MUST: MUlti Agent Simulation of Multi-Modal Urban Traffic (Demonstration)

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ABSTRACT

Large cities with multi-modal traffic systems are complex that need to be understood to help analyze and make policy decisions. Understanding such complex systems requires simulation, experimentation and observation. We have built a MUST system to simulate big cities with multi-modal traffic system with large number of agents (humans), each participating in many movement activities. Building such a system would require high performance back-end, and a user friendly front-end. In this paper, we give a brief description of the system, and its functional components. The demonstration will show the system's capabilities.

Categories and Subject Descriptors

I.6 [**Computing Methodologies**]: SIMULATION AND MODELING

General Terms

Design, Experimentation

Keywords

Multi-agents, Traffic simulation, Multi-modal traffic, Agent simulation

1. INTRODUCTION

In December 2011, Singapore, well known for efficient and prompt public transportation system (comprising of metro rail, bus and taxi transport), witnessed a series of breakdowns [1] one of which affected 127,000 passengers on a single day for more than 4 hours. After the incident, SMRT (Singapore Transport Authority) acknowledged that the rail network has grown, and hence is more complex. Therefore, made it difficult for the operator to execute its emergency plans [1].

Understanding (i) human travel patterns, (ii) infrastructure changes to rail and road networks and (iii) other factors (such as capacities and limitations) help in planning out effective mass transportation facilities (like train and bus) in a city under normal and emergency situations. To study the authenticity of patterns one needs to design specific experiments driven by human behavioral patterns and world environment situations (like increasing number of trains, rail rupture, rail breakdown). The simulated outcome from these experiments is to be analyzed. Further, it is imperative to have a realistic simulation [2, 3] of the environment and the human behavior to get valid experimental data. Therefore, we built *MUST: multi-agent simulation of multi modal urban traffic*.

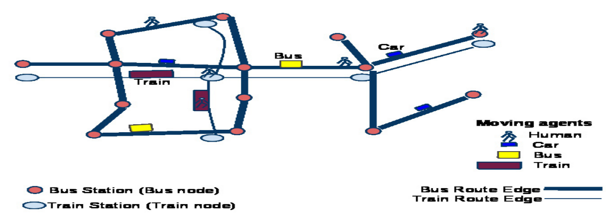

Figure 1: Instance of World Environment Scenario

2. MUST SYSTEM

MUST system considers the world environment to be a big city with interlinked mass train and bus transportation systems. The trains and buses follow specified routes and maintain the timing of the bus/train at bus stop/train station. There is big road network and rail network upon which the buses, taxis and trains travel. Apart from train and bus, the other modes of transportation are by taxi and by foot. World environment has four types of transport agents: Train, Bus, Car and Human and two different types of networks interlinked (bus and train networks). The train agents run on train network, while the bus and car run on road network, and humans perform movement activities by walking and/or taking train and/or bus to go from one place to another. A sample instance of the world environment scenario is given in Figure 1.

MUST System has components to: (i) define environment, (ii) create the environment, (iii) govern the traffic rules, factors affecting the environment and (iv) the simulation components to execute simulation, as described below:

Configuration Manager: The configuration manager defines the environment, the agents, and frequency of agents travelling based on the time and initializes individual agent (human, train, bus) behavior. The user, prior to simula-

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Figure 2: MUST: Simulation screen-shot

tion, defines the expected world environment by providing these configuration settings. The updates made to the configuration manager controls the world environment and the agents. This manager creates the Agents Database and Locations Database (maintains state of the simulation).

Environment Manager: This component creates the environment (the city layout, travel routes for various transport agents, the underlying rules to follow) for the simulation. It starts the simulation by activating agents.

Agent Manager: The agent manager sets the agents into motion and monitors the movements of all agents. When an agent is created, it creates and stores information into a database; this database is maintained to track the agents at various points of time. The next action for the agent is also chosen on the previous state of the agent. The agent movement data (agent's location over time) is logged in the database by this component.

Routing Manager: Routing manager decides how an agent moves from one location to another (finds the route to be taken by the agent). It takes the various inputs from the Agent Manager to decide the routes. This routing manager is implemented as service running on a machine in the cloud. When the route service is started, it generates a graph network of buses and a graph network of trains by reading their timetables for a particular city. Each node in the graph represents a train/bus stop and an edge from node A to node B represents a bus/train service from A to B. The edge properties store the timings of all the services connecting those two nodes. We modified the Djikstra algorithm to improve the search for paths in the bus/train network.

Visualization Manager: Visualization manager generates the visualization of simulation results. It is built using QT, OpenGL and City images generated by a maps tile server. Tiled images of city map are stitched according to user's viewing area and are used as a background texture. Locations of trains, buses and human agents are fetched from database and are drawn as moving pixels over the city map.

3. IMPLEMENTATION

A prototype of the simulation system has been implemented using [4] with trains, buses and human agents. The system is able to conduct various experiments by changing the earlier mentioned settings (like number of agents, number of stations and city maps).

Table 1: Simulation statistics

No. of Human Agents	Each iteration time	Time to initialize
1000	0.05 seconds	3 seconds
10000	0.27 seconds	25 seconds
100000	1.80 seconds	150 seconds

Simulation on the cloud: The simulation system is deployed on a cloud of 9 machines (one master and eight slaves). Screen-shot of a visual presented upon completion of simulation is shown in Figure 2. It displays the state of world environment during the simulation; the red, green and blue dots represent the human, train and bus agents in motion. Table 1 displays different simulation experiments performed with different number of agents and the time taken for each iteration and initialization of the experiment.

4. SUMMARY

Large urban cities with multi-modal transport systems have many issues with respect to understanding user behavior patterns and incorporating them in their decision-making about managing the transport system. MUST enables simulation of large cities, for which the transport system details are got from corresponding authorities and incorporated with the mapping environment to visualize the simulation. Further, one needs a high performance backend system to simulate traffic movement activities of large number of agents and hundreds of trains and buses. MUST system shows the functionality of the system. Future work includes city traffic data analytics, including factors that reflect infrastructure limitations like wear and tear of vehicles into simulation experiments.

5. REFERENCES

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