A SIMULATION IMAGE OF URBAN HEAT ON SOLAR ABSORPTION COFFICIENT BY AUTOCAD AND GAUSS MATRIX BLUR METHOD

MR. NGUYEN QUANG HUY
Faculty of Architecture, College of Science, Hue University, Vietnam
quanghuykt99@yahoo.com

Abstract. Many professional software simulated urban heat. However, the simply software for student or beginner of urban planning is very rarely in practice. From viewpoint of an architectural student, this paper is an attempt to a simple method to simulation image of urban heat on solar absorption coefficient by AutoCAD and Gauss matrix blur method, which is simple and suitable with architectural student and beginner of urban planning design.

Keywords. Solar radiation, absorption coefficient of material surface, CAD layer, Gauss blur method

1. Introduction

1.1. BACKGROUND

Solar radiation in Tropical City is always problem of ventilation in summer. Therefore, the control microclimate with urban design is necessary for designer. In urban design, urban heat simulation for scheme planning design is necessary for designer and environmental evaluator. One of factor increase urban heat is the absorption of material surface in urban.

1.2. PROBLEM

1.2.1. The requiring simulation of urban heat for AutoCAD

Nowadays, not much software could simulation urban heat. Beside the difference of interface or compatibility between design-software and simulation-software limited the approach of designer to urban heat simulation. Therefore, the evaluation on urban heat of solar absorption was ignored.

In particular, AutoCAD is popular software of design for architects in urban design. Therefore, the requiring simulation of urban heat for AutoCAD is necessary for beginner urban designer and architectural student.

1.2.2. The simple simulation map of urban for evaluator

In fact, a map of urban heat could be captured from satellite. Beside, it is complexity for evaluator because the IR- image sometime did not have linear of heat level, which make evaluator find different heat- zone easily. Moreover, if urban planning is still on scheme, then map satellite could not work for requirement.

Thus, the simple map of urban heat is necessary for evaluator. Then they can get idea of urban form easily, which relate to future form for Sustainable Cities.

1.3. TOPIC OBJECTIVE:

According to research problem, this paper aim to answer the research question is follow:

1.3.1. Could AutoCAD simulate urban heat of mass surface absorption from solar? How can it do?
The answering this question find a simple method to simulate urban heat of mass surface absorption from solar. Hence, architects and architectural student easy to simulate urban heat of their urban planning scheme.

1.3.2. How can we find the line near of urban heat?
The answering this question aims to the simple simulation map of urban heat. Hence, researchers or the evaluator easily sees the difference surface heat of city, which is basic data to predict local wind, ventilation, probability of thunder in city...etc. Then, planner could adjust scheme planning so that they are suitable with purpose of planning designer.

1.4. SIGNIFICANCE

Every beginner of urban design could simulate urban heat easily with popular software. Therefore, they will have more planning schemes when evaluate on environment aspect, which related sustainable development of urban design.

2. Literature Review

2.1 REVIEW METHOD OF URBAN ENERGY SIMULATION

Man-made environments can create microclimates of their own, deviating from the macroclimate of the region to a degree depending on the extent of man's intervention. Such intervention with natural environment is greatest in large towns or cities (Koenigsberger et al). Some factors causing deviations of urban climate from the regional macroclimatic are *The changed surface qualities* (increased or decreased absorbance of solar radiation); *Buildings* (Casting a shadow …etc); *Energy seepage* (heat out put of internal combustion engines and electrical appliances) and so on.

According with above factors, each research developed simulation on each factor to urban climate:

Focus on quantification of urban solar access, computer simulation offers afar more effective, reliable and consistent approach to predict and investigate total annual irradiation than physical measurements in either real or scale model settings. A computer-based method to predict total annual irradiation in arbitrarily complex urban settings has recently been developed by the author (Mardaljevic and Rylatt, 2003). The design goals for the new approach are as follows:

- To accurately predict the total annual incident irradiation/ illumination on surfaces (e.g. ground, building) base on hourly meteorological data
- To provide facility to compute and temporal or source component of realistic sky pattern as well as radiation from the sun
- To account for shading of and inter-reflections between buildings
- To extract geometrical information from the images allowing for quantitative assessment of the surface area associated with each pixel

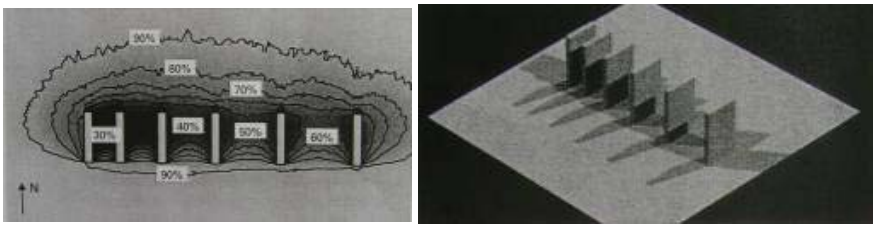

Figure 1: A simulating ground level solar access around variously spaced tower block, Mardaljevic, J (2003)

The new approach is called Irradiation Mapping for Complex Urban Environments or ICUE. The ICUE approach is currently implemented in software on a UNIX workstation as an 'expert-user' tool for proof-of-concept, demonstration and research. The theoretical basic for ICUE is derived from the work carried out by the author on lighting simulation. The data requirements for the ICUE simulation are a three dimensional (3D). Therefore, users have to be 'expert-user'

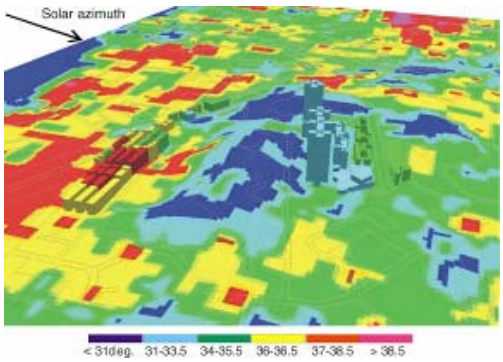

Figure 2: Simulation urban heat from satellite IR-map and 3D Virtual Reality models. Nichol, J (2004)

In other hand, Nichol, J (2004) demonstrates the ability of current satellite-based sensing systems to depict parameters of urban environmental quality over large areas at detailed level, using 3D Virtual Reality models. A method is described for increasing the spatial detail and spectral accuracy of Landsat ETM+ thermal data, by fusion with an IKONOS image representing vegetation. Additionally, by depicting the complete radiating surface involved in energy exchange between the surface and atmosphere, including vertical walls, as well as the horizontal surfaces 'seen' by the satellite, a more accurate representation of the urban thermal environment is obtained. The models permit 3D visualization and fly-through animation to represent urban environmental quality, based on quantifiable image parameters, and assist the understanding of the complex and dynamic factors controlling urban environmental quality.

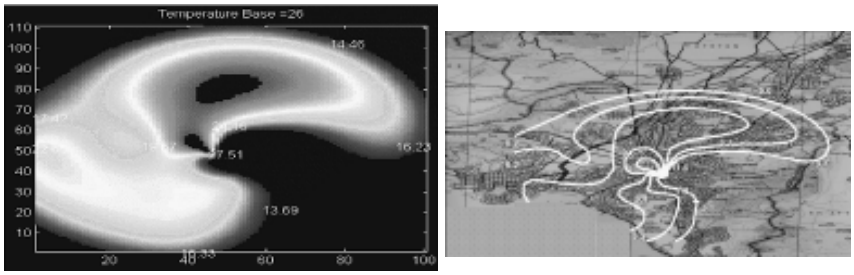

Figure 3: Simulation urban heat from energy consumption of building in Athens, 1996, Santamousris, M et al, (2001)

Focus on heat out put of internal electrical appliances, in their work of Santamousris, M et al, (2001), the results of an urban study carried out in Athens aiming, to investigate the impact of the urban climate on the energy consumption of urban buildings. An extended network of measuring stations has been installed and climatic data collected for a 3-year period. Specific airflow and temperature distribution experiments have been also carried out in 10 urban canyons. The data have been used to evaluate the impact of increased ambient temperatures on the heating and cooling performance of buildings. Also, air flow and temperature distribution data in urban canyons have been used to evaluate the impact of canyon geometry and characteristics on the potential of natural ventilation techniques to provide passive cooling to urban buildings.

Toshiaki,I et al,(1999) quantifies the contribution through energy consumption, to the heat island phenomena and discussed how reductions in energy consumption could mitigate impacts on the urban thermal environment. Very detailed maps of anthropogenic heat in Tokyo were drawn with data from energy statistics and a very detailed digital geographic land use data set including the number of stories of building at each grid point. Animated computer graphics of the annual and diurnal variability in Tokyo's anthropogenic heat were also prepared with the same data sources. These outputs characterize scenarios of anthropogenic heat emission and can be applied to a numerical simulation model of the local climate.

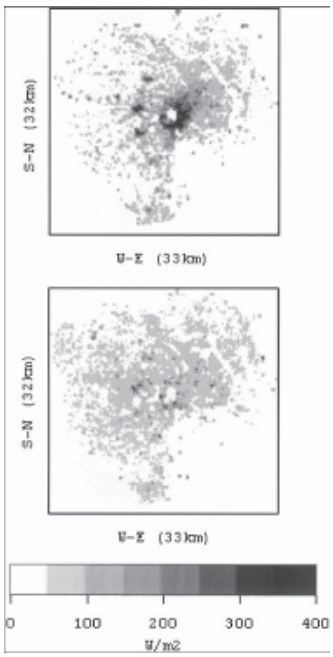

Figure 4*: simulation of anthropogenic heat in Tokyo, Toshiaki,I et al,(1999)*

In summary, researchers had the similar in simulation:

- Input the parameter of energy factor to simulation (such as: solar irradiation, electrical consumption…) with the same unit of energy coefficient. (kWh, or W/ m^2…)
- Using level color to depict level of urban heat, which is depicted on raster image.

According to research problem, almost urban designer or architectural student manage data on object surface of urban, such as road, vegetable, water face, roof building...etc. In particular, Surface of material could be used as parameter of factors to simulation. Therefore, what is typical coefficient of material surface?

2.2 SURFACE ABORPTION COEFFICIENT OF MATERIAL

When solar radiation strikes a surface, apportion of the energy is absorbed and the rest is reflected. Absorptance of a material depends on the color, finish, and type of material. (Brown, Z ,2001). Thus, the heats get from absorption of material relate to earth's energy budget, which is the basic of urban heat and urban climate.

In particular, coefficient absorption of material relate coefficient reflection of material.(A + R=1) example Table1.

TABLE 1: Coefficient absorption and reflectance of material

Color /material	Absorptance(A)	Reflectance (R)
Optical flat black paint	0.98	0.02
Wet Sand	0.80	0.10
Concrete	0.54-0.65	0.46-0.35

In short, the simulation of urban heat from solar by coefficient absorption of material is contribution for urban climate evaluation, which is also necessary for urban designer in designing.

2.3 RELATIONSHIP BETWEEN CAD AND GIS

GIS (Geographical information system) represent a technology designed to achieve particular objective, which include spatial information system, surveying, environmental science, regional science, planning and geography. Experience suggests that there can be no doubt that the application of GIS is making significant contribute in facilitating the availability, integration and presentation of information.

In classification of Henk, J and John, C (1990), CAD is one in three main groups of spatial information system, which fall under GIS umbrella. Thus, CAD systems are graphics, which are used by industrial designer, architects and landscape to support and display their work. Graphics software development has been under incorporate CAD features. GIS is totally involved with the concept of the database whereas CAD is more concerned with the design process.

Vector, Raster, and Quadtree are three forms of data storage of GIS. Normally, Satellite provides raster information. In a satellite photograph, a single value is attached to each cell. In this way, factual data can be collected in very efficient way.

AutoCAD is software in term CAD. Data of AutoCAD are stored similar GIS. GIS also divide the world into layers and store attributes and graphics in separate (new GIS allow users to define their view of data).

Nowadays, new versions of AutoCAD export their data from vector to Raster easily. This support of AutoCAD is potential for simulation site, which still on planning scheme. In particular, each layer of material in urban surface is correlation to coefficient absorption of material. Therefore, AutoCAD could depict the map of heat absorption of urban surface.

2.4 REVIEW LINEAR METHOD WITH SUPPORT GAUSS BLUR METHOD

The linear of urban heat is related to island heat, which is also idea for urban designer. Thus, review relevant method of linear will be support for simulation of urban heat.

Application of Gauss blur to make simple image was suggested by Jianqing, Z (2003). In this research, author applied Gauss blur to simple satellite image, which aim to find out urban residential area and countryside residential area (figure 5).

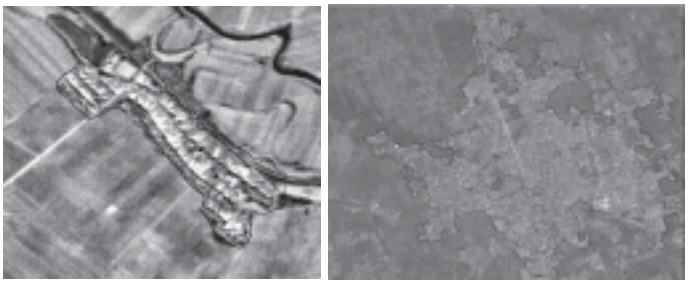

Figure 5: linear border of residential area with a support of Gauss blur method. Jianqing, Z (2003).

Beside, Gaussian elimination is a equation method in numerical method of energy simulation (Clarke, J,A 2001). Thus, we can apply Gauss blur to make simple urban heat map, which support for the simulating solar absorption of urban surface material by AutoCAD.

3. Proposing Method

According to research question and applied from preview research. This research follows two steps:

Step 1: to simulating urban heat on absorption coefficient of material surface from solar radiation by AutoCAD software.

- Using a AutoCAD included a urban planning map

- Sort absorption coefficient of material in a decrease. The colors of material surfaces, which depicted in color of AutoCAD layer, are also sorted from red to green (according with the highest and lowest of absorption coefficient).

- Export vector image of urban planning map to raster image

Step 2: Make raster image to simple image, which could be seen the linear of high absorption area and low absorption area. Gauss blur was applied in map by Photoshop software.

4. Result experiment:

According to proposing method, below image are results of experiment, (figure 6).

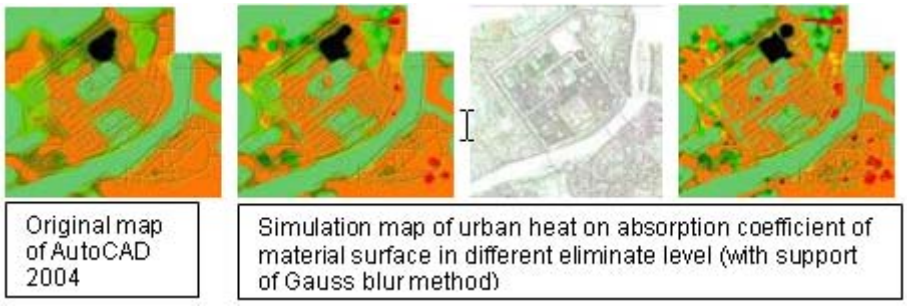

Figure 6: Result of experiment

5. Summary

Follow the answer research questions, the urban heat on absorption coefficient of material surface from solar radiation can be simulated by AutoCAD software. Beside, the support Gauss blur method can make the simulation map more simple and the linear or boundary between high absorption areas and low absorption area. This simulation method is easy to use for architectural student and beginner of urban planning designer. In future research, if the thermal capacity of material is included in this simulation then the simulation is more effective and useful.

Acknowledgement

This simulation was experimented in simple condition and individual of student. Therefore, others factor of simulation, which are also effect to urban heat, was overlooked.

References

Brown, Z . and Mark, D. :2001. *Sun, Wind, and Light: Architectural design strategies*,Jonh Wiley & Sons,Inc. pp:218-221

Clarke, J,A :2001. *Energy Simulation in Building Design*. Butterworth-Heinemann. London, pp: 57-59

Jianqing, Z. Jungjin, S.U. Quingwu, H.U. :2003. *Semi-automatic Extraction Technique of Residential Area in High Resolution Remote Sensing Image*, School of Remote Sensing and Information Engineering, Wuhan University, P.R. China

Koenigsberger, O.H. Ingersoll, T.G Mayhew, A. Szokolay, S.V. : 1973. Manual of Tropical Housing and Building. Part one Climatic Design. Longman London and New York, pp: 34-37

Mardaljevic, J. and Rylatt, M. :2003. Irradiation Mapping of Complex Urban Environment: An Image-Based Approach. *Energy and buildings* 35(2003): 27-35

Nichol, J. and Wong , M.S. :*Modeling Urban Environmental Quality in a Tropical City.* Landscape and Urban Planning 73 (2005) 49–58

Santamousris, M. Papanikolous, N. Livada, I. Koronakis, I.Georgakis, C. Arigious, A. :2001 On the impact of urban climate on the energy consumption of buildings *Solar Energy* Vol. 70, No. 3, pp. 201–216

Toshiaki, I. Kazuhiro, S. Keisuke, H. :1999, *Impact of anthropogenic heat on urban climate in Tokyo*. Atmospheric Environment 33 (1999) 3897}3909