Traffic Simulation

Software Design Document

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**Introduction:**

This project is a traffic simulation involving different cars, drivers, and weather conditions along a straight variable-lane road with a variable speed limit. The goal of the project is to allow the user to observe how cars react to changes in driving conditions, such as a changing speed limit, weather, or a stopped vehicle in one lane. For example, the simulation could be run as a three-lane highway with a slowdown in one lane. The user could observe how the simulated cars react to the slowdown and determine the optimal course of action if the situation happens in real life. This document provides a description of the traffic simulation project, including detailed descriptions of the goals the project hopes to achieve and the ways those goals are to be accomplished.

**Problem Description:**

Cars are an extremely common transportation method for much of the world. This fact can be described with the Private Car Index, or the number of personal cars per 1,000 people, as illustrated by V. A. Profillidis, G. N. Botzoris in *Modeling of Transport Demand: Analyzing, Calculating, and Forecasting Transport Demand*:

*Chart

Description automatically generated*

This project aims to simulate traffic, defined as “the movement (as of vehicles or pedestrians) through an area or along a route” by Merriam-Webster. In this case, the simulated traffic is cars along a straight road. Each car is driven by a driver, and the driver-car pairs are referred to as “cars” in this document unless one specific component is being discussed. It is assumed that every car has infinite gas and will not break down, and that the roadway is perfectly maintained. These simplifications exist to allow the simulation to be completed within the time allotted. The “road” is a linear plane the cars move along. The simulation is designed to be used and interpreted by a human operator, referred to as the “user.”

Each car has a position, velocity, acceleration, deceleration, and maximum speed. The position is measured in miles from the start, which has a position of 0. The maximum position is 100 miles and upon reaching this position, a car’s position resets to 0 and keeps increasing. The velocity is a measure of how many miles a car can travel in an hour (mph) at the current instant in time. Acceleration and deceleration are used to determine how fast a car’s velocity can increase and decrease respectively and are measured in miles per hour squared.

Along with cars, the simulation includes drivers with different acceleration and deceleration (reaction speeds), visibilities, and maximum speeds. The driver’s speed properties take precedence over the car’s speed properties as long as the car’s properties exceed those of the driver. A driver’s visibility is measured in yards and is affected by the weather. For example, rain and nighttime decrease visibility while daytime and clear skies increase it. Visibility is the maximum distance another car can be from the driver for the driver to detect it and respond to actions the car ahead makes(braking, accelerating).

The simulation reports the number of cars on the road, the average speed, and the traffic flow rate. The average speed is calculated by dividing the sum of each car’s current speed by the total number of cars on the road, and is measured in mph. The flow rate is the product of the traffic density and the average velocity, measured in cars per hour (University of Idaho, 2003). The traffic density is the number of cars within a one-mile reference point, measured in cars per mile (University of Idaho, 2003). The traffic flow rate depends on the density reference point; this point can be changed by the user if it is within the bounds of the road (0-100).

The user can pause and the simulation at any time and choose to set the speed limit, weather, or lane number. These changes affect the entire road all at once when the user un-pauses the simulation. The user can also select lanes of cars and cause the leading car to slow to a stop as quickly as the driver’s deceleration speed allows. The following cars will respond to the slowed car by slowing down or switching lanes if there is no other car beside them. The simulated cars should react as they would in reality, not accounting for the simplifications necessary for this project.

**Problem Solution:**

**References:**

Merriam-Webster. (n.d.). Traffic. In Merriam-Webster.com dictionary. Retrieved October 16, 2022, from https://www.merriam-webster.com/dictionary/traffic

Profillidis, V. A., Botzoris, G. N., Profillidis, V. A., & Botzoris, G. N. (2018). *Modeling of transport demand : Analyzing, calculating, and forecasting transport demand*. Elsevier.

University of Idaho. (2003). *Speed-Flow-Density relationship*. Transportation Engineering Online Lab Manual; University of Idaho. <https://www.webpages.uidaho.edu/niatt_labmanual/Chapters/trafficflowtheory/theoryandconcepts/SpeedFlowDensityRelationship.htm>

**Appendices:**