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Agent- Based Traffic Simulator for Autonomous Vehicles

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Abstract- In near future, there is a great possibility of autonomous vehicle navigation. These days stop signs, traffic lights, and intersections assist the human-driven cars to cross the traffic. Now the computers will take over the human drivers i.e., the computers will "behind the wheel". With the help of computerized drivers, automobile travel will be much more safe and efficient because of more accurate control, highly defined sensors and quick reaction times.

Keywords- AORTA, AIM, Intersection control policy, multi-agent approach, Project Object Model, Open Street Map, reservation idea, traffic simulation

I. INTRODUCTION

The increasing traffic chaos is now attracting much attention to come up with a revolutionized solutions[1]. This, however, might be costly and impractical in many cases. Traffic simulators are beneficial tools for providing a simulated environment of the network[2].

Many experiments have been done to simulate traffic operations. The simulation techniques have been used by the transportation specialists to study and compare the alternative geometric configurations. Many of the simulation models are under progress. The inappropriateness of extensive models may yield misleading results which thereby cause limited use. Any simulation model should consider all the simulation-related issues to eradicate traffic problem[3].

II. II LITERATURE REVIEW

Many feature descriptor schemes have already been published in literatures such as AORTA (Approximately Orchestrated Routing and Transportation Analyser). AORTA makes the use of OpenStreetMap(OSM) which makes available the data related to roads publicly to make simulations for the real world.

AORTA has designed intersection policies and some automated behaviours for driver agents. Due to the incompleteness and inefficiency in OSM data, the map construction in AORTA has suffered. OSM consists of only geometric data, it lacks the functional data related to on the roads are meeting.

III. ALGORITHM DESIGN

The overall algorithm is divided into several modules to enhance the performance of intersection management process.

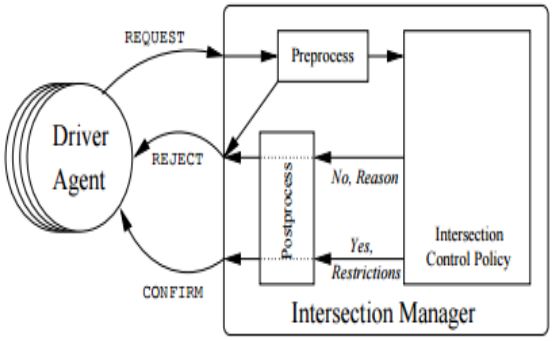

Fig.1- A Multi-agent approach to JAVA Autonomous Intersection Management

AUTONOMOUS INTERSECTION MANAGEMENT

Autonomous Intersection Management has following characteristics:

1) allow for fully distributed and autonomous control by the vehicles,
2) have low communication complexity,
3) assume non-expensive vehicle sensors found in production,
4) use a standardized communication protocol,
5) be incrementally deployable,
6) be safe, and
7) be efficient.

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The Reservation Idea

Vehicles "call ahead" at the intersection in order to reserve the space-time slot[2]. At every intersection, intersection manager is installed which is also called as arbiter agent. The computer programs control the driver agents which further control the vehicles. At the intersection point, the driver-agents reserve a space-time slot. The arbiter manager then decides either to accept or reject the requested reservation using an intersection control policy.

Intersection Control Policy

The intersection is divided into reservation tiles by the help of the prototype of intersection control policy. The arbiter manager manages the reservation requests which consists the vehicle size, velocity of arrival and time etc. to decide the physical behaviour of the vehicle across the intersection [6].

IV. IV EXPERIMENTAL SETUP

Simulation Environment:

JAVA: It is a highly secured programming language. It is supported by Open Source Committee. Because of its portability or platform independency, it has been used in the project.

Apache Maven: It is a software for project management and also provides us comprehension tool. Maven is solely depends on Project Object Model (POM) which manages the Java- based project's structure, reports and documentation.

1. Simulation Setup Screen

On starting the simulator, the following window will be generated:

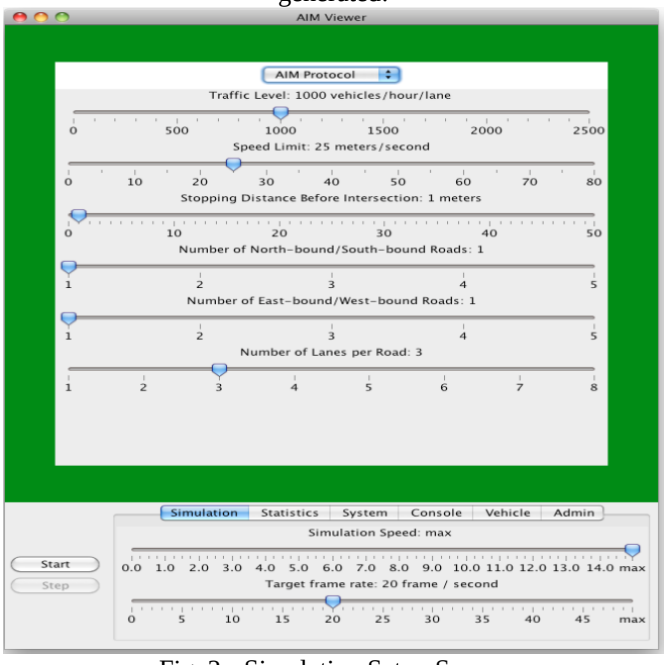

Fig. 2:- Simulation Setup Screen

The AIM protocol controls all the intersection-simulations which is shown in this setup screen[4]. Various parameters for simulation have been used as shown in this setup screen:

- Traffic Level. This shows the number of vehicles crossed through each cross point/hour/lane. Here the default traffic level is set as 1000 vehicles/hour/lane.
- Speed Limit. This parameter shows the speed of the vehicle. Here the default speed limit is set as 25 m/s.
  - Stoppage Before Intersection. This defines the distance before the intersection a vehicle should stop if it has not received a reservation. Here the default distance is 1 m.
- Number of North-bound/South-bound Roads. This shows the number of north-south direction roads. The value is set as 1.
- Number of East-bound/West-bound Roads. This shows the number of north-south direction roads. The value is set as 1.
- Number of Lanes per Road. It defines the lanes per road. The value is set as 3.

We can also select other setup screens by the pull down option in the menu box. For example, if we choose "Traffic Signals", the following setup screen will be generated:

Fig. 3:- Traffic Signal Simulation Setup Screen

This setup screen shows all the simulations for the traffic signals. For instance, if "Stop signs" is chosen, the following setup screen will be generated:

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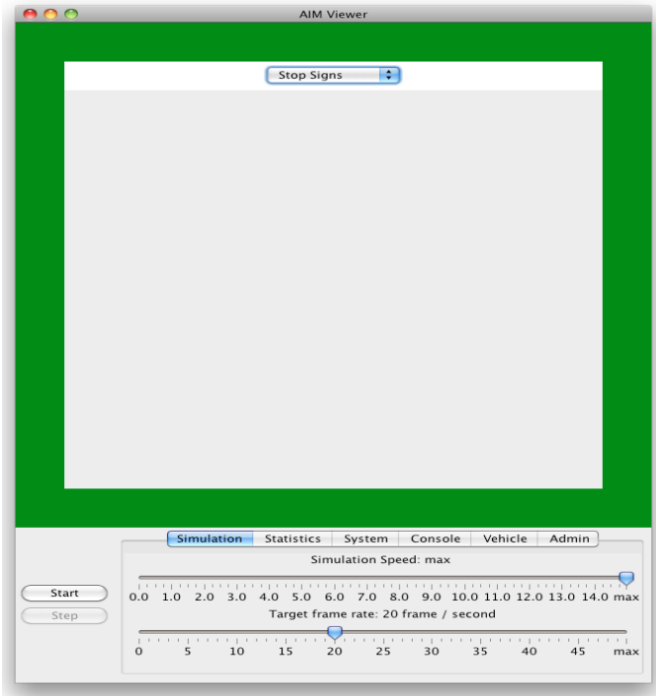

Fig. 4:- Stop Signals

Here in this simulation, all intersection controls are stop signs. Presently, this setup screen has no settings for stop-sign controller.[7]

2. AIM Protocol Simulation

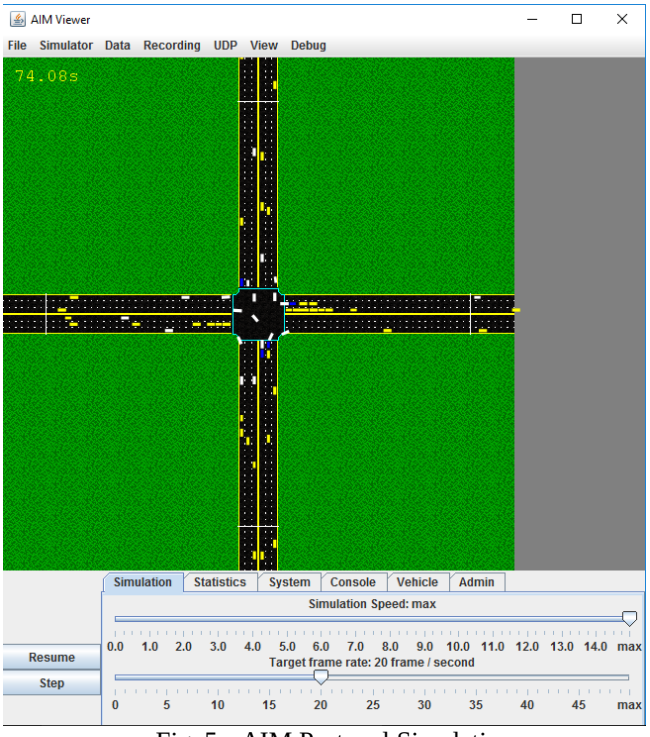

Fig. 5:- AIM Protocol Simulation

Different colours have been used to indicate the vehicles' state of reservation:

- Yellow vehicles – This shows that the vehicles have not received any reservation and also not currently waiting for the reservation.
- Blue vehicles – This shows that the vehicles have not received any reply from the arbiter manager against a reservation request.
- White vehicles – This shows that the vehicles can now enter into the intersection as the reservation request is granted by the arbiter manager.

3. Traffic Signal Simulations

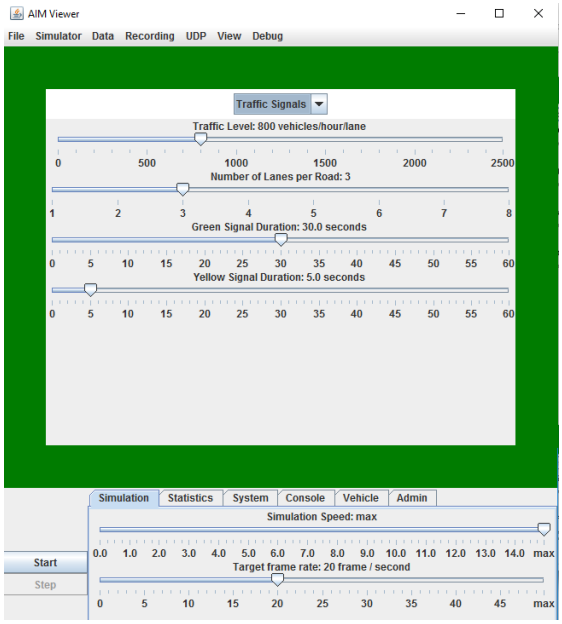

Fig. 6:- Traffic Signal Simulation

In this setup screen, the traffic signals control the intersections by these simulation parameters:

- Traffic Level. This shows the number of vehicles crossed through each cross point/hour/lane. Here the default traffic level is set as 800 vehicles/hour/lane.
- Number of Lanes per Road. This defines the lanes per road. Here the default number is set as 3.
- Green Signal Duration. This defines the green signals' duration. The default duration is 30 seconds.
- Yellow Signal Duration. This defines the yellow signals' duration. The default duration is 5 seconds.

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4. Stop Signs Simulation

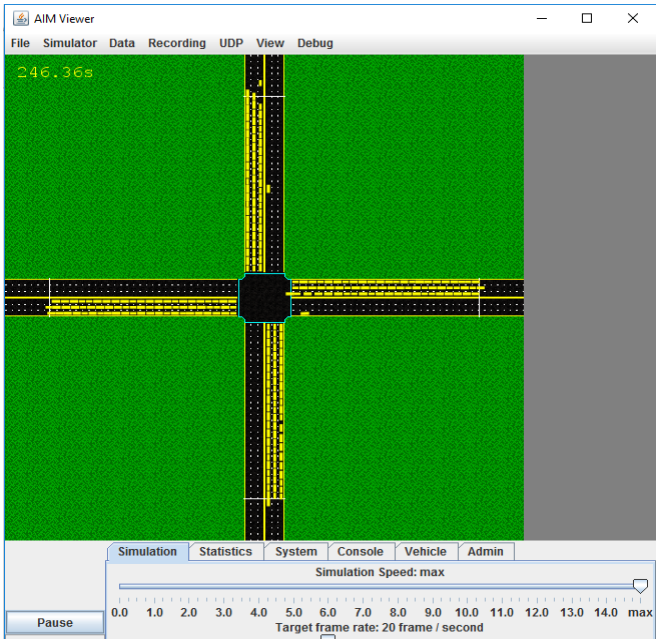

Fig. 7:- Stop Signal Simulation

In this simulation, only single vehicle at a time is allowed for right way entry into the intersection. This is not true: actually when a vehicle has almost completed its journey inside the intersection, then another vehicle can enter the intersection. The entry of the vehicles inside the intersection is defined by First Come First Serve (FCFS) algorithm basis under the stop signs. If any conflict occurs, suppose multiple vehicles are stopping at the intersection, then the entry to the vehicles is given in a counter-clockwise direction.

V. SIMULATION CONTROLS

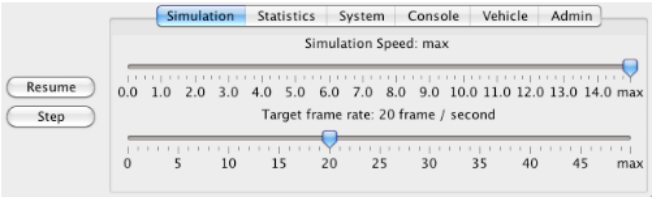

Fig. 8:- Simulation Control parameters

There are some control tabs for simulation and for the display of useful data. The tabs are:

- Simulation Tab – controls the simulation process speed.
- Statistics Tab – shows the complete statistics of the process.
- System Tab – it shows the information of the simulator.
- Console Tab – it shows the messages generated during the simulation process.
- Vehicle Tab – this shows complete information about the selected vehicle.
- Admin Tab – this possess the authority to change the arbiter managers when the simulation is going on.

VI. CONCLUSION

AIM is all new constrained based intersection management system enabling fully-autonomous, semi-autonomous, and humans-driven vehicles to cross the intersection in an AIM-style. In future, a better constraint based reservation policy using vehicles is intended.

VII. REFERENCES

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