Optimizing Urban Modeling based on Road Network and Land Use/Cover Changes by Using Agent Base – Cellular Automata Model

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Abstract:

Simulation urban road network is important because it can study models too complicated for analytical or numerical treatment, can be used for experimental studies, can study detailed relations that might be lost in analytical or numerical treatment and can produce attractive visual demonstrations of present and future scenarios. Cellular automata (CA) play an important role in urban modeling and simulation of computationally many aspects of urban development such as traffic and land use/cover models. Recently different CA models have gained considerable importance as a mean of optimizing urban different traffic network strategies. Discrete event and continuous-time simulation of the available CA models in traffic systems is a difficult task due to their discrete and continuous nature. This article introduces a new method for simulation of traffic network, which combines CA and Agent. The Multi-Agent System (MAS) and the Cellular Automata (CA) modeling are two methods for the traffic micro – simulation. Computational time of traffic simulation for the proposed model is considerably lower than the time of simulation based on CA. Thus, the simulation results can be obtained in a much shorter time. The proposed simulation algorithm is suitable for real-time applicant and Erbil's traffic system.

Keywords: Cellular Automata, Agent - Base, Traffic Simulation, Real-Time Computing, Traffic Optimizing.

1. Introduction:

Modern urbanism is considered as complicated system that is results of urban expansion in different period of time (Batty, 2005). Urban Land Use/ Cover Changes (LULCC), changes of urban movement model, changes of vehicles types, Changes of people movement, oversaturated highways and congested main roads in major cities reflect the facts that the existing roads networks are not able to support the demand for mobility which will increase with urban expansion, therefore, the existing road network has to be used more efficiently using Intelligent Agent Base Transportation System (IABTS).

These systems work only successfully if the road user is convinced to change his behavior. Basically, there are six different possibilities: the driver can abandon his trip or choose another means of transportation (Spatial - Temporal Transportation Model or STTM), an alternative route (Spatial) or another departure time (Temporal) based on Local Time Moment Model (LTMM).

Behaviors like a shorter travel time or a shorter travel path, to have a more comfortable trip, changes in Spatial – Temporal data/ information about timetables and delays which makes public transportation more attractive, is current useful user's politics to cities modern transportation network. This approach is easier than recommending another departure time because in such a short-term traffic time (STTM) traffic forecast or rather anticipatory route guidance is necessary. The transportation network is characterized by a high degree of uncertainty and dynamicity especially when considered in complex cities. Therefore, the use of simulation can result into improvements to the design and analysis of several management solutions for the optimization of the urban network through using Intelligent Transportation Network (ITN) that allowing these algorithms to be implemented and polished before being deployed.

In this paper, we present an urban traffic network base on ABM – CA model that combine all these requirements, providing current methods of urban simulation and practitioners with a tool that can instantiate an Artificial / Intelligent Transportation Network (AITN) of drivers and Intelligent Traffic Light management solutions, immersed in a realistic traffic environment.

2. Erbil City and Simulation

Erbil City is located in the north of Iraq. Erbil Province borders Turkey to the north and Iran to the east. Erbil composes with both Dahuk and Sulaymaniyah, the area run by the Kurdistan Regional Government (KRG). The City of Erbil is the capital of both Erbil Province and the KRG (OCHA and UNAMI, 2009).

The urban structure of Erbil ,the city is developing in a radio-centric manner around the ancient castle like shells around the historic core, with a sometimes organic morphology as result of spontaneous development. This radio-centric structure of Erbil is reinforced and completed by the planned ring roads and the highway belt in the northern development areas (OCHA and UNAMI, 2009).

The construction site is situated in the north of the ancient city between the ring road under construction and the northern highway belt, eastern of Ainkawa. Because of the neighborhood of the airport and the excellent accessibility by traffic this site is predestined for a high urban density and utilization. The presence of landscape is beside the requirement for density another condition which should be respected (Khajavi eal, 2014).

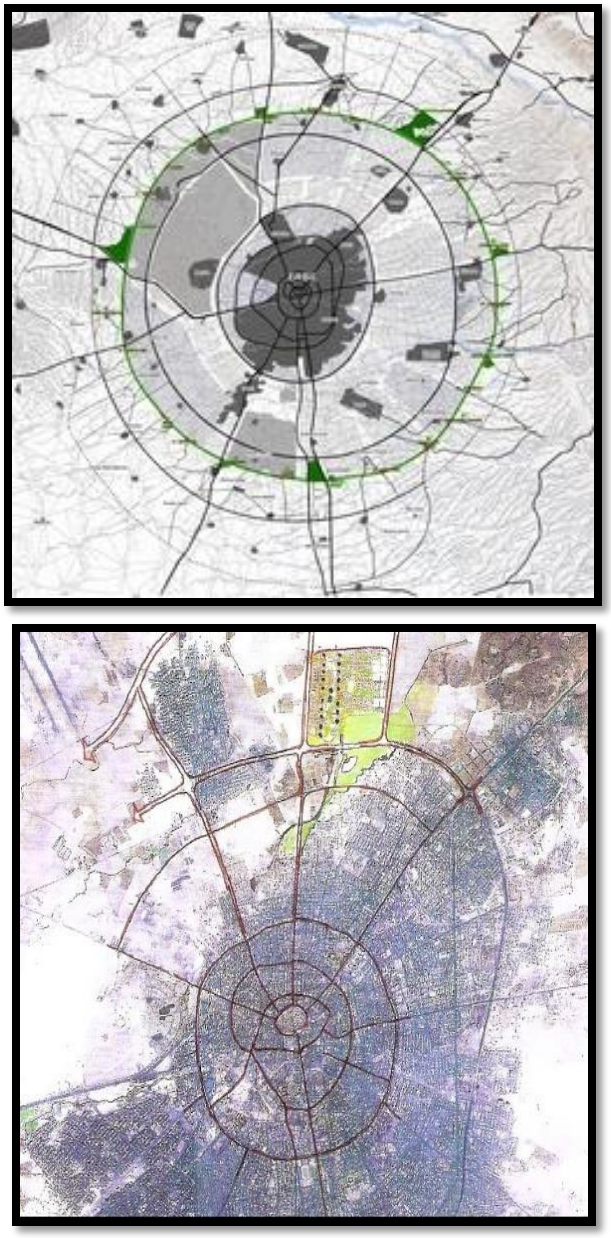

Figure 1: Schematics of Erbil’s Road Network

Erbil city's development varied very much in two periods, from the start of 1980s to the start of 1990s and especially from the start of 2000s to the end of 2012s (social - economical parameters are very important), in spatial pattern and temporal aspect, to present the two different periods of development, the CA - ABM model will be useful rather than CA model because, agents have strong effected on Erbil's urban model (Khajavi et al, 2014)

CA model couldn't completely simulate the rules of agent, because after 2000s Erbil has shown rapid expansion based on agents. A few policy scenarios for baseline development, rapid development and green land protection under the influences of the behaviors and decision modes of regional authority agents, real estate developer agents,

resident agents and future agents and their interactions must be apply to predict the future development patterns of the Erbil metropolitan region (Khajavi et al, 2014).

3. Data and Processing

The list of available data include: Urban Land Cover for 1990, 2000 and 2010, Land Cover Map (LCM) classification for 1990, 2000 and 2010, Classified Road Network for 1990, 2000 and 2010, DEM Data, Urban Traffic Network, Business center, Population database based on urban different region/s or zone/s, Urban network file/s, Land use/ cover maps, Distribution/ Location of fuel stations And others layers that connected to urban network and style (Erbil's Municipality GIS Center, 2014).

4. Materials and Methods:

Cities modeling are a very complicated simulation and are controled by many active / interacti environmental factors. Urban road network modeling based on land use/cover algorithms proved to be an effective approach to analyzing and designing optimized traffic solutions in urban complex system (Wainer et al, 2007).

One major contribution in this research is to introduce the promising complex network science to advance spatial – Temporal network modeling within the field of Geosciences.

Firstly, seven main types of agents including: historian agents, residential agents, future developer agents, religion agent, government agent, socio- economical agents, and geographical agents interact with each other and have a direct influence with the environment. This work uses a spatial-temporal criterion to allocate agents to get a better result. Compared with actual urban growth based on different satellite data, the simulated results show that the multi-agent model is effective in simulating urban growth phenomenon in Erbil with a total accuracy of 95% for three classes: developed, semi - developed and undeveloped areas.

Secondly, land use/cover data have raster format and are based on satellite data but in other side road network data have vector formats that are achieved on surveying process. We need to establish best simulation model due to a dynamic model was built to study long-term urban growth through modeling raster land-use change and vector road network expansion

5. Conclusion:

Today, Erbil's road network users are now a central figure in the new vision of urban systems, and most simulators follow a macro/microscopic approach as an attempt to improve the representation of traffic flow and management rather the traveler behavior. This paper focuses on modeling urban growth phenomena based on land-use/cover simulation, urban street networks modeling and analysis between land use/cover changes based on and road network. Therefore we present a powerful framework based on multi-agent systems that representing different aspects of the traffic domain such as the agents model that embedded in intelligent system to designing complex transportation network

A circle growing weighted network model was proposed with neighboring connections. Both mathematical analysis and numerical simulation are studied rigorously. A nonlinear degree-strength relationship implies that the accelerating growth of new weights deserves more attention in the urban road patterns between 1990 to 2010 have more relationship between social – economical and road network patterns. Erbil city's

development varied very much in two periods, from the start of 1980s to the start of 1990s and especially from the start of 2000s to the end of 2012s (social - economical parameters are very important), in spatial pattern and temporal aspect, to present the two different periods of development, the CA - ABM model will be useful rather than CA model because, agents have strong effected on Erbil's urban model.

In the result, Transportation network in Erbil has circle form. CA model couldn't completely simulate the rules of transportation network, because; as we said before after 2000s Erbil has shown rapid expansion based on multi different agents. A few policy scenarios for baseline development, rapid development and green land protection under the influences of the behaviors and decision modes of regional authority agents, real estate developer agents, resident agents and future agents and their interactions must be apply to predict the future development patterns of the Erbil metropolitan region.

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