GeoS4S Module Smart City

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Abstract

Smart City is a complicated system and represents the effort of seeking to optimize existing urban infrastructure, network and human behaviour through the deployment and utilization of information system and sensor system. This module focuses on introducing the complexities of cities using geo-information technology, ICT, big data urban analytics and the design of New Urban Systems for modern cities. During this module students will have a basic understanding of the emerging field of Smart City and acquire basic knowledge of the state of the art in this field. The current paper summarizes the learning objectives, lesson content, teaching and evaluation system for this module.

Key Words: Smart City, ICT, Big Data, Geo-spatial Technology, Urban Administration

1. Introduction

Smart City is an application based on cloud computing, social networking, intelligent search, intelligent analysis and other tools to realize city information integration, which can greatly improve the energy efficiency, water use, public safety, traffic congestion, food safety and many other areas of city governance. Smart City is the inevitable trend of future development of cities. Graduate education in Smart City tends to help students to understand how GIS and related spatial information technology application in Smart City components. Through the study of this module, students can have a more comprehensive understanding of Smart City, but also can inspire more students willing to research it.

1.1 Module Description

In recent years, with rapid development in cities and increase in urban population, cities under traditional operation mode is facing traffic congestion, management inefficiency with rapid development in cities. Smart City can make full use of information and communication technology to sense, analyse, integrate city core systems in all kinds of key information to respond the various requirements intelligently in the people's livelihood, public security, urban services, and create a better city life for human beings.

This module introduces the concepts, components, and cases of Smart City. Some lessons roughly present how GIS and related spatial information technologies such as ICT, IoT, cloud and ubiquitous computing system, system optimization and coordinating, spatio-temporal big data analytics and mining are applied in Smart City. Others provide several cases from different aspects to show the operation and relationships between different topics of Smart City. There are no textbooks for Smart City. The bulk of the information available about Smart City can be found in many case studies, journals, and special books, some of which are relatively informal. For this reason, this module requires more extensive reading than many of the other GeoS4S modules. In addition, the number of smart cities currently has exceeded 160 and is still increasing. Students can learn knowledge of Smart City from these case cities.

1.2 Learning Outcomes

Learning the latest geospatial technological innovations of urban informatics, strategies, and policies being developed. Understanding and mastering geospatial technologies/tools to find the solutions for smart city. On completion of this module, the students should be able to:

1) Build overall recognition of Smart City by learning basic concepts, latest technologies and methodologies applied into it.
2) Understand the role of ICT, IoT, big data, cloud computing and other technologies in supporting Smart City.

3) Understand and master the technologies and methodologies of data collecting, spatial modelling, spatial analysing, data mining, geo-visualization etc. which involved into Smart City.

4) Have analyzing the ability to use geospatial technologies/tools to find the solutions for Smart City and develop a holistic and system-level perspective on Smart City from geospatial view.

2. Module Structure

2.1 Module Overview

This module consists of 15 lessons with 25 slides and accompanying notes, plus extra reading, exercises for self-assessment by the students, and assignments for evaluation and grading by the teacher / instructor. The overall student effort is estimated at 160 hours, and the module is intended to provide credit equivalent to 6 ECTS. The module materials are designed to be used flexibly, in either a traditional classroom setting or for on-line self-study. The module is organized into six sub-modules as described in section 4; the sub-module presentation order can be revised depending on the background and goals of the students.

2.2 Summary of Lesson Content

This section briefly presents the content and goals of each lesson.

- *Lesson 1: Introduction to Smart City* - This lesson introduces and describes the background, concepts, characters, inner mechanism, composition, and the core component and phase of Smart City, explains the relationship between Smart City and sustainability. It also shows some cases of Smart City.
- *Lesson 2: From digital city to smart city* - This lesson introduces the concepts of urbanization and urban information, describes basic concepts and composition of Digital City, explains related technologies of Digital City, and analyses the relationship between Digital City and Smart City. It also compares the Digital City and Smart City, and lists three traits of Smart City.
- *Lesson 3: Geospatial methods and technologies applied into Smart City* - This lesson analyses the city information resources system and platform architecture, introduces the data acquisition method and technology, data integration and fusion method and technology, spatio-temporal data warehouse technology and data mining method, and data visualization method and technology. It also presents the spatial information public platform.
- *Lesson 4: ICT and its contributions* - This lesson introduces the concept of ICT (Information Communications Technology), and presents the development history and mechanism of ICT. It also demonstrates some relevant standards of ICT for Smart City applications.
- *Lesson 5: IoT and its contributions* - This lesson introduces the concept of IoT (Internet of things), states the architecture of IOT, and describes some key technologies of IoT.
- *Lesson 6: Cloud and ubiquitous computing and their contributions* - This lesson introduces the concept and mechanism of Cloud Computing. It also considers some mainstream Cloud Computing platforms and systems.
- *Lesson 7: Big data and its contributions* - This lesson introduces the concept of big data in smart city, explains the technology and applications of big data in smart city, and then discusses the challenges and trends of big data.
- *Lesson 8: System optimization and coordinating* - This lesson introduces the basic system engineering and optimization methods, discusses the process and mechanism of city management, and analyses the workflow and business process adaptation, optimization, automation and building methods of forecast model. It also indicates information sharing and coordinating between systems.
- *Lesson 9: GIS-driven urban intelligent information system architecture and pattern* - This lesson describes the digital city geographical framework, urban spatial grid and city management, explains the GIS based information system architecture, and demonstrates the GIS-driven service pattern.
- *Lesson 10: Latest progress and toward of Smart City* - This lesson includes the evolution of city by new technologies and new technologies of Smart City. It also demonstrates the trends of new technologies of Smart City.
- *Lesson 11: Case study 1: Kunming Smart Underground Pipeline* - In this lesson, students can understand an example of urban public infrastructure management system: Kunming digital underground pipeline project. It also presents the detail description of the framework of the Kunming digital underground pipeline project, and explains the applications of the project.
- *Lesson 12: Case study 2: IBM Smart Water Management* - This lesson presents a typical case of urban environmental monitoring and control system: IBM smart water management. It describes the

underground, key water management challenges and main points, and framework of IBM smart water management.

- o *Lesson 13: Case study 3: GeoKSCloud: The Geographical Knowledge Service Cloud* - An example of urban public security management system - GeoKSCloud: The Geographical Knowledge Service Cloud is described in this lesson. In this lesson, students can understand the aim, three layers architecture, five functions, and three key technologies of GeoKSCloud.
- o *Lesson 14: Practice* - This lesson requires students to use what they have learned to realize the urban intelligent planning and management/other intelligent systems to deepen their understanding and cognition of Smart City.
- o *Lesson 15: Visiting the local Urban Administration Departments* - This lesson aims to let the students understand the operation of Smart City through visiting the local Urban Administration Departments. This way enables students to truly understand how scientific research serves social practice.

3. Hands-on Sessions

The module provides several interactive and hands-on activities to supplement the lecture content, deepen students' understanding, and develop their practical skills. Many of these activities are part of the module evaluation scheme.

- Spatial data analysis technologies by using ArcGIS (Lesson 3)
- The application of free cloud computation platform (Lesson 6)
- Finding check-in hot spot areas for both native and non-native people in Beijing City (Lesson 7)
- A system architecture and service model of Smart City (Lesson 9)
- Draw the future map of Smart City (Lesson 10 - Lesson13)

This module does not assume any prior knowledge of specific software, although some of the activities will be easier if students have some exposure to GIS related software.

4. Teaching and Learning System

The module is divided into six sub-modules, which use rather different learning methods.

Sub-module 1: (lessons 1-2) introduces concepts, components, and technologies of Digital City and Smart City. Aside from studying the overview provided by lecture notes, students will read several short papers understanding the backgroud and practice of Smart City.

Sub-module 2: (lessons 3) focuses on geo-data acquisition, intergration, visualization and mining. Students will complete a exercise about spatial data analysis technologies by using ArcGIS.

Sub-module 3: (lessons 4-7) considers computer-related technology, such as ICT, IoT, Cloud Computing, and big data. Students will accomplish two related exercise. They will also complete a hands-on assignment, one focusing on spatio-temporal data warehouse and data mining technologies.

Sub-module 4: (lessons 8-9) introduces the technologies related system optimization, coordinatng, architecture, and pattern. Students will complete a exercise and a hands-on assignment.

Sub-module 5: (lessons 10) presents latest progress and toward of Smart City. Students will be required to prepare a exercise on drawing the future map of Smart City.

Sub-module 6: (lessons 11-15) presents several case studies and practice of Smart City. Students will complete a exercise. They will also need to accomplish a hands-on assignment, which requires students to use knowledge and methodology to find solution to urban intelligent information system.

5. Evaluation System

Performance evaluation for this module includes three components: class participation (10%), two reports (assignment 1: 15%, assignment 2: 25%), and a term paper (50%). The details are as follows:

1) Class participation (10%): Class participation will require students to attend the classes in classroom or online.

2) Two reports (40%): Assignment 1: A review on geospatial information technologies and methodologies applied into Smart City (15%) (not less than 2000 words). This assignment requires students to study and analyse some cases about smart urban information systems, and conclude the technologies and methods from geospatial view. Assignment 2: A study on design of intelligent information system in Smart City (25%) (not less than 2000 words). This assignment requires students to learn system design method based on geo-information technology including geo-data organization, geo-visualization, geo-modelling, geo-tools, and software developing.

3) Term paper (50%) (not less than 4000 words): This assignment requires students to use knowledge and methodology of this module to find solution to urban intelligent information system such as urban intelligent transportation, urban intelligent management, and other cases.

6. Conclusion

Smart City is an application based on cloud computing, social networking, intelligent search, intelligent analysis and other tools or methods which realizes city information comprehensive thorough perception, broadband ubiquitous connectivity and intelligent integration. This module considers geospatial information technology as an important basis and mean of through providing geo-data, spatial modelling, spatial analytic method, visualization tool and etc. This module focuses on how geospatial information technologies performs and supports to make our urban environment more sustainable and increase quality of life and efficiency of urban operation and services, and competitiveness.

During this module, the students will have a basic understanding of the emerging field of Smart City and acquire basic knowledge of the state of the art in this field, learn the latest geospatial technological innovations of urban informatics, strategies, and policies being developed, understand geospatial technologies/tools to find the solutions for Smart City, and develop a holistic and system-level perspective on smart sustainable cities from geospatial information view. By studyding this module, the students will obtain the ability of working for city administration and related acadmic communities.

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