TJHSST Senior Research Project
Simulation of Traffic Congestion on Route 1
2009-2010

Jimmy O'Hara

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Abstract

Route 1 in Alexandria, VA is a constant nightmare for drivers trying to navigate it during rush hour. The road is not capable of holding the amount of traffic that travels on it on a daily basis. The purpose of this project is to create a realistic simulation of this congestion and then to define traffic management solutions that can ease the current congestion. Hopefully, this project will create a viable solution to increase traffic flow during peak hours that can save drivers both time and money.

Keywords: traffic simulation, congestion, traffic management solution

1 Introduction

1.1 Simulation of Current Situation

Currently, Route 1 has trouble with traffic congestion during rush hours, when many people use it to commute to their workplaces. I will create an accurate model of the traffic congestion on Route 1, by creating a multi-agent system. A multi-agent system will allow for the cars to interact with each other while attempting to complete their own traffic goals. This will ensure a realistic driver behavior, allowing for the simulation to more accurately simulate the congestion that is occuring on Route 1. In addition, the system

will be based on traffic count data from the Virginia Department of Transportation from 2008. The data and simulation will be used to find the cost to each driver on the current system using a variety of factors such as: average speed, cost of gas, and travel time. Similar projects have been completed at TJHSST in the previous year (Galvin, Haseler, Wood), as well as around the world (Elsi et al, Jin et al, Tranouez et al) , as the traffic congestion problem is one that affects everyone around the world.

1.2 Finding Viable Solutions to Congestion

Using the cost per driver on the current system as a control, I will then manipulate the traffic system in order to find ways that can ease both the congestion and the cost to the driver. Some solutions that could be viable to this process are: adding an additional lane, creating a bus-only lane, naked intersections, and round-a-bouts. These are traffic management solutions that are often used in situations similar to the one on Route 1 and are very common traffic management decisions. The system will allow these solutions to be implemented together as well such as adding an additional lane and converting to naked intersections. The goal of this will be to find a viable solution to the congestion problem on Route 1.

2 Background

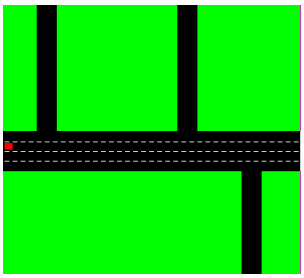
I have done extensive research into how to simulate traffic as well as preliminary research into traffic management solutions. I reviewed the TJ senior research projects from 2008-2009 which dealt with the simulation of traffic including projects by: Craig Haseler, Timmy Galvin, and Paul Wood. From their projects, as well as viewing some applets on the web, I decided that the best language to use in my project would be Java. I then did some research on the ACM database, and found an article on traffic congestion and traffic management solutions. This article will help me in the more advanced aspect of simulating the decisions of drivers. In addition, the article had many factors with which to determine the cost to each driver of each traffic management decision. I hope to incorporate some of these factors into my calculations. Two other articles dealt directly with urban traffic easement simulations, one titled "City Traffic Simulation and its Utilization" and another titled "A multiagent urban traffic simulation Part 1: dealing with the

ordinary". These two projects are very similar to my own and allowed me to look into the conclusions of my fellow researchers. Both offered solutions such as specific-use lanes and increased driver knowledge as ways to ease congestion on urban streets. I also did research online into the various ways congestion is alleviated around the world. In Europe a new idea is naked intersections or, in other words, intersections with no traffic lights or stop signs. This method is based on the fact that with normal intersections drivers will be stopped for long periods and accidents can happen when people do not follow the system. But with naked intersections drivers will be forced to slow down when they reach the intersection ,follow etiquette and allow people whose turn it is to go through the intersection to do so, because it makes an intersection a social encounter rather than mechanical encounter. Another idea that is very popular is to designate a lane for public transportation only. This allows the regular traffic lanes to be more free-flowing, because one lane does not suddenly stop when the bus stops to pick someone up. In addition, it allows for greater access to public transportation, which will decrease the amount of cars on the road. Finally there are older solutions such as adding a lane or converting intersections to round-a-bouts. Both of these methods have already been proven successful in other situations, but may not be in my simulation.

3 Procedure and Testing

The first piece of the project I am working on is the graphics part. This includes creating the road system to an accurate scale, creating the cars, and having them behave as actual cars. The road system will be a multi-agent system where the cars are the agents. This allows for the cars to interact with each other while still mainaitng their own goals. In this way the cars will act as real cars because they will make decisons based on their own goals first, then they will consider the goals of the system as a whole. The cars interact through the use of a matrix that creates a grid system over the image, where each agent occupies a single space in the matrix. Therefore the cars are able to determine when it is clear to change lanes and what the appropriate speed to travel at is. In addition the cars can look ahead and to the sides of them similar to a human driver, determining the holes in traffic that allow them to accomplish their travel goals. This part is being tested mostly through an eye test, in other words is the car acting like a normal car would, does the

car move to the correct lane to turn off the road and does it turn off the road realistically. The second part of the project is to input the data from the VDOT traffic report in order to analyze the cost per driver in the current system. This will be tested against the visual representation, in other words, does the data fit with what the model is saying.



The car driving on Route 1.

4 Results

The visual system is complete. The matrix has been created and the multi-agent system is fully functional. The cars drive down a two-way, multi-lane road, following their own route in order to reach their destination, interacting with the other cars on their side of the road in order to create a normal, efficent and safe driving environment. The cars are able to turn right freely and turn left when they have the light. The traffic lights are timed to give a realistic amount of time for the cars to flow freely. Finally, the VDOT data has been used to accurately introduce cars into the network system. A pattern has developed in the traffic development as time goes on the congestion on the road increases. For example take two cars one travels on the road 10 secs after the next, the second car will always have a higher cost per driver than the first car.

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