SAMU (Simulation of multi-Agents and Urban Modelisation)

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Abstract

Agent-based simulation has been widely used in the context of traffic simulation. In spite of the fundamental role in the system of urban daily mobilities, walking remains a important mode of displacement well-known. But unfortunately, there are very rare works which have been done in this field, so from this point of view, a virtual urban environment or a simulation software, SAMU is created and is populated with autonomous agents like pedestrians and motorists of multi-agents type. Different constraints, affecting the mobility of the whole system are considered. The model belongs to the microscopic category, where pedestrians/vehicles behave in their environment by making a sequence of decisions. The interaction among vehicles and pedestrians is also incorporated which signifies the accident risk of pedestrians. Netlogo which is a multi agent based modeling language is used as the programming platform for SAMU.

Introduction

Pedestrian simulation has only recently received a more important attention in the context of crowd evacuation management, and panic situation analysis like Dirk Helbing , Antonini *et al.* The ability of predicting the movements of pedestrians is valuable in many contexts. Apart from panic situations, capturing the behaviour of pedestrians is of growing importance in architecture, urban planning, land use, marketing and traffic operations. A certain number of work recently tried to explore this field, in particular from the point of view of the complex systems, but rare are those tackling the problem of the dynamics of pedestrian displacements in interaction with the road traffic, which is however the key dimensions of this living urban environment.

The development of Intelligent Transportation Systems has triggered important research activities in the context of behavioral dynamics. Several new models (driving and travel behavior models), new simulators (traffic simulators, driving simulators) and new integrated systems to manage various elements of ITS, have been proposed in the past decade see Mahmassani, Golledge. With regards to pedestrians, the focus of ITS has mainly been on safety issues see, for example, Fuerstenberg *et al*, and modeling pedestrian movements in detail has rarely been considered.

In order to fill this gap, this paper presents some glimpse on how to contribute, through creation of multi-agents simulator supplied with ethopsychologic observations in real situation. Such a virtual laboratory would indeed allow the explorer, on a quasi experimental basis, to find solutions of various problems related to this area. The objective of this study is the development of a computer simulation software SAMU for pedestrian and vehicular movement in architectural and urban space. The characteristic of the model is the ability to visualize the movement of each pedestrian in a plan as an animation. Based on response to various safety and health-related scenarios, the participant makes decisions regarding the effect of the virtual built environment on his safety and comfort. The findings can be reintroduced into field conditions allowing improvements in public health and safety. So architects and designers can easily find and understand the problems in their design projects. SAMU is developed in NetLogo which is a programmable modeling environment for simulating natural and social phenomena. It is particularly well suited for modeling complex systems developing over time. Modelers can give instructions to hundreds or thousands of independent “agents” all operating in parallel.

How SAMU works ?

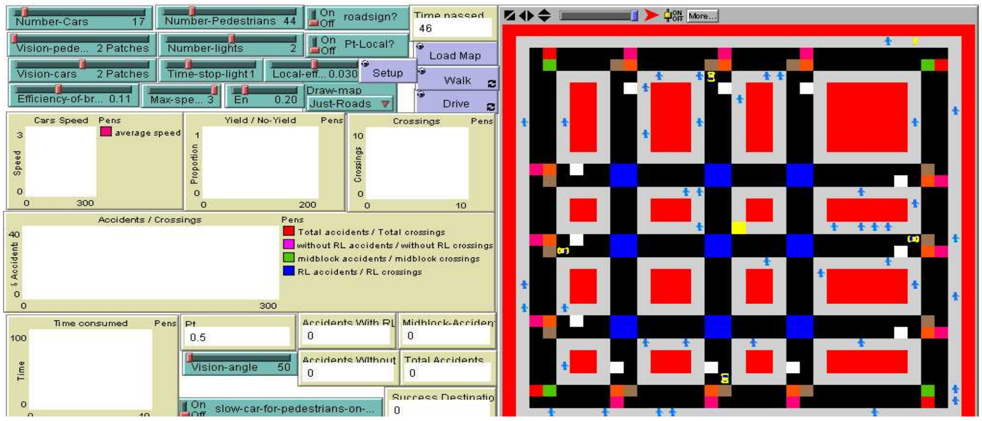
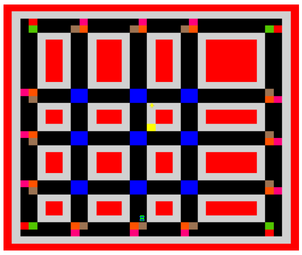


Fig. 1. Initial setup of SAMU before running any simulations.

The above figure shows a typical urban environment with two-way traffic roads, sidewalks, buildings etc. Notice here that it is no more a NxN square lattice as it was in BML/ChSch model where the distance between each crossing was assumed to consist of D cells. The length of each street is equal. Cars furrow the streets randomly (i.e turning movements are made at random), by respecting the direction of circulation, while randomly located pedestrians converge at the same point (destination, which is always fixed) by the shortest way. The cursors make it possible to specify the number of agents (Cars and Pedestrians), crossing is added. Cars can change their speed only in integer values (0,1…Vmax) whereas pedestrians can take random floating values ranging from 0.1 to 0.2 (as each cell length is 7.5 m, so a speed of 0.2 corresponds to a walking speed of 1.5 m/s). The agents evolve/move thus in parallel and adapt their speed according to the local interactions which they share.

There are a lot of buttons, windows and sliders in our model which can be seen in the figure 1. Let us discuss them one by one.

Graphics window. This part of the interface contains the urban network consisting of buildings, sidewalks and roads, occupied by pedestrians and vehicles. One can see the movements of cars/pedestrians during simulations and observe the behavior.



Menu Bar. This is located on the top of the figure. It has many functions like information regarding the model, procedure of the code etc. It also contains some built in functionss like Edit, Zoom, Help etc.

Sliders. It represents the constraints which are given in the model for both pedestrians and vehicles. One can play with these parameters by changing the position of the cursor. Let us explain the physical meaining of each slider. The value shown in the sliders corresponds to the position of the cursor.

1) Number-cars/Number-pedestrians
Using these sliders one can vary the number of agents (cars/pedestrians) in the urban network and observe the results for varying car/pedestrian densities. There is no limitation of the number of agents one wants to consider in the simulation.

2) Vision-pedestrians/Vision-cars
It is directly related to the distance up to which a pedestrian/car can see in the urban network e.g. for a vision of value 2 (15 m.) indicates that the agents can see what is happening in the radius of 2 cells from the agent.

3) Efficiency-of-brakes

It indicates how powerful is the braking capacity of the car. It is same for every car and comes into picture when a car sees a pedestrian and apply the brakes. Obviously if the braking capacity is more than braking distance decreases so as the chance of an accident.

4) Max-speed

One can vary the maximum speed of the car using this slider. It is the maximum desired speed of a driver.

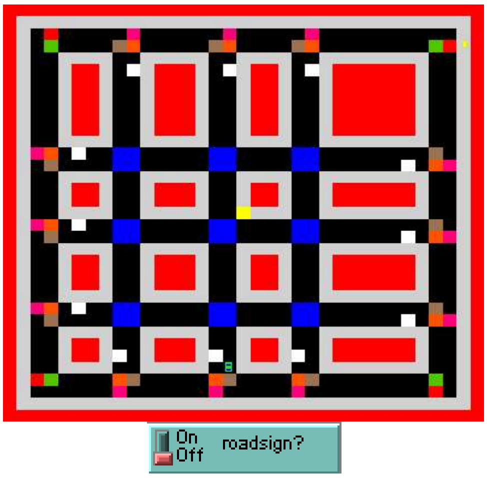
5) En (Noise in the system, ε)

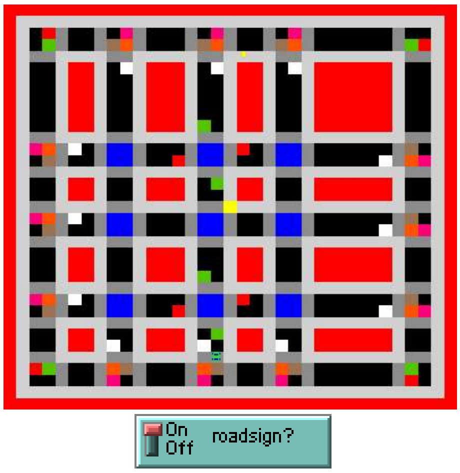
To change the probability of randomness in chosing the option Yield/No-Yield for pedestrians. If En is more, the system becomes less stable, hence fluctuations in *pt* increases and vice-versa.

Switches. There are few swicthes (On/Off) in our interface which are helpful in switching from one mode to the other i.e. to change the configuration of the urban environment (Roadsign?) and changing the bahavior of cars or pedestrians (Slow-don-for-pedestrians-on-sidewalk) or Pt local ?) .

1) Roadsign?

If this swith is "Off" that means we have very simple urban environment without signals and crosswalks. Othewise if it is "On" one can have much more complex urban system, with signalized/unsignaized intersections with marked crosswalks. Also the a*ttraction field* will be functional only when there are marked crosswalks in the system.





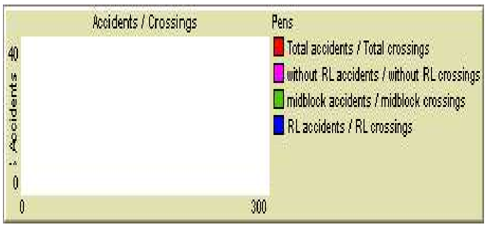
2) Slow-down-for-pedestrians-on-sidewalk?

This switch changes the behavior of cars in terms of pedestrians on sidewalk i.e. if a group of pedestrians is detected on the corner than cars will slow down their speed with an exponential decay function that depends upon the number of pedestrians on the sidewalk.

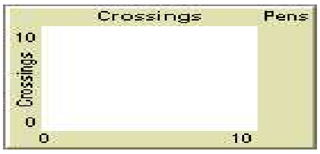
Plots As explained earlier in the last section about the *risk indicators*. We have several plots which are quite enough to observe the behavior of pedestrians/cars and the effect of changing the constraints or switches.

1) Accidents plot

Accident rates are recorded and plotted for 4 different categories; 1) Midblock accident rate, 2) Rate of accidents at signalized crossing, 3) Rate of accidents at unsignalized crossing 4) Total rate of accidents.



2) Crossings plot
Plots the crossings for 4 different categories (same as above mentioned).



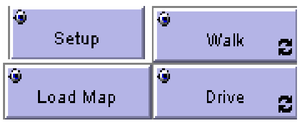
3) Time consumed plot
Plots the time consumed by each pedestrain in the urban network during the simulation for 3 different categories namely 1) Total time spent in the network, 2) Total time spent on the sidewalk, 3) Total time spent on road while crossing.

4) Yield/No-Yield plot
This plots the proportion of *Yielding* pedestrians in the urban environment.

5) Speed at accidents plot
This graph plots the speed of the car at the time of accident. Through this One can estimate the degree of severity of an accident.

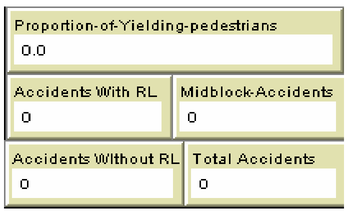
6) Average speed
Plots the average speed of cars.

Buttons.
There are few buttons; for initializing the environment (pedestrians and vehicles) in the urban network, for running the simulation (Walk and Drive).



Chooser.
There is one chooser "Draw-map" on the interface to help the user to check the instantaneous condition of the urban network about the path followed by the cars, pedestrians and the places where accidents are more prominent.

Monitors.
To make SAMU more user friendly we have introduced some monitors. One can easily keep track of values like accidents with signal (RL)/without signal, proportion of yielding pedestrians etc. during the simulations.



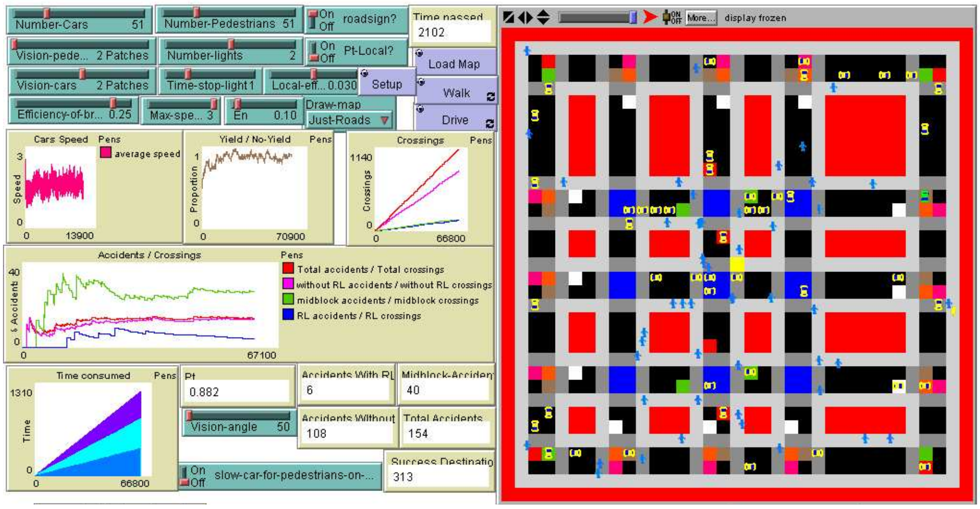


Fig. 2. Picture taken at any time during the simulation. One can easily observe the interactions going on in the environment by simply looking at the graphs and monitors and can also change the value of parameters (sliders) in between the simulation to observe changes for different conditions.

Results

In this section we will be discussing some fundamental results of the simulator. Most of the results are quite interesting to observe in the sense that they give a picture that is generally found in the *urban complex systems,* arising from a lot of interactions among the agents which belong to different categories.

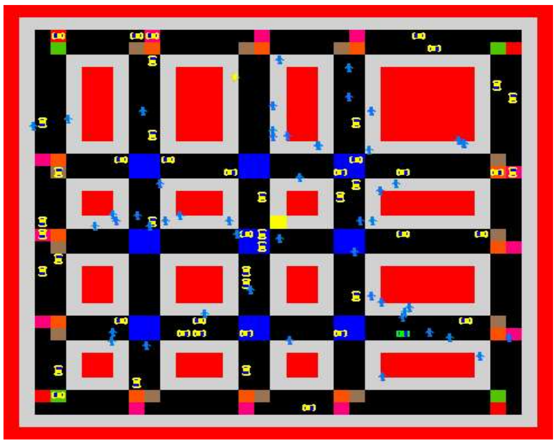
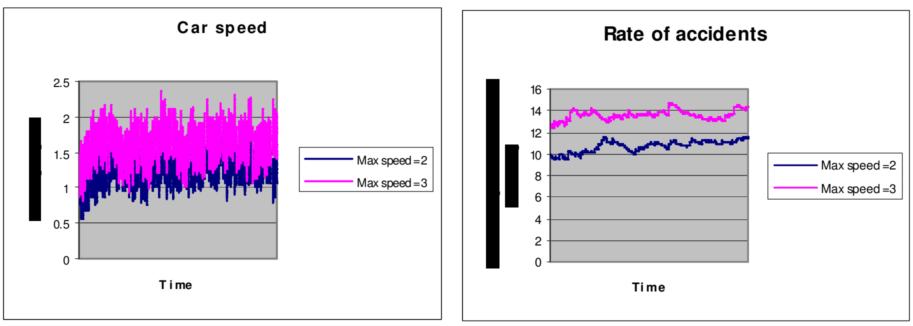


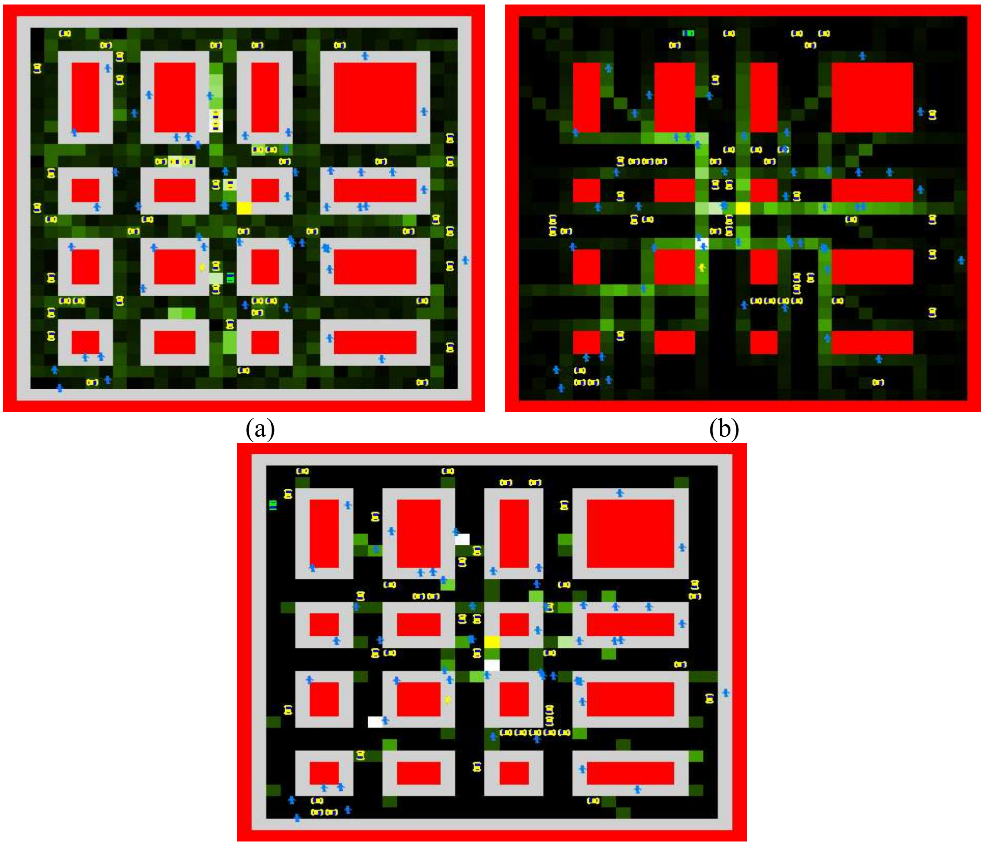
Fig. 3. Pedestrian-vehicle interactions in urban network. Observe the cars, stopping and giving way to pedestrians.



(a) (b)

Fig. 4. (a) Average speed variation with change in maximum speed (b) Rate of accidents for different maximum speed of cars other parameters are same for both cases.

Some maps are also incorporated in the simulator to make it more user friendly and to observe even the minutest details of the interactions which are going on in the urban environment at the time of simulation. A few sample pictures from the simulation are shown below which will make the use of "draw-map" more clear.



(a) (b)

(c)

Fig. 4. Maps at any intermediate time. (a) Automobile traffic recorded by the cells ((b) Pedestrian traffic recorded by the cells (black: weak traffic; white: heavy traffic) (c) number of accidents recorded by the cells (black: low number of accidents; white: high number of accidents)

The dynamically updated graphics make it possible for the user to follow the evolution of certain parameters incorporated such as the distribution of vehicles/pedestrians and the path followed by them or the sites where accidents are more prominent. This can be very helpul in the sense that a user can assess his/her conditions which are given in the urban environment and can modify them accordingly to obatain accurate results which are more realistic.

Conclusions

Pedestrian and vehicular Simulation is a new area of safety and health research employing contemporary technology in a form traditionally used in areas of vehicular transportation, skill acquisition and defense. This paper discusses the design considerations of developing such a simulator, which provides scope for multi-modal research in the fields of safety, health and transportation. The point that we would like to convey in this paper, however, is that—at least methodologically, the techniques discussed here represent a move towards more theoretically sound, behaviorally realistic, and ultimately more *useful* simulation environments. Certainly, these simulations can be developed as proof-of-concept tools and the methodologies can be refined in academic contexts in preparation for a day in which these tools can be used to plan and manage better cities. In the meantime, even as abstract tools, these simulations can do a lot for our understanding of how cities work and perhaps provide new insights into how we might construct a more sustainable urban future.

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