

Exploring Potentials of GIS Application in Urban Planning and Design from Interdiscipline Viewpoint

TSOU Jin-yeu

Department of Architecture

The Chinese University of Hong Kong, Shatin, NT, Hong Kong SAR, China
jinyeutsou@cuhk.edu.hk

XUE Yucai

Department of Architecture

The Chinese University of Hong Kong, Shatin, NT, Hong Kong SAR, China
xueyucai@cuhk.edu.hk

Abstract: GIS can supply large quantity of useful information about spacial relationship, consequently there exists great potential of GIS supporting for decision making strategies related to urban design and environmental planning. In different discipline areas there exist different information representation methods and considerations having direct or indirect relationship with spacial information, how to use GIS as a tool for facilitating the work in other discipline field, there are two basic questions crucial to the success of these interdiscipline applications. The first one is interoperability among GIS and other applications, the second is the paradigm difference between GIS and other domain field regarding problem solving.

In this paper, we investigate the spatial information of the urban environment provided in the analyses of the urban visual sustainability, urban daylighting environment and urban wind environment. We also discuss the challenges and opportunities for cross-disciplinary GIS application regarding the aspect of Information Collection, Information Generation, Information Analysis and Information Visualization.

Keywords: Urban planning, GIS application, interdiscipline, architecture design

1. Introduction

With the development of spacial information technology, including remote sensing (RS), geographic information system (GIS) and global position system (GPS), many researchers utilize these technologies to monitor, investigate and plan urban natural landscape. Since GIS can supply large quantity useful information about spacial relationship, various types of spacial analysis can be conducted in GIS. Consequently, by integrating the spacial information with the sophisticated data base engine GIS has the advantage in supporting for decision making strategies relating with geographic space.

In different discipline areas there exist different information representation methods and considerations having direct or indirect relationship with spacial information, how to use GIS as a tool for facilitating the work in other discipline field, there are two basic questions crucial to the success of these interdiscipline applications. The first one is interoperability among GIS and other applications, the second the paradigm difference between GIS and other domain field regarding problem solving.

Based on the experience of our team research work about GIS applications in urban planning and architecture design, in this paper, we investigate the spatial information of the urban environment provided in the analyses of the urban visual sustainability, urban daylighting environment and urban wind environment. We also discuss the challenges and opportunities for cross-disciplinary GIS application regarding the aspect of information collection, information generation, information analysis and information visualization.

2. GIS and Urban Visual Sustainability

With rapid urbanization in china, natural visual landscape is under deterioration due to improper construction and planning. One of the main reasons is feebleness in planning supporting methodology and technology in respect for visual landscape. Visual landscape evaluation acts as a significant component in such supporting information. For maintaining a coherence urban natural environment, GIS provides the needed mechanism to correlate the information it is the only approach to access visual value distribution in large-scale region [3]. Especially in high-density urban area like Hong Kong, maintaining urban visual sustainability of natural landscape is important for relieving the sense of over-congestion, and then improve habitants' living quality. Open spaces in Hong Kong public housing estates not only supplies a very common way for local habitants to access outside natural environment, it also can help to solve the problem of urban natural ventilation and energy conservation. At the same time open spaces also contribute important social functions in the hyper dense habitation environment.

Our research group analyze the visual ratio of every locations of the selected plaza within different visual distance.

Through statistic data, spatial opening quality distribution for different visual distances classification in foreground, midground and background are mapped. Through scientific visualization, these data are presented in 3D to offer reliable decision making supporting. We examine the relationship between the behavior pattern and urban visual sensibility distribution of natural landscape through overlay the analyses result and comparison[4] (Fig. 1, 2, 3).



Fig. 1. behavior map

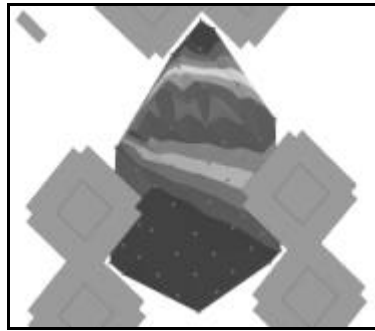


Fig. 2. visual ratio map in background (visual distance 500-1000m)

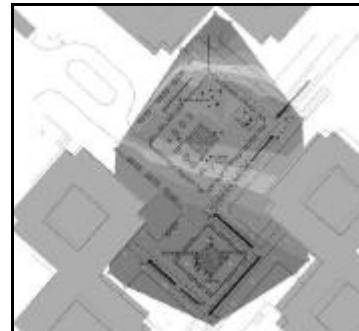


Fig. 3. composite image

Comparison with urban daylighting analysis and urban wind analysis, currently GIS seemingly have stronger and more natural ties with urban visual sustainability evaluation to support urban planning and design. The viewshed functions embedded in GIS has provided useful means to support the direct analysis regarding urban natural landscape assessment. And visibility analysis is common in traditional GIS analyses, GIS plays a key role in urban visual sustainability analysis. However for other psychological and physical issues related with human visual sensibility, the corresponding factors still need to be tested and verified for the methodology improvement.

3. GIS and Urban Daylighting Analysis

For architecture design, efficient daylighting is important for environmental temperature control and energy conservation, it is an essential component of human's living quality and comfort with directly affecting human's physical and psychological feelings. Our research group evaluate buildings' daylighting situation through measuring its profile's daylighting accumulating amount in one year. Through computer visualization and scientific analysis, it can offer scientific advices for daylighting design and future improvement.

By investigating daylighting analysis methodology and process(Fig. 4,5,6),It will be easily found that this method concentrated on study points' surrounding true 3D environment. Daylighting analysis focused on study points nearby 3D environment in small scale. For this reason maybe it will more closer to human physical feeling and more easily be accepted by human than other methods. For current geographic information system, their data structure and 3D presentations are mostly based on 2.5D information. For this reason it construct the obstruction for cross-disciplinary information integration and applications. Relying on GIS development or finding another way without directly touching these limitations we hope to achieve the goals. Since GIS analysis is also describing local environment openness from different viewpoint in large scale, there should be great potential for this kind of analysis information integrating with GIS.

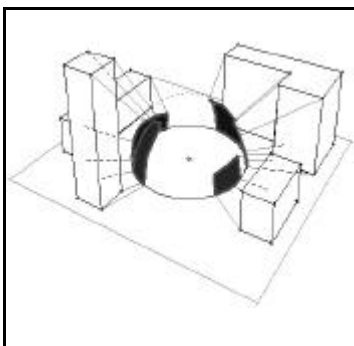


Fig. 4. sun window of one point (From : <http://www.squ1.com>)

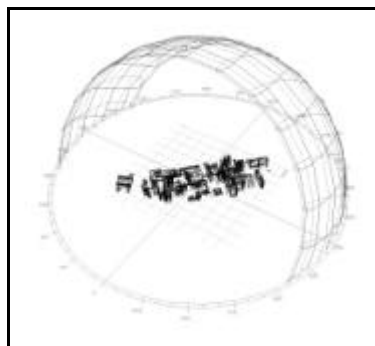


Fig. 5. 3D daylighting orbit map and urban environment

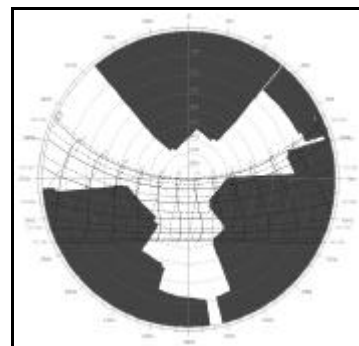


Fig. 6. daylighting amount map in one year through overlay sun window with daylighting orbit map

4. GIS and Urban Wind Analysis

Urban wind environment directly affects human's physical comfort in regional habitation. With the outburst of SARS, local wind environment rises more and more concern in building design and urban planning. It is one fundamental consideration in "Green Architecture" design and energy conservation. For urban wind analysis computational fluid dynamics (CFD) technology is usually applied to investigate the airflow pattern and potentials of passive cooling design.

For scientific calculation and computer simulation traditionally CFD method consumes huge amount of calculation resource, such as supercomputer, etc. It limited CFD application in large scale and also forms the block for urban wind element being from taken into account in architecture design. Does there exist one way to facilitate CFD technology efficiently applying in building design and urban planning, GIS takes advantage of its spacial analysis (Fig. 6) and should give a hand in this issue for the inherent relationship between urban wind environment and urban space openness. While for different discipline methodology differs from each other, the natural ventilation formula and regulation used for must be constructed based on CFD technology before GIS can help. It is crucial to the success of this kind of cross-disciplinary GIS application and information integration.

5. Conclusion and Future Discussion

For urban planning and design, providing a comprehensive evaluation method and system is important to plan urban space as a whole in order to maintaining urban sustainable development. Cross-disciplinary GIS application and information integration is the basic way towards this destination. During this process investigating other discipline methodology definitely can broaden GIS application in scale and depth. There still exist a lot of challenges and difficulties including data loss during the information exchange, common interface between different discipline, missing and data detail level of abstraction for cross-disciplinary applications, etc. How to takes the physical and psychological issues in other discipline area into GIS also can't be neglected during this cross-disciplinary applying process.

References

- [1] Niu Xinyi, 2002. GIS application in urban design, *Journal of urban planning*, 4: 41-45
- [2] Peng Zaide, Ning Yuemin, 1998. Shanghai urban sustainable development and spatial structure optimization, *Journal of urban planning*, 2: 17-21
- [3] Jie HE, Jin Yeu TSOU and Selina LAM. "Potential of Using a GIS-based Natural Visual Landscape Evaluation Tool in Large-scale Urban Planning: A Comparative Study in Dongshan New Town", Proceeding of the 20th Education for Computer Aided Architectural Design in Europe (eCAADe). Poland: Warsaw University of Technology, September 2002.
- [4] Tsou Jinyeu, Xue Yucai, 2002. Visual Sustainability Comparative Study of Open Space In Hong Kong Public Housing Estates: Virtual 3D Urban Simulation Environment Based, The 2nd Workshop on Virtual Reality and Geography, Beijing.