The HKIS Outstanding Dissertation/ Thesis Awards 2018 Executive Summary of Winning Papers

SPATIO-TEMPORAL DATA MODELLING FOR AN ANALYSIS OF THE DYNAMIC BEHAVIOUR OF URBAN HEAT ISLANDS

Postgraduate Category - Grand Prize
Awardee: ZHU Rui
The Hong Kong Polytechnic University – LSGI

Abstract

An urban heat island (UHI) is widely considered an environmental phenomenon in which city temperatures are higher than those in surrounding rural areas. This is a major problem for most cities. Given the world's rapid urbanisation, it will likely become a serious problem due to its potentially adverse effects on people's health and increase in energy consumption to cope with it. To gain a better understanding of this phenomenon, the author consulted previous relevant research, which mainly focused on two aspects:

- UHI intensity estimation and super-resolution reconstruction at a fixed time instant, where thermal satellite images with very fine spatial and/or temporal resolutions covering a micro-scale of urban areas were rarely obtained; and
- causative factorial analysis by studying the correlation between thermal images and related factors (e.g. solar radiation, urban morphology, and anthropogenic heat).

However, these studies did not track the evolutionary process of the UHIs continuously in both time and space domains. Thus, the objectives of this thesis are fourfold. The first is to conceptualise the UHI phenomenon as an object-based behaviour. The second is to model the dynamic behaviors of UHIs in three aspects (temperature, areal extent, and location). The third is to track the UHI spatial behaviors over time. The last is to evaluate the effectiveness of the model by computing with near-surface thermal images.

This study presents the concept of a UHI and describes the previous research problems in trying to continuously track its dynamic behaviour. The author has designed an object-oriented dynamic model to reconstruct the evolutionary process of UHIs. Each UHI is modelled as a spatiotemporal field-object with its own life cycle and its dynamic behaviour is defined by a series of filiations. For instance, a UHI's areal extent in two consecutive time instants can expand or contract. Furthermore, the study will propose six hierarchical graphs to track the continuous changes in three properties. Finally, the author will define and reveal several patterns from the results.

The developed model was implemented in an object-relational database, while the near-surface air temperature data were collected from automatic weather stations on an hourly basis before they were applied to the model for testing. The thematic and spatial behaviors of UHIs over six months were analysed. The results suggested that the model could identify different behaviours and effectively track the complete life cycles of UHIs.

This study should make several contributions to and impact the GIS modelling community. It will reveal the interesting phenomena and evolutionary trends of UHIs in Guangzhou throughout the year. It will also systematically develop the theory of object-oriented data modelling to track field geographical phenomena. In addition, the study will provide new approaches for other researchers to study the different distributed spatial phenomena. The developed models can be used in urban planning to help mitigate the UHI phenomenon while building a sustainable city.

THE ABSTRACT OF IDENTIFICATION DRAWING DETAILS THROUGH PATTERN RECOGNITION TECHNOLOGY DURING THE BUILDING DESIGN PHASE

Postgraduate Category - Grand Prize
Winner: ZHANG Xueyi
City University of Hong Kong

Abstract

In any building construction project, building design is the first and probably most important step. However, many design errors happen during this phase due to the inattention of engineers or a lack of communication between the engineers and project managers, which may result in a series of problems, according to previous studies. Some design errors lead to poorer construction quality and/or greater maintenance difficulties, for which contractors and employers would bear the loss. Starting anew a construction project also consumes extra time, materials, and effort. All of these could be avoided if the design had been sound from the outset.

Nowadays, computers have become an intensive tool for helping people perform their jobs more efficiently, while engineers rely on computer software to make drawings and check the capacity of designed building. Thus, computers can be valuable tools for reducing construction defects.

For the ultimate purpose of decreasing the number of problems in engineering drawings, schools should teach and train their students to use computers to recognise the profiles or facilities shown in drawings followed by teaching them to identify the functions of each area being drawn and what constitutes reasonable standards. In this dissertation, the author focuses on the first step and identifies the internal facilities contained within the drawing because the detailed symbols that represent different facilities like closets and tables have more complicated shapes. Stronger visual expressions are needed to demonstrate the utility of each area.

Many scholars had already published relevant works and, based on their results, feature detection is an intensive and efficient method for pattern detection. Scant Invariant Feature Transform (SIFT) is a convenient feature extraction approach. Through several steps in building multiple scale space to obtain the Difference of Gaussian (DoG) pyramid, identifying key locations by detecting maximum and minimum value in the filtering function, eliminating low stable key features, and describing the orientations and positions of the remaining key points, the represent characteristic could be extracted from the sample icon and be shaped into a descriptor that includes its key information. Afterwards, hamming distance is applied. The purpose of the matching process is to find the same feature descriptors in both target icons and architectural drawings. The ideal result would be to find them in all target icons and architectural drawings.

Therefore, along with these basic results, computers would help generate future studies that involve programming them to match the function of areas that being designed to the design standards or offer advice on adjusting designs that adapt different aims and specific requirements.