



“SMALL TRAFFIC” – AN AGENT BASED TRAFFIC MANAGEMENT SYSTEMS ANALYZER

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Abstract

An efficient traffic signals system can reduce the loss of time at great extent, with minimum budget and minimum disturbance to roads. There are many systems widely available, having certain advantages and disadvantages. New approaches are emerging and old approaches are improving with passage of time. Any new approach cannot be practically applied at once before completion of its cycle and proper testing. Simulation is the most cost effective solution to observe the effectiveness of any proposed system. On the other side Software agents are intelligent entities that work autonomously to achieve their task.

The novelty of this paper is integration of Micro-simulation with Multiagent system based on real time approach to add autonomy and elegant behavior through software agents. A simple genetic algorithm and a learning classifier have been integrated in the body of software agent. The user will be able to define realistic models consisting of roads, traffic signals and traffic volume facilitated by suitable and appropriate figures and various property sheets. This type of approach is a unique model where signals are assigned agents of different traffic systems to make a complete traffic management approach. Different approaches will be simulated at once and the agents working at background will generate comparison report of all the simulated approaches. Though many simulation models are available in the market to address various problems but integration of intelligent agents make this model different from the others.

Keywords: Multi-agent systems, Simulation, Traffic, Signals, Genetic Algorithm, Learning.

1. Introduction

Traffic Control Systems are one of the hot topics in today's fast moving world. A person finds it very disturbing to spend a large amount of time in moving from home to work and vice versa, as it is of no gain, simply a loss. Government Agencies and high officials know this loss, thus trying their best to minimize it. One of the solutions can be Efficient Traffic Signals. Different research studies have been conducted from time to time in order to efficiently set the time of traffic signals for efficient traffic flow. Some models have been studied and compared with the proposed model. Syracuse was deployed as a computerized traffic signal system and optimization of signal (Al-Dabass, *et al.*, 2006). Video Vehicle Detection Systems was developed and integrated into Athens' traffic management system. High-resolution, low visibility cameras were used that could collect more useful information. Wireless Road Traffic Management System (WRTMS) was aimed to promote open systems that support future road traffic management policies, procedures, and measures, both in Jordan, Gulf Area, and overseas (Balaji, G., *et al.*, 2008). Airborne Self-Separation, a new concept was proposed for adaptable management of the air traffic

in which pilots have various options to opt a suitable path. Aircraft is directed an adaptable model based on the heuristics (Masci, P., *et al.*, 2009). A generic and modular mobility simulation framework (GMSF) has been proposed that makes design simple and addition of new model is very easy. This model will only work after complete deployment (Baumann, R., *et al.*, 2009).

It is very costly to test a traffic management approach by physically implementing it in the field. Simulation is the most cost effective solution for testing new ideas, approaches and models. By using simulation, one can easily get the results of the test. The accuracy of the result depends highly on the simulator. There are many simulator techniques available now a day. Micro-simulator technique is considered one of accurate result giving technique. In this technique all the components (players) of the environment involved in simulation, function at micro level, i.e. they try their best to mimic the functions of the original player in real world. For adaptability and learning of the agents simple genetic algorithm has been implemented in the body of the agents.

In the proposed system cars will function at micro level and they will try to mimic the behavior of the original cars. The junction will control the lamp of the road according to its pre-described function, and the waiting time of the cars will be calculated to determine the performance of the pre-described function of the junction. The currently available software provide versatility in some ways. The problem with them is that either they are restricting the user according to the current technologies (i.e. controllers in use) or to achieve versatility one has to try different utilities (more learning time). Researchers think ahead of time, and their thinking is consumed by hardware vendors, oppose to that they are limited by hardware. They do not have enough time to keep learning different utilities for simply small task. The proposed system will show its versatility due to its development strategy. Due to autonomous property of agent, the underlying working of any component can be easily changed, as per requirements, without affecting the overall system. So there will be consistent way of designing, modeling and simulating each and every approach. One will have to learn only once and then will be able to utilize system in any possible way (Rigolli, M., 2005).

2. Material and Methods

The system under consideration is Simulation-based software that facilitates the user to simulate and compare different traffic approaches available over a "Road and Signal-junction" model. Following functionality will be provided by the system:

- a. User can create Road and Signal-junction Model
- b. User can create different approaches by applying signal agents to models
- c. The user can simulate the approaches
- d. The results of the approaches can be compared and presented in executive report

The model will prove to be a milestone in this unique field of research. Most of the barriers found by researchers will be lifted, and new research dimensions will appear. Government transport agencies can get enterprise decision with it. They can try many approaches and see their results, before implementing practically, so that they can detect many unsighted problems. User will be able to create realistic models consisting of roads, traffic signals and traffic volume with the help of graphs and different property sheets. The signals can be assigned different/custom agents while designing the model.

This assignment of agents at design time will make it possible to design different scenarios having different signals working (such as central server and message exchange). A model with a certain set of signal agents forms an approach.

After the design phase completes, user can pass the approach to simulator. Simulator will be used to get different information (pros and cons) about the approach. As the simulation starts, the traffic will start flow as per traffic volume data entered in design phase, and execute the signals according to the agents assigned to the signals. At the same time different information about the approach starts to calculate. On completion of simulation, user will be presented with executive reports, notifying user about the different facts of the approach. User can simulate different approaches having same model. Simulator will simulate each of them at same time while calculating their information. On completion of simulation, user will be informed with the executive reports, notifying the user about the facts of each approach along with the comparison reports of each approach against all other approaches.

The SimAll traffic system will consist of five components:

- **Model Creator:** This component will be used to create models; those are required by user to simulate through the system.
- **Approach Creator:** This component will facilitate User to create different approaches based on the required model.
- **Simulator:** This component will be heart of the system, and will be responsible to obtain results of approaches over a respective model.
- **Comparator and Report Generator:** This component will compare data collected from different approaches and will present the result to the User in easily readable form.
- **Traffic Agent Base:** This component will be the collection of base classes from which user can inherit and compile to form its requirement specific signal agents.

3. Result and discussion

Following functions are backbone of the system:

- Creation of model (roads, signals and traffic volume and flow) graphically by using pointing devices and inputting device.

- Creating approach, by assigning signals to signal agents.
- Attaching the approach(es) to simulator.
- Starting the simulator.
- Equally simulate all approaches.
- Calculate the information of each simulation.
- After completion of simulation, show report about the different facts of the each approach with respect to model, also show comparison of each approach against all other approaches.

The model designing should be easier and close to real world scenarios, as it will require less time to learn and design. The system should not be restricted to any hardware factor. Large models should be allowed, as large as hardware supports (large models may result slow simulation on low end machines). The simulator should calculate the information as close to reality as possible. The signal agents should be given proper turns to execute their tasks. Simulation will be performed at microscopic level, means the location of traffic cars will be captured and delivered to signals in constant time (may be less than one second) (Elfazziki, A., *et al.*, 2009 Zoysa, K., *et al.*, 2007).

The simulation can be made close to real world scenarios, but cannot be made exactly like real world, due to real world chaos effect, and real world does not show ideal conditions. So the calculated information from the simulator should not be considered exactly same for real world, there can be minor difference. But due to the relativity of simulation with real world, simulated results will be proportional to real world results (also in case of approach comparison results). During the creation of custom signal agents, traffic rules and principles should be paid special attention otherwise serious harm may be experienced in practical implementation (Vaa, T., 2009 and Wooldridge, M., 1996).

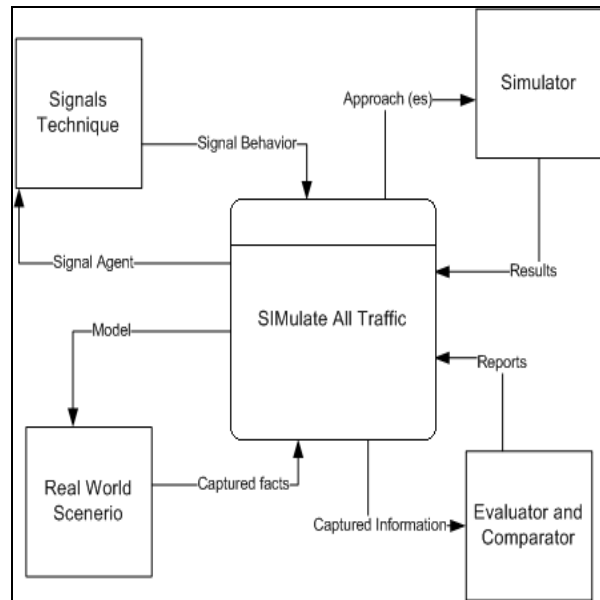


Fig. 1. Major components of the proposed system

3.1 System’s Major Components

The system will be consisting of four major components, stated in (Fig.1). “Real World Scenerio” agent will allow the user to enter the real world facts into the system and create a model of it, later on this model can be used in one or more approach (Shaikh, N.A, *et.al.*,2010). “Signals Technique” gives user an abstract interface allowing users to create their custom signal agents having specific behavior. “Simulator” agent will simulate one or more approaches based on single model and will collect useful information about given approach. “Evaluator and Comparator” agent will evaluate the results extracted from simulator and present them into executive reports to user. These reports will contain user friendly view of information in the form of graphs and charts. If the results generated by simulator belong to more than one approach, this agent will present the user with comparison reports, comparing each approach with all other approaches, so that the decision making, which approach to apply, could be easy and effective (Chen, X., *et.al.*,2007).

3.2 Graphical User Interfaces (Prototype)

A prototype has been designed and tested that has been shown through GUIs.

- a) **Road Junction Creation:** Circle refers to junction, where two or more roads meet; while arrow refers to road.

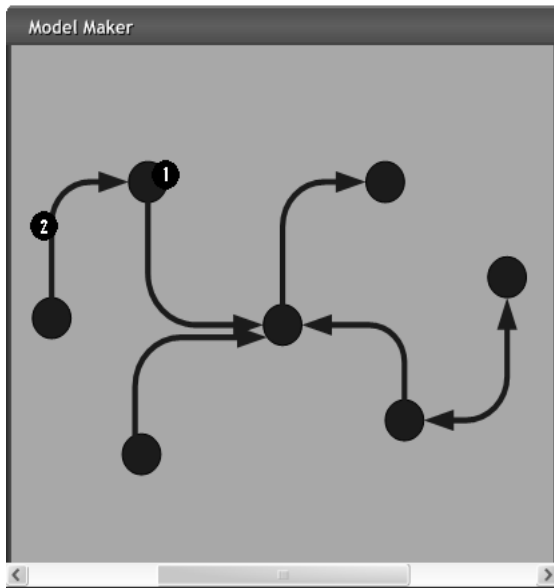


Fig.2. GUI to show Road junction creation.

- b) **Road:** Selected arrows are identified as green arrows. In selected road properties, number of lanes contain by road will be entered and finally OK button will be pressed to apply changes.

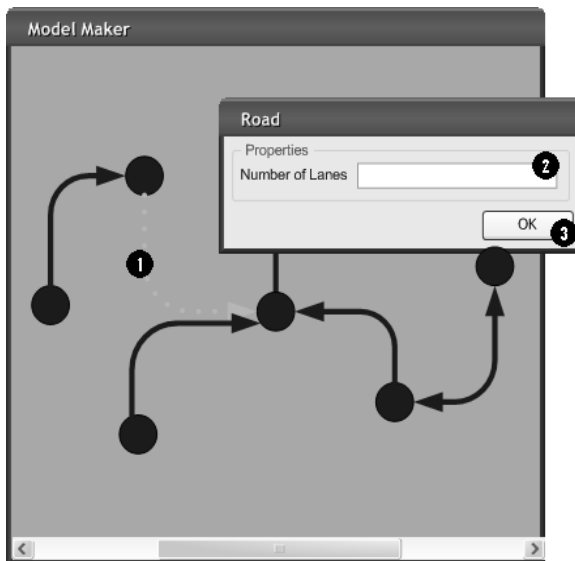


Fig. 3. Creation of lanes on a particular Road.

- c) **Junction:** The dotted square around junctions represents selected junction. The name may be given to the junction and an agent is to be assigned to junction for simulation (This is optional in designing model). Agent can also be assigned later. The road is selected to see its traffic facts. Traffic volume information is collected for selected road. Finally OK button is pressed to apply changes.

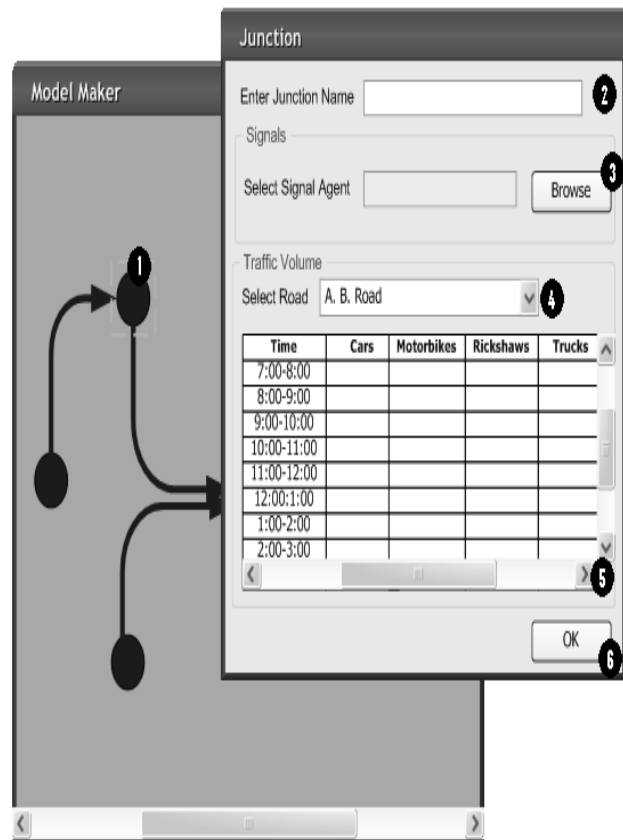


Fig. 4. Creation of junction and agents Assignment.

- d) **Simulation:** Simulator shows the simulation of one of the many loaded approaches. It also shows selected simulation view of one approach and simulation information collected so far for selected approach. It graphically shows the performance of selected approach.

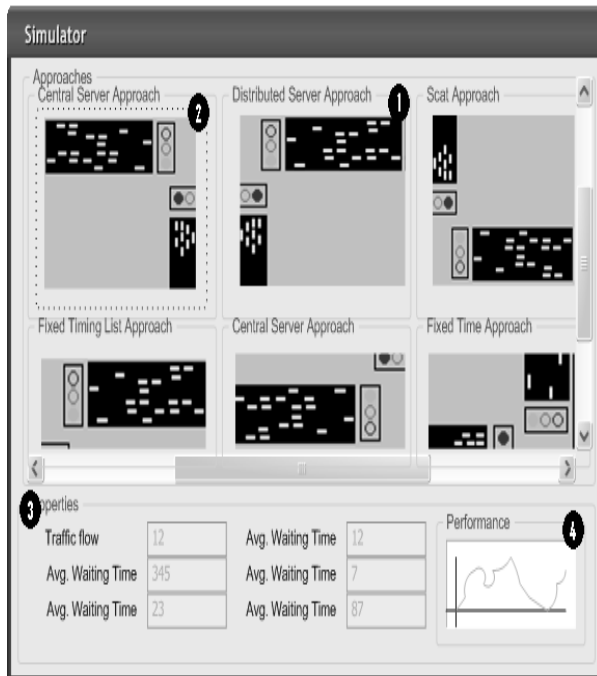


Fig. 5. Simulator’s output in form of graphs.

- e) **Report:** Report model textually and graphically shows performance of different components of an approach. It also generates overall performance of the simulated approach.

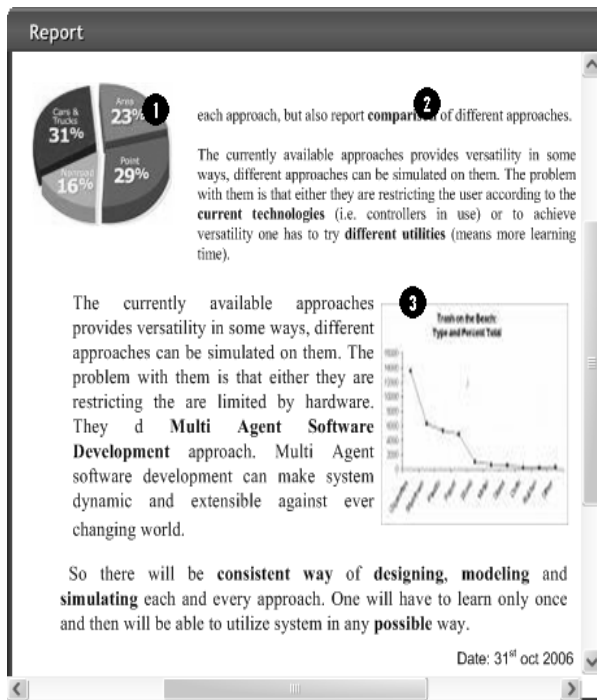


Fig. 6. Report generation to compare performance of various models.

4. Conclusion

SiMALL Traffic – Micro-simulation using Multi-agent systems have been designed through simple genetic algorithm where user will be able to define realistic models consisting of roads, traffic signals and traffic volume with the help of figures and different property sheets. The signals have been assigned agents of different traffic systems to make adaptable and intelligent traffic management approach. The major approaches used in the simulations are: Central server approach, Distributed server approach, Scat approach, Fixed timing list approach and Fixed time approach. The user maps real world scenario to system model and save this system model permanently for future use. The signal agents are integrated with the model to form an approach and later on can permanently store it for later use. At the end of the simulation, user is able to generate the executive reports describing various properties of each approach against all other approaches. The model is cost-effective and can be used to make decisions to opt optimal approach. During comparison of the proposed model with the existing models it has been found that simulation based models exist but with the integration of agents’ intelligence and learning component through genetic algorithm it becomes more efficient than the others. On the other side the models that are developed through software agents and not simulated they become expensive. Hence the proposed model is effective and cost-effective with integration of micro-simulation and software agents. Because of use of intelligent technology like agents there is least chance of the risk and the problems of scalability.

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