ATS – An Autonomous Traffic Simulator

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***Abstract***: **In today’s world, autonomous cars are becoming more of a reality with each passing day. The prime example of such a vehicle is of Google’s autonomous car. Supporters of autonomous vehicles envision a future in which every day driving hassles, such as traffic jams and car accidents, become a thing of the past. They claim that since autonomous vehicles will have the ability to communicate with all other surrounding vehicles, one’s autonomous car will be able to “predict” the movements, actions, and responses of its neighbors to keep traffic moving safely and efficiently. While our team is supportive of the development and advancement of these autonomous vehicles, we are curious to see if such claims are true as the number of vehicles on a road increases. We created the Autonomous Traffic Simulator (*ATS*), a discrete-event simulation built upon the open source ROSS framework(1). Our simulation models a simple, yet common everyday occurrence: traffic lights at intersections. We will use this simulation to model how much time the ideal autonomous vehicle will take to traverse from a starting point to a destination point when having to obey traffic lights at each intersection.**

***Keywords* –autonomous, vehicle, simulator, traffic, lights, ROSS**

I – Introduction

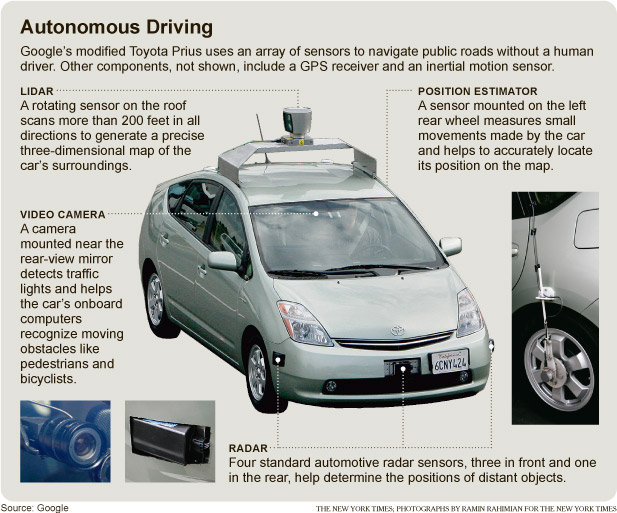
Autonomous cars are not a recent invention; one only needs to look at science fiction movies and novels to see countless examples of such vehicles. Perhaps the most famous autonomous vehicle is Google’s Self-Driving Car (**Figure 1)**. Google uses a high-performance computer in conjunction with a variety of sensors, most notably a LIDAR (Light Detection and Range) sensor mounted on the roof.

Individual Contributions:

**Bryant**: Designed and implemented ATS Traffic Light Event Handlers, wrote up this paper

**Derek:** Implemented Autonomous Vehicle Inter-Vehicle Event Handlers

**Matt**: Designed and implemented ATS Traffic Light Event Handlers, wrote up this paper

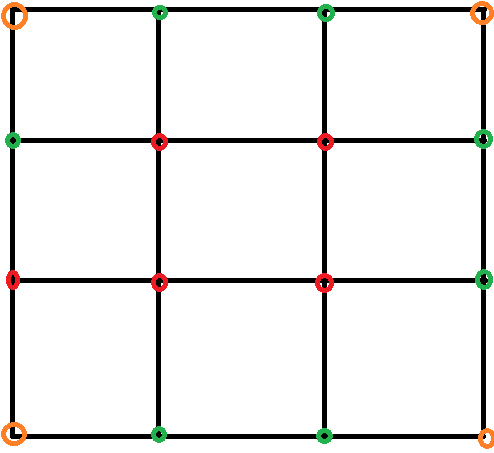


**Figure 1** – Google’s Autonomous Vehicle(2)

One of the goals of autonomous vehicles is to reduce daily commuting time to and from work. Proponents of autonomous vehicles claim that these vehicles will achieve this goal because the cars are able to communicate with each other and thus synchronize their movements to improve traffic conditions and ensure a smooth flow of traffic. However, our team was interested in the case where everyone is driving an autonomous car that is capable of communicating with all other cars. We decided to write up a simulator to see how much time the average autonomous vehicle takes to traverse from one point to another as the number of vehicles increases on a fixed world size and under the condition that in each intersection on the world, there exists a traffic light.

II – The World

In ATS, the world is referring to an *X* by *Y* grid. **Figure 2** gives an example of a 3 x 3 World.

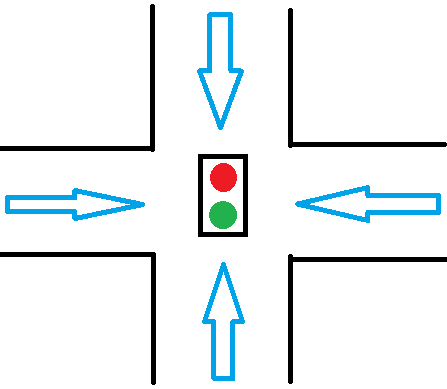


**Figure 2** – A Sample 3 x 3 World

In Figure 2, each black line segment refers to a road that autonomous vehicles can travel in. Each intersecting line (indicated by either a red, orange, or green circle) represents an intersection. At these intersections, a traffic light is placed. A red circle indicates a four-way intersection; a green circle indicates a three-way intersection, and an orange circle represents a two-way intersection.

In each road, there are two-lanes; one for each direction.

An intersection is defined as a set of intersecting lines. A traffic light is placed at this intersection, and has two states: red or green. **Figure 3** shows an example of a four-way intersection with a traffic light.



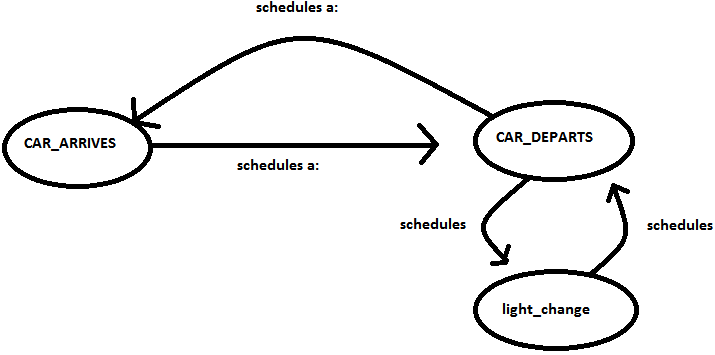
**Figure 3** – A four-way intersection with a traffic light

The arrows in Figure 3 show the possible directions that traffic can move in. It is important to note that our traffic lights have a ten-second counter. In addition, we assume that it takes one-second for a car to cross the intersection.

III – Traffic Light Event Handler Algorithm

Our team drew inspiration from the “traffic” simulation provided as part of ROSS(3).

We defined three separate events that our traffic light event handler needed to create. These events are: 1) **light\_change** (when does a light change?); 2) **car\_arrives** (handle when a car arrives at the intersection; and 3**) car\_departs** (handles how a car leaves an intersection). **Figure 4** shows a state table showing how the above three events interacting with each other.



**Figure** **4 – State Diagram of Traffic Light Intersection Events**

When a car arrives at an intersection, the intersection calculates the number of cars arriving from each direction. To get from a starting point to an ending point, a car will first travel either north or south in the Y-Axis until the car and its destination point both have the same Y-coordinate. Next, the car will turn left or right and then travel to east or west until the car reaches the destination point. If the car has reached its destination, the event breaks and returns to main. The car arrives event calculates the next intersection and direction the car must travel to in the next iteration of the simulation. Finally, the CAR\_ARRIVES event schedules a CAR\_DEPARTS event.

The departure event, as indicated by Figure 4,

The algorithm for the traffic light event handler is shown in **Listing** **1**:

**Listing 1 – Traffic Light Event Handler**

*If light\_change\_time == 0:*

*Set event = light\_change*

*endif*

*If event == light\_change:*

*If traffic\_permitted == NORTH-SOUTH:*

*If NORTH-SOUTH directions have left-turn:*

*If left-turn == GREEN:*

*Set north and south left-turns to RED*

*Turn north and south straight lanes GREEN*

*Reset traffic light to original time*

*Else:*

*Set traffic\_permitted = EAST-WEST*

*Set all NORTH-SOUTH lights to RED*

*Set EAST-WEST left-turn light to GREEN*

*Reset traffic light to original time*

*Endif*

*Else*

*Set traffic\_permitted = EAST-WEST*

*Set all NORTH-SOUTH lights to RED*

*Set all EAST-WEST lights to GREEN*

*Reset traffic light to original time*

*Else if permitted\_traffic == EAST-WEST:*

*If EAST-WEST has left-turn arrow:*

*If left-turn is GREEN:*

*Set EAST-WEST left-turn lights RED*

*Set EAST-WEST straight lights GREEN*

*Reset traffic time to total time*

*Else:*

*Change traffic\_permitted to NORTH-SOUTH*

*Change NORTH-SOUTH*

IV – Future Research

The currently developed world is simplified compared to a real world setting. Further research can be done using actual map data from Google Maps. This can accurately determine travel time between lights, the maximum number of cars between intersections, the speed limit and many more factors. In addition, adding more than one lane to an intersection creates a more realistic map. Some intersections have a combination of one to three lanes with left turning lights. Lastly, the current model only has red and green lights. Adding the yellow light will have new affects on how cars move from intersection to intersection. Most drivers tend to speed up to get through a yellow light. The newer model can mimic the same behavior.

References

1. “ROSS Wiki Main Page”, *Rensselaer Polytechnic Institute*. <http://odin.cs.rpi.edu/ross/index.php/Main_Page>,

2013.

2. “Google-self-driven-car.jpeg”, *Alecdifrawi*.

<http://www.alecdifrawi.com/wp-content/uploads/2011/08/google-self-driven-car.jpeg>, 2013.

3. “Traffic ROSS Simulation”, *Rensselaer Computer Science*. <http://www.cs.rpi.edu/websvn/filedetails.php?repname=rossnet&path=%2Ftrunk%2Fross%2Fmodels%2Ftraffic%2FIntersection.c>, 2013.