rage, externally imposed urges, being late, needing to stop for biological needs….) leading to interesting dynamics.

Drivers (and their vehicles) enter at random times from some highway entrances and attempt to reach, in the shortest time, a specific exit.

We want to select a varied population of drivers, vehicles, time and location of entrance and objectives for exit together with variable environmental and road conditions and traffic rules to evaluate occurrence of accidents (and their statistical cause), traffic flow speed, and appearance of collective behaviors (e.g. platooning). Also we want to shed light on the “mysterious” phenomenon of spontaneous formation of no-cause traffic jams that sometimes (often) occur in real highways.

Initial implementation tasks

- Define an object representing a generic vehicle with reasonable attributes, a list of some attributes (most likely not all of them) is
    - Position in 2 dimension (2-dim vector?)
    - Velocity and direction of motion (2-dim vector)
    - Dimensions of the vehicle (e.g. represent like a rectangle in 2 dimension)
    - Weight of the vehicle
    - Maximum vehicle speed
    - Maximum vehicle acceleration (how fast can you increase the speed?)
    - Maximum braking capabilities (maximum deceleration… how fast can you stop?)
    - Type of vehicle (e.g. car, motorbike, truck, 16-wheeler…)
- Define an object representing the highway. Again, some of the attributes are as follows (define a set of reasonable attributes). The highway can be defined as an array of "positions" and position relate attributes as defined below. Other implementation are fully acceptable.
    - The road "path". It can be defined as an ordered set of 2-dimensional points where the road path is the set of segments joining two subsequent points
    - The position dependent number of road lanes (or the road width). This takes into account the fact that the road can change width in different locations. This info can be combined with the "path" descriptor
    - A set of highway entrances and exits (e.g. defined as a set of positions of the entrances/exits). It could be, otherwise, combined with the "path" description by adding a "flag" to the intended position labelling them as entrances/exits
    - A position dependent set of speed limits (as of now, we can make them time independent)
    - [future] a position dependent "slipness" and "visibility" factor on the road that defines the local road conditions (may be related to some "weather" variable in the future.)
    - ….
- Define an object representing a driver (or a driver's strategy) with the aim to move, according to his/her time constraint, from the entrance point on the higway to the selected exit
    - The driver could (initially) merge in a lane and remain there until it reaches its exit
    - Further "strategies" may include methods to switch lanes and change speed to achieve a faster travel time
    - Multiple strategies can be implemented to deal with the speed limits (comply, comply "more or less", ignore when deemed safe, completely disregard…)
    - Similarly, multiple passng strategies can be implemented from a conservative "safe" algorithm to extreme "pass until you die" methods
- Finally, the drivers must be paired with cars and cars must be inserted, at different times and at different entrance points in the highway each having its own selected exit point.
- The simulation can operate at constant time step where the new position of cars is determined based on their past position and velocities
- A visualization algorithm (e.g. by OpenGl or anything else) could support a more interesting view of the simulation
- Finally, statistical data about the traffic can be extracted (average travel speed, car density, number of crashes…)