Intelligent Traffic Controllers

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Abstract

Traffic controllers are machines that dictate how traffic will flow from one street to another. Since most highly urbanized areas have traffic lights based on timing sequences, there becomes a need for a traffic controller which can adapt to its surrounding environment. This environment includes automobile traffic, pedestrians, and neighboring traffic controllers. In order to fill this need, this project is focused on building a new, adaptive controller based on a multi-agent framework and TCP/IP inter-connectivity.

Problem Formulation

To illustrate the traffic controller system, we will use the downtown Houston (Texas) area as an example. Since a target area exists, we can further analyze the problem. Traffic controllers based on timing sequences, like the ones in downtown Houston, aren't efficient ways to control traffic. By this we mean that they do not adaptively minimize the waiting time for cars approaching the light. For example, if a solitary car was stationed in the vicinity of one of these lights, even if it had no traffic that would be against its movement waiting on the adjacent street, the light would still force the car to wait on an existing traffic. This is obviously a loss in time for the person who had to wait. And since we take optimal traffic movement to be our solution, it is then obvious that minimizing the time a person waits for the light to change is an optimization of traffic. Thus even though lights based on timing sequences are simple and intuitive, improvements can be made to better control traffic; to control it in an intelligent manner that allows for optimal traffic flow in even various situations. This is where the work begins.

The Simulation

This project main focus was on building a proper simulation of a Multi-Agent Controlled Traffic Light Systems. This is due to the cost and manpower that would be needed to actually create a real-life working prototype of the system and our limited resources. So we decided that a proper simulation could easily be built in a semi-virtual environment based on incoming traffic between several computers. Each computer would represent the light of an intersection and house two agents, one based on a light possessing two agents is that one was structured to gather information and the other existed for making decisions. Traffic would be simulated by allowing data to be transmitted from one computer to the other via TCP/IP protocol packets. To make this simulation truthful, we added several factors that would exist in a real world environment. Before data could be transmitted it had to travel a certain pre-defined distance. Also, each piece of data was given a random speed that it used to travel this distance faster or slower than other data objects. Since we based our model on streets that have only one lane, one piece of data could not go faster than the data that was ahead of it on the information highway. So in this sense, we had virtual cars that had to travel down a virtual street and reach the intersection before they could be popped off and sent to the next computer. This structure allowed us to observe the behavior of the Multi-Agent system when dealing with conflicting traffic in various situations. Also, we had the ability to create the cars (data to be transmitted) at random so that we could simulate the unpredictable amount of cars that would appear on a street during the day, due to the complexity of human behavior.

Methodology

First, a multi-agent system must be created to simulate a traffic controller. A multi-agent is an object based on the following principles:

• Must support automated action
• Automated action simply means the system will run on its own once started.
• Must be able to communicate with others.
• This could include, but not limited to, other controllers and human traffic controllers
• Must take in its environment data
• This can be further divided into two categories:
  • Reactions
  • Controllers will react to data given to it
• Pro-Action
• Controllers will anticipate new data based on communication
• Must set as a human would
• Since humans can control traffic more efficiently than a time-based controller can, the controller must reason like a human would to a given environment

Now, criteria is made for which the controller will make educated decisions about.

For our purposes, this includes:

• Number of cars that exist on a given street
• This detects the current load of the street
• Time a car has been waiting for a red light to change to green
• In order to be realistic, a car won’t be allowed to wait for extended amounts of time
• Average speed of current traffic
• This also helps to detect the current load of the street

Now that rules are defined, there must be simple ways to implement these policies.

The tools we use are:

• C++
• Naturally a programming language must be used. In this case, C++ was used to the simulation
• FuzzyCLIPS logic engine
• Converts crisp values (number of cars, wait time, average speed) to fuzzy values (High, Medium, Low)
• TCP Sockets
• Used for communication from one traffic light to another
• Inlricht Game Engine
• Used for 3D Simulation of the traffic flow
• 3D Studio Max
• Used to create models for the 3D Simulation
• Threads
• Used to allow for concurrent, autonomous execution

Intelligence

One important aspect of this project was to provide a quantity of intelligence to the agents that controlled the light. While this intelligence was not as grandiose as which we findIntelligent Traffic Controllers
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Intelligence

One important aspect of this project was to provide a quantity of intelligence to the agents that controlled the light. While this intelligence was not as grandiose as which we find in mature humans as are able to express, we found that limited intelligence that our structures gave the system accomplished the desired goal. What we used to create this intelligence, was a control system based on rules that could be weighed by Fuzzy Logic. In the beginning of our project, we used a very simple fuzzy logic. While it was not our fuzzy logic, it was able to flexibly measure certain situations based on the rules and implement the required action. However, we have recently introduced the Fuzzy-Clips library into our system to allow for full fledged fuzzy logic.

Conclusion

We have successfully created our test-based simulation model and tested it under different environments. However, our 3D version of the project was setback due to various, unexpected errors that occurred during compilation of code. We are planning on creating a simulation of the timed light sequence and test the two under the same traffic conditions to see which one performed better. Though our hypothesis and estimation is that the Multi-Agent system will perform the timed light sequences, this evidence relies on human logistics and reasoning rather than an actual experiment. We also, in the future, may even decide to test this system against a human opponent to find which is more efficient. We assume that the Multi-Agent system would eventually win even in this situation due to the human’s attention span and inability to dictate numerous amounts of lights at once. However, we still need the raw data to prove such a hypothesis. In any event, our project shows that the Multi-Agent Traffic System is indeed a system that could be implemented that would allow us an ability to control traffic at least as good as a timed light system. Other points of interest that we did no research into that would be important in future work are: how cost effective is this system? To what extent can the complex input devices of this system be built?

Future Work

• Completion of the 3D Simulation
• Turning Implementation
• Multiple Lane Adaptations
• Addition of the Light Rail system
• Pedestrian Awareness

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