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Real-geographic-scenario-based virtual social environments: integrating geography with social research

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Abstract. Existing online virtual worlds, or electronic environments, are of great significance to social science research, but are somewhat lacking in rigour. One reason is that users might not participate in those virtual worlds in the way they act in real daily life, communicating with each other in familiar environments and interacting with natural phenomena under the constraints of the human–land relationship. To help solve this problem we propose the real-geographic-scenario-based virtual social environment (RGSBVSE). The aim is to enhance the ability of current virtual worlds in social issues studies by promoting virtual geographic environments that are built with real scenarios in the physical world. In this paper we first discuss the potential shortage of current virtual worlds for serious social research. We then explain how real geographic scenarios can contribute to building a virtual social environment by providing (1) real geographic data, including the time dimension, in terms of data acquisition and organisation; (2) dynamic or real-time natural phenomena and processes for scenario simulation and expression; (3) shared spaces that enhance participants' interaction through a mix of virtuality and reality; and (4) shared hot spots of social phenomena for researchers from multidisciplinary (eg, sociology, psychology) performing collaborative research. Furthermore, two of our projects, the virtual Chinese University of Hong Kong and the Virtual Globe of the Chinese Family Tree, are introduced as case studies, to illustrate how the RGSBVSE can play a significant role in a number of critical social research issues from the local to regional scale.

Keywords: virtual social environment (VSE), real geographic scenarios, virtual world, social research

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1 Introduction

Human social environments encompass the immediate physical surroundings, social relationships, and cultural milieus within which defined groups of people function and interact (Barnett and Casper, 2001). To understand these complex environments, online digital environments, or virtual worlds, have recently been employed for research concerning social and behavioural sciences (Damer, 1998; Friedman et al, 2007; Zhang et al, 2010). With these novel environments, people can participate as virtual avatars and interact with each other and virtual objects for communication, education, and even business, while sociologists and scientists can conduct social experiments by collecting data related to, for example, social psychology and cognitive behaviour (Bainbridge, 2007; Blascovich et al, 2002; Castronova and Falk, 2009; Messinger et al, 2009; Wallach et al, 2009).

However, the tremendous social research potential of these imaginary worlds does not hide the fact that their development is rooted in game playing (Messinger et al, 2009), which, to some degree, has inherent negative implications for serious research (Djorgovski et al, 2009).

First, in these imaginary worlds people often live in ghost towns that fail to attract sustained engagement (Kohler et al, 2009). However, it is evident that serious social experiments or investigations can only be conducted with sufficient participants.

Second, many such existing systems are too focused on visualisation while ignoring the real geographic representation of the immediate physical surroundings (Hu et al, 2011, Lin et al, 2013). Social investigations related to real locations and areas, such as how many people in a certain area usually go shopping at a particular supermarket, are almost impossible to conduct in such imaginary worlds. Even in experiments conducted by establishing certain scenarios that exist in the physical world to explore human behaviour and cognitive psychology (Jansen-Osmann, 2002; Peruch and Gaunet, 1998) and to investigate people's attitudes toward buildings prior to construction (see http://www.virtualaloft.com/), the feedback might be incomplete and cannot be generalised to draw conclusions about individuals in the real world (Ross and Cornell, 2010). For example, one may build a hotel in a virtual world before constructing the building in the physical world in order to determine whether it is attractive or needs improvement. The idea sounds good, but in the real world the actual value of a hotel is determined not only by the appearance and quality of the building but, more importantly, by the surrounding facilities and environment. A hotel on the top of a mountain or near the sea may be more attractive than the same hotel sitting beside a refuse dump. In this case, presenting the surrounding environment corresponding to the real world is essential; people's attitudes towards this hotel may change completely if they are told about the surrounding environment.

Lastly, people may bring certain laws of social influence into the imaginary world (Eastwick and Gardner, 2009), but they may still act more or less optionally and presumptuously because they are hidden in an anonymous world, which, to some extent, creates irresponsible and immoral possibilities (Castronova, 2007). For example, one may easily steal a car in a game world without worrying about being arrested; people may engage in vulgar or abusive language in a game world when masked by a fake name and identity. In order to maintain real-life restrictions on behaviour and morality in the virtual world, cognitive psychologists have suggested that people will act more analogously if they are in familiar surroundings (Taylor et al, 2008; Tversky, 2005). This indicates that creating familiar scenarios (eg, real places, natural phenomena) in the virtual world would make participants act more naturally so that the results of serious social research would be more valid and reliable (Mania et al, 2010). However, it is obviously difficult for the social scientist to develop virtual environments in imaginary worlds that correspond to physical worlds. To date, it is still unclear what enhancements are needed to constitute a good virtual world for serious social research (Bainbridge, 2007). The International Conference on Games and Virtual Worlds for Serious Applications has been held annually for the past three years, and potential enhancements are still under study (see http://www.vs-games.org.uk/; http://www.vsgames2010.org/; http://www.vs-games.org/).

A real geographic scenario provides a fundamental strategy for organising and synthesising observations of the physical world (Berry, 1964), which also constitutes the critical foundation of human society (De and Harm, 1996; Jognston, 2010; Kobayashi, 2010; Werlen, 1993; Zimmerer, 2010). This scenario consists of real places, natural dynamic phenomena, and physical surroundings. In this paper, we attempt to complement the virtual worlds for serious research by taking the geographers' perspective. The real-geographic-scenario-based virtual social environment (RGSBVSE) is suggested. This aims to provide a supplementary tool for serious social communication and research, but will not replace other mature virtual worlds equipped for other targets. The remainder of the article is organised as follows. An explanation of what real geographic scenarios can contribute to building a virtual social environment (VSE) is given in section 2. In section 3 we introduce the virtual Chinese University of Hong Kong as a case study at the local scale, while in section 4 we introduce the Virtual Globe of the Chinese Family Tree as a case study at the regional scale, to show that the RGSBVSE is capable of benefitting social research. We conclude the article with a summary and discussion of future work.

2 What real geographic scenarios will contribute to building a VSE

Following Schroeder (2002), four primary processes are involved throughout building a VSE. These can be summarised as follows: (1) data acquisition and organisation; (2) scenario simulation and expression; (3) interactive channel design; and (4) collaborative research-mode design. Accordingly, what real geographic scenarios can contribute to building a VSE is illustrated in figure 1.

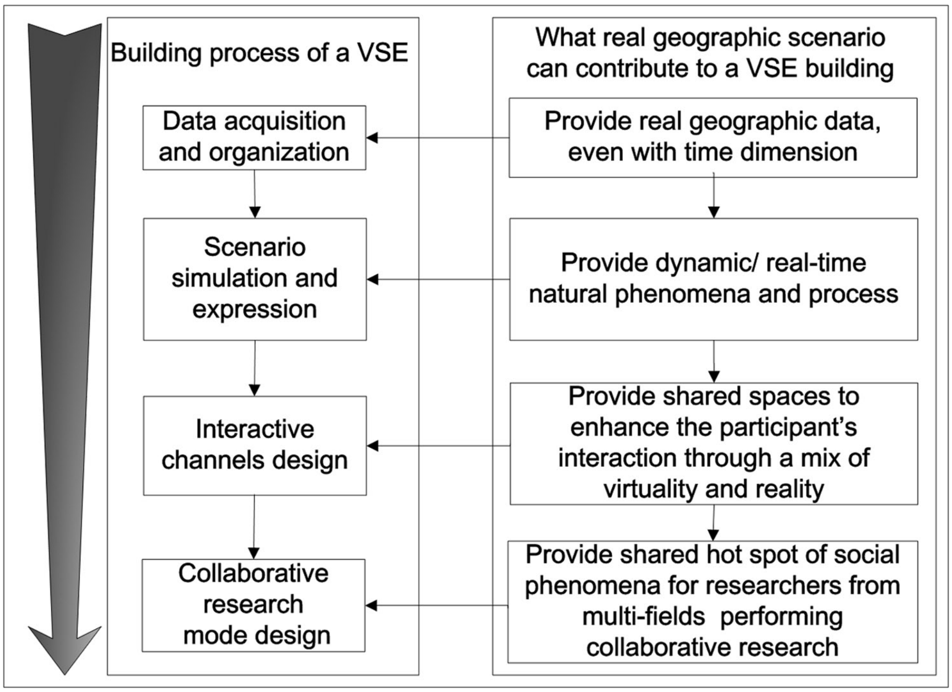

Figure 1. Real geographic scenario contributing to the process of building a virtual social environment (VSE).

First, the acquisition and organisation of data, which is the essential first step for building such a virtual environment, forms the most critical foundation of a VSE. Currently, some imaginary worlds are built without real geographic data, which makes them unreal or unfamiliar to participants' normal perception. Compared with virtual worlds equipped with real scenarios, they are not suitable for serious social research such as cognitive psychology experiments (Taylor et al, 2008; Tversky, 2005). Real geographic data derived from real geographic scenarios play a crucial role in building virtual scenarios in a VSE, and bring special abilities to social research and investigation. For example, in order to gather comments, one can foresee the impression of building a virtual hotel in both Google Earth (http:// www.google.com/earth/index.html) and Second Life (http://secondlife.com/) before the real one is constructed. With more information in the virtual world about the real surrounding environment, people may get more-complete views on the forthcoming hotel. Nowadays, with the increased development of image recognition and 3D automatic modelling technologies, distributed photographs and videos acquired from real geographic scenarios can increasingly contribute to building a VSE (Elwood, 2008; Goodchild, 2008). Furthermore, spatial data with the time dimension can also be obtained from real geographic scenarios that cover different periods. With time information, not only can the current world be rebuilt virtually, but also ancient stories can be reconstructed in the virtual world (Lin and Zhu, 2006), which would be of benefit to historical social researchers. For example, a virtual Kyoto with the time dimension has been built from a large collection of digital archives of buildings, houses, and streets, and this can help human understanding of the historical social environment and the evolution of culture (Yano et al, 2006).

Second, as a part of the social environment (Barnett and Casper, 2001), the physical environment consists of various dynamic natural phenomena, such as precipitation, accordant junctions, evaporation, storm winds, earthquakes, and volcanic eruptions. Real geographic scenarios that include dyamic phenomena will help to build an animated and dynamic VSE that is familiar to participants, and can further encourage them to interact more naturally with physical phenomena (Wu et al, 2008). Combined with real-time distributed sensor networks and geographic processing models (eg, the Fifth-Generation NCAR/Penn State Mesoscale Model or Community Multiscale Air Quality), real geographic scenarios and related dynamic geographic phenomena can be linked and merged with the corresponding VSE, and the relationships can be further enhanced through their continuous communication and cooperation (Lifton, 2007). Figure 2 shows how a real geographic scenario contributes to building a dynamic VSE.

Third, the most common ways that humans participate in current virtual worlds are as follows: (1) using a PC one can control one's own avatar or character with peripheral equipment such as a mouse or keyboard; or (2) interacting with the virtual world in an immersive way by using immersive devices such as wired gloves or stereoscopic displays. However, real geographic scenarios will extend a VSE's interactive modes through greater flexibility. A case in point is the location-based system, which is currently attracting increasing numbers of users, and the 'check-in' function that has been popularised around the world by Foursquare (http://foursquare.com/). Via Foursquare, dispersed users can share their real-time locations with friends while collecting points and virtual badges; it guides real-world experiences by allowing users to bookmark information about venues that they want to visit and by showing relevant recommendations about nearby venues. Similarly, an RGSBVSE can provide shared places or regions, which exist in both the real world and the corresponding virtual environment, and enable participants to interact through a mix of virtuality and reality. With these shared spaces, participants can control their avatars using a mouse, have an immersive walk to experience the real environment using special devices, or just join in by

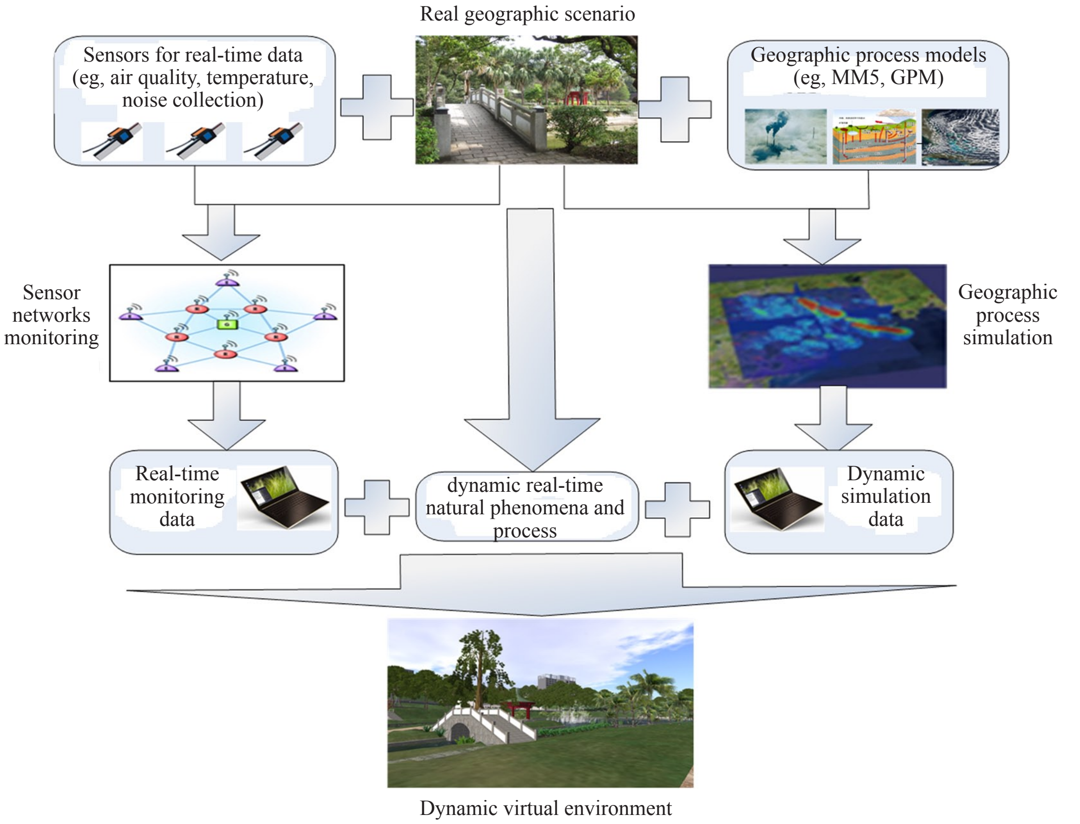

Figure 2. [In colour online.] Developing a dynamic virtual social environment based on a real geographic scenario combined with sensor networks and geographic process models

using location-aware devices such as mobile telephones equipped with GPS while walking in the physical world. In this case, people either inside or outside the real scenarios are able to participate in the corresponding shared environment, and perceive and exchange the local geographic conditions as well as the social milieu. This capability will encourage the public to share their location-based social behaviour and social networks in the virtual world to further enhance the ability of a VSE to support social research.

Fourth, the real geographic scenario can provide shared hot spots of social phenomena for researchers from various disciplines performing collaborative research. Collaboration is becoming a critical aspect of scientific research, which is dominated by complex problems, rapidly changing technology, dynamic growth of knowledge, and highly specialised areas of expertise (Hara et al, 2003). In terms of social research, one obvious limitation of previous studies is that many of them focus on a single discipline, but interdisciplinary (eg, psychology, geography, linguistics) collaboration is required to explore human social behaviour and social phenomena in the physical world (Bryman, 2001; Neuman, 2000). To support the collaborative work of multiple researchers in a VSE, the priority is to determine the common concerns of social issues, among which the hot-spot regions, physical phenomena, events, and other related elements are shared (Neuman, 2000). In terms of this, imaginary elements which do not exist in the real world may be hard to recognise and illustrate, and this will increase the difficulty of researching common concerns. Thus, a shared real geographic scenario will be of great significance in building a foundation for social research using a VSE.

In summary, real geographic scenarios will help build a 'real' VSE, in which the public can experience social life through a mix of virtuality and reality, such as checking their house while away from home, shopping in their neighbourhood when sitting beside a computer, or watering their flowers from the workplace (Hendaoui et al, 2008); at the same time, researchers can conduct serious and collaborative social research using both collected data and shared phenomena achieved in the VSE.

3 Virtual Chinese University of Hong Kong (CUHK)

In this section, we employ one of our scientific projects, the virtual CUHK, to explain typical characteristics of an RGSBVSE at the local scale.

3.1 Building the virtual CUHK

A campus is an epitome of society (Chang, 2005). Constructing a virtual campus will not only create the possibility for participants to understand the campus environment better and to communicate with schoolmates, but will also allow for a better exploration of social behaviour that cannot be understood fully in the physical campus (Friedman et al, 2007). Moreover, the campus-based virtual world can extend to a large scale and embrace more social space by linking more individual behaviours and social interactions. Figure 3 illustrates the relationship between a real campus and a virtual campus, as well as the three levels of a virtual campus provided for social research and behaviour analysis.

Given these findings, we have built the virtual CUHK. The real CUHK campus is located at 22°25′E, 114°12′N, with 134 ha of mountainous terrain in the New Territories in Hong Kong. Figure 4 is the digital orthophotographic map of CUHK.

The development of the virtual CUHK platform is based on an open-source server called OpenSimulator 0.7 (http://opensimulator.org/wiki/Main_Page). It is developed for cross-platform and multiuser 3D applications, in which distributed data management, 3D visualisation, and interoperability can be realised flexibly.

All original geographic resources for building the virtual environment are collected from real campus scenarios using various devices. Besides the digital terrain map and digital orthophotographic map, the data-collection process of a typical vertical construction is illustrated in figure 5. A personal digital assistant is employed to collect tracking data and to record the related attribute information for modelling reference, while the digital camera is used to record the 3D geometry and texture data of buildings. After the data collection of one theme, the collected data will be transferred to the central database clusters, and multiuser collaborative 3D modelling is ready to construct the virtual campus via the wide area network (Hu et al, 2011). It is worth mentioning that, currently, only modellers with special rights can modify the building in this platform, which is not the case in other virtual worlds. This is because if all users are allowed to create nonexistent geographic objects, even if this mode may enhance participants' creativity, many unpredictable problems may arise when reproducing real scenarios for serious research.

3.2 Personal perception in virtual CUHK

Each participant can join in the virtual CUHK as an avatar and enter an immersive experience when walking around the real campus. People who live outside the CUHK campus or are absent from the campus, or even nonlocal students, are allowed to perceive the campus environment and its surroundings virtually and freely via the Internet. Through immersive walking and perceiving, participants can generally understand the distribution of buildings and facilities in the school as well as the natural phenomena of the campus. Figure 6 shows the virtual scenarios of the virtual Chung Chi College and University Mall.

Aiming to establish a real-time virtual CUHK to mirror the dynamic and real scenarios of the real campus, we have erected a number of distributed sensors in the campus to monitor physical or environmental conditions. In this way, the whole virtual CUHK campus can be visualised with the real-time monitoring data acquired from the real geographic scenarios. For example, wind feel and air conditions in the physical world are barely visible to the naked eye. In the virtual campus, however, the real-time monitoring data of wind speed and direction combined with air-pollution conditions acquired from the distributed sensors can be integrated and then visualised in various colours and shapes (eg, points, line fronts). Visually experiencing the diffusion processes of air pollution would help people to be fully aware of the air pollution on the campus, and further allow them to compare intuitively the different morning and evening situations. Figure 7 gives an example of a participant experiencing the transmission of smoke with real-time wind direction. In further research,

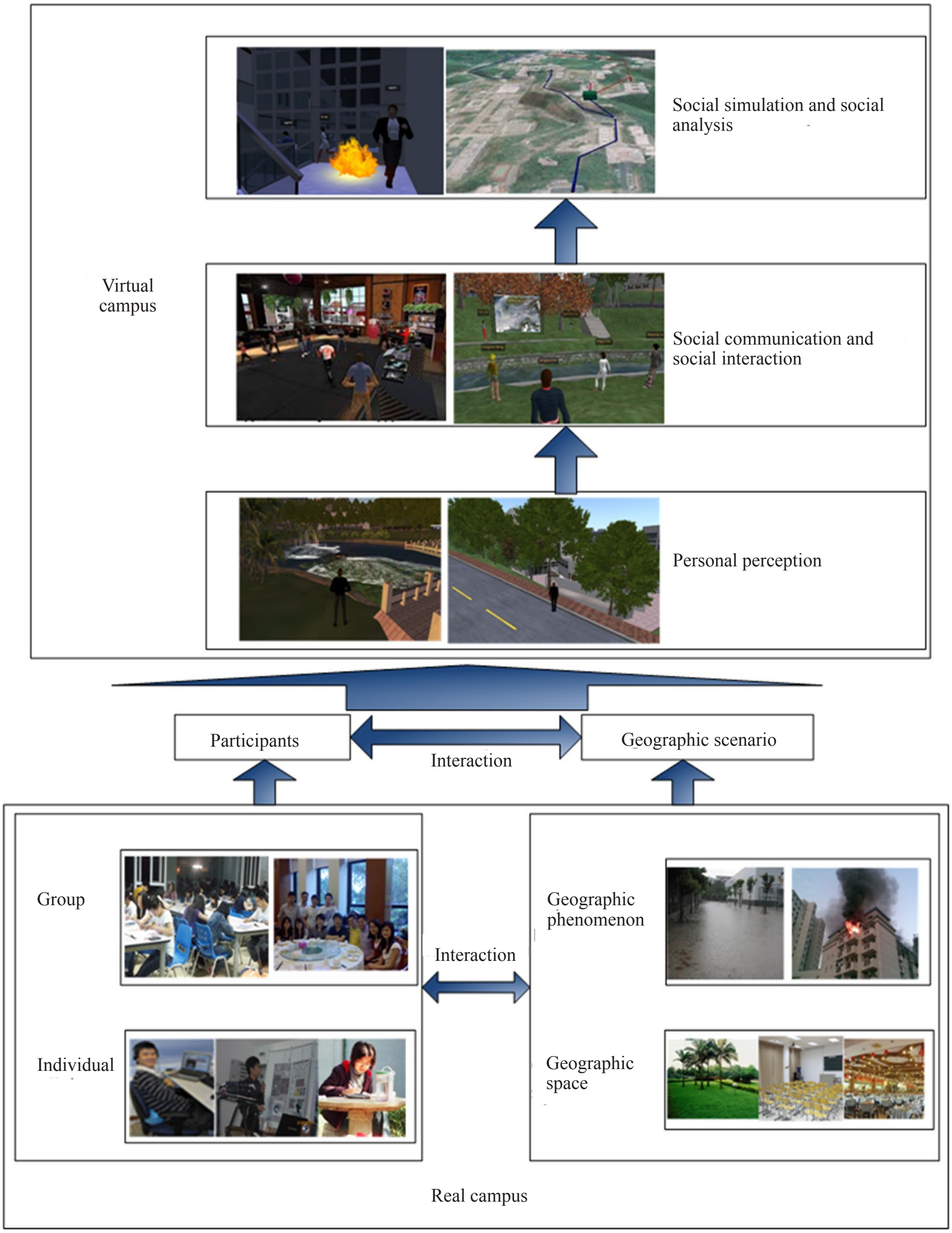

Figure 3. [In colour online.] Relationship between a real campus and a virtual campus as well as a virtual campus' interaction function.

Figure 4. [In colour online.] The digital orthophotographic map of the Chinese University of Hong Kong in 2005.

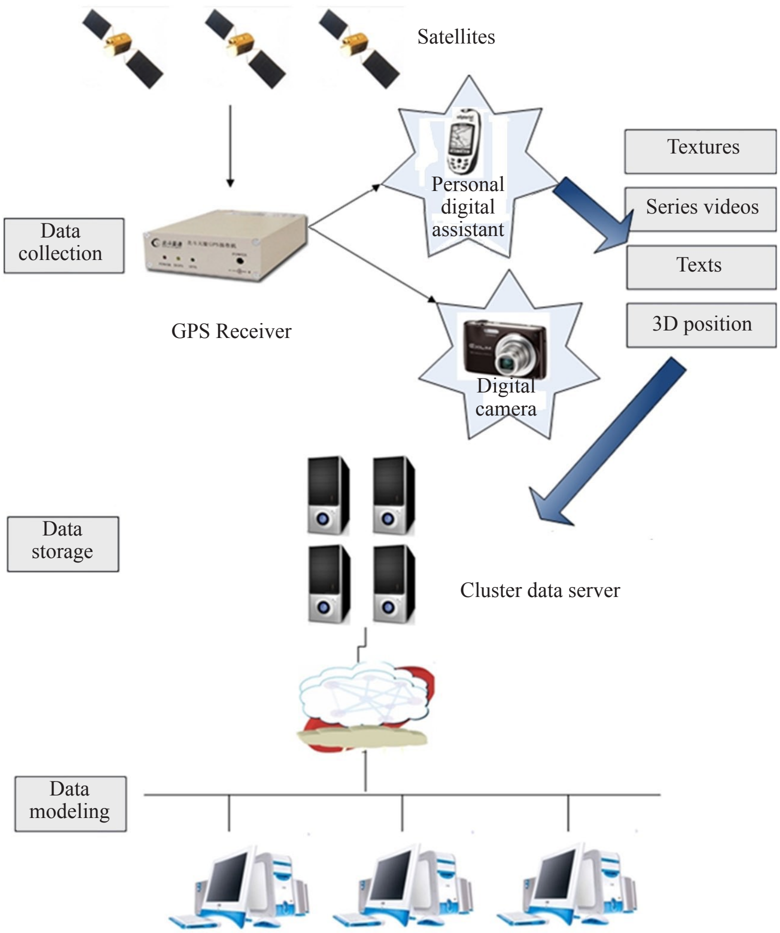

Figure 5. [In colour online.] Data processing for a virtual Chinese University of Hong Kong building.

Figure 6. [In colour online.] Virtual geographic scenarios in the virtual Chinese University of Hong Kong: (a) Chung Chi College; (b) University Mall.

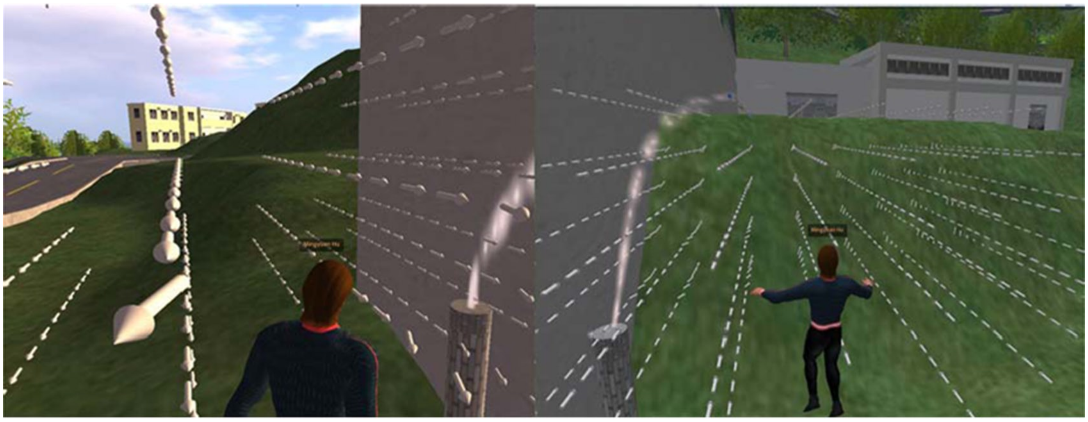

Figure 7. [In colour online.] Virtual scenarios of smoke diffusion and real-time wind field (Hu et al, 2011).

the scientific computing capabilities of small-scale numerical geographic process models (eg the Atmospheric Dispersion Modelling System) will be expanded, and increasingly numerical geographic process models will be combined with easy-to-use interfaces to estimate or predict air pollution, which will make the transmission and dispersion of air pollution more easily understood and assist officers' decisionmaking.

3.3 Social communication in virtual CUHK

Using the real geographic scenarios in the campus, the distributed participants can interact through a mix of virtuality and reality in the virtual CUHK, and can communicate and discuss real-time natural or social phenomena with each other. Figure 8 (a) shows students learning chemistry in a virtual classroom; figure 8 (b) shows an immersive discussion based on real-time weather conditions. Within these social scenarios, some participants are indeed present at the physical location and join in the virtual environment via a location-aware system (those with white names), while the remaining participants are outside the real location and participate as avatars (those with orange names) using PCs. In this way, the absent students are allowed to participate and perceive the same social environment and real-time interaction as the others. Furthermore, participants' virtual and real personal information can be collected, classified, and analysed, and conclusions can be drawn to serve the serious study of certain social issues.

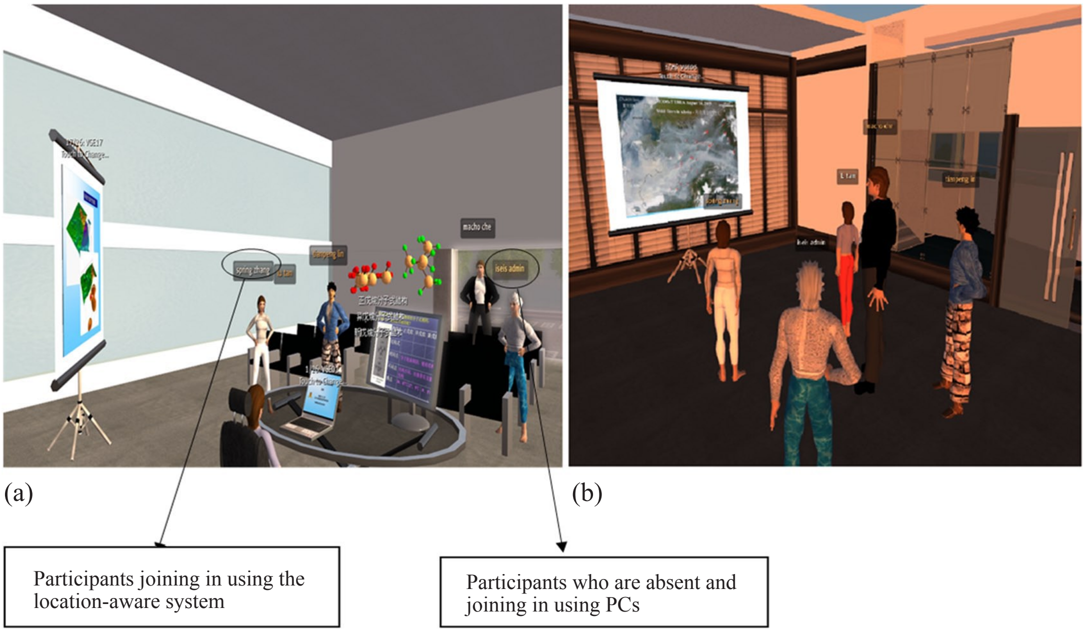

Figure 8. [In colour online.] Communicating through a mix of virtuality and reality modes in the virtual Chinese University of Hong Kong. (a) A virtual classroom for chemistry lessons; (b) an immersive discussion based on real-time weather conditions. Participants at the physical location are labelled in white and avatars are labelled in orange.

Figure 9. [In colour online.] The repair order for a damaged building marked by participants in the virtual Chinese University of Hong Kong.

Moreover, participants can interact not only with each other within the virtual campus built on the basis of real geographic scenarios, but are also allowed to communicate with the physical environment and natural objects. Virtual repairs are a case in point. Those who notice damaged facilities in the real campus will no longer need to inform the estate management office (EMO) in person or by telephone, but can mark the damaged facility in the virtual CUHK. The EMO staffer will instantly receive the maintenance order by the well-designed alerting mechanism. With the accurate attribute information of the facility stored in the virtual CUHK system, appropriate repair plans are expected to be predesigned. In this way, manpower and time can be saved effectively. Figure 9 shows how the EMO receives the repair order when a damaged building is marked by participants in the virtual CUHK.

3.4 Social simulation and social analysis in the virtual CUHK

The virtual CUHK plays an irreplaceable role in many ways. On the one hand it can serve users as a virtual social platform for immersive perception and real-time communication; on the other hand it can serve decision makers and scientific researchers in making timely decision making and for social behaviour studies, respectively.

First, as mentioned above, some virtual worlds have been employed by decision makers to investigate building renovation and architectural design and to collect feedback from the public. However, if only focusing on the single objective of buildings (eg, hotels) but ignoring the simulation and expression of facilities close by, the respondents would not have the chance to consider the building with the surrounding facilities and environment, and biased conclusions may result. A complete, dynamic, and real microgeographic environment is provided by the virtual CUHK to serve the decision makers (eg, the campus development office) as a convenient experimental platform. First, the familiar and real environment in the virtual CUHK would encourage participants and respondents to provide more enthusiastic conclusions and suggestions. Second, the focused real social events will make the results of the serious investigation more valid and reliable. Figure 10 shows an experiment directed by the campus development office and based on the virtual CUHK. The aim is to collect feedback from teachers and students on whether it is suitable to build a new dormitory near the sea.

Furthermore, the real geographic scenario-based virtual CUHK will also meet the requirements of experts from multiple disciplines. For example, traditional cognitive psychologists explored human social behaviour by employing volunteers in the physical environment and collecting their feedback. Although virtual environments are employed increasingly (Loomis et al, 1999; Tarr and Warren, 2002), cognitive psychologists are still eager to find a workspace with detailed geoinformation corresponding to the physical environment in order to explore complex social behaviour (Tversky, 2005). In other cases, however, experts in artificial intelligence often simulate human social behaviour by employing agents or multiagents (Ekstrom et al, 2003), but such methods usually need to be improved by adding psychological factors (Santos and Aguirre, 2005). In such cases, with the support of the geographic scenario-based virtual CUHK, psychologists and researchers of artificial intelligence can conduct collaborative research based on the common concern and explore

Figure 10. [In colour online.] Social scenario simulation for collection of opinions.

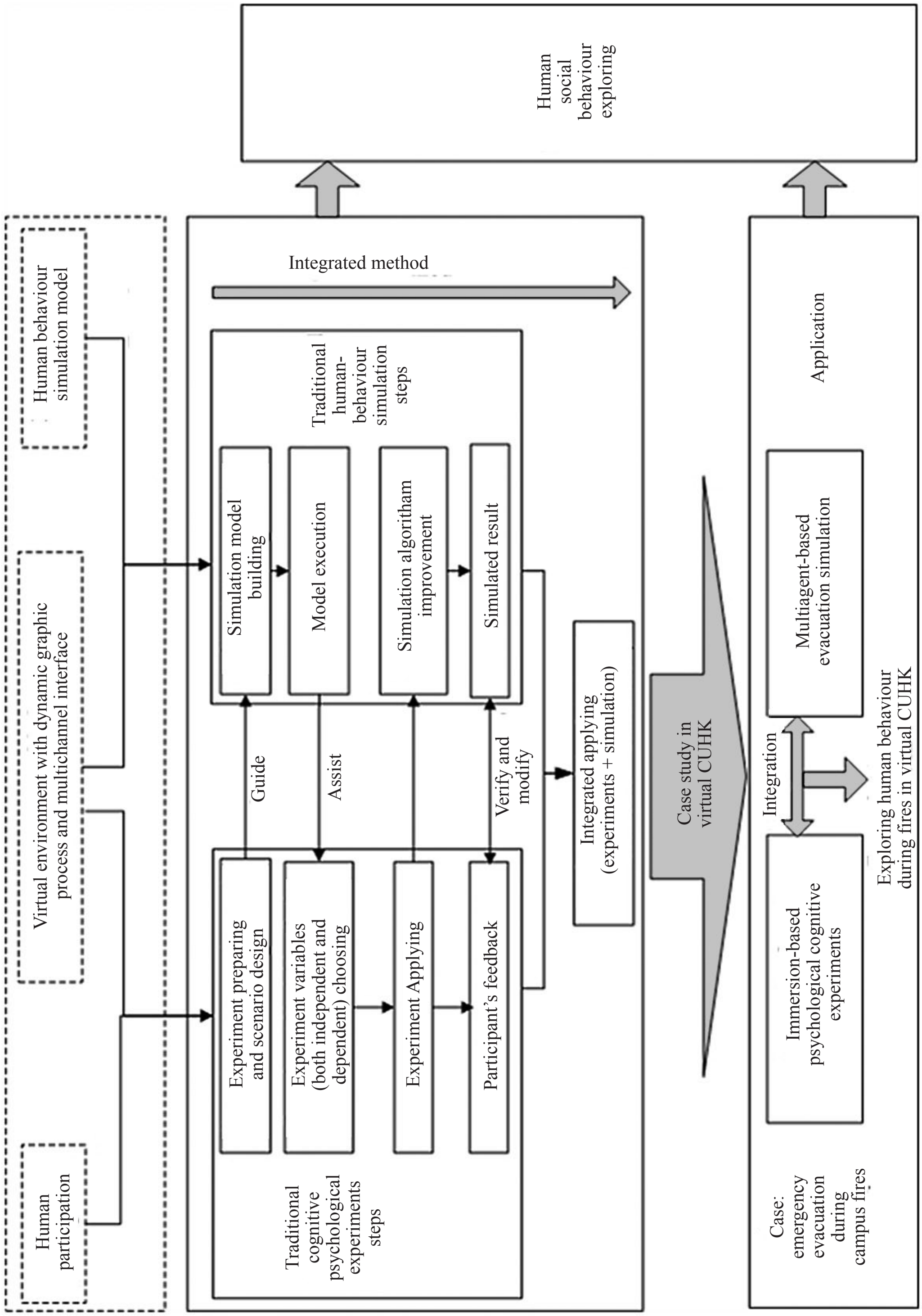

Figure 11. A case study designed for collaborative social research in the virtual Chinese University of Hong Kong (CUHK).

certain human behaviours in specific situations, such as evacuation in the event of a campus fire. The experimental procedure is shown in figure 11. Following a well-designed fire scenario, several participants equipped with immersive devices enter the building and the multiagent model is employed to simulate other individuals. When a virtual fire breaks out, participants start to escape from the real building. Since they can see the virtual fire, feel the virtual burning, and collide with both other avatars and agents through special immersive devices, they will contribute their real responses. The result of the simulation is expected to be better than merely employing agents because more real and natural behaviour is involved. During the whole process, the interaction among avatars, agents, and virtual buildings will be monitored and collected. In comparison with conducting fire evacuation drill in real buildings, costs will be saved and more virtual experiments can be conducted (eg, increasing the number of people evacuating the building by adding more agents) for multisituation analysis. In this way, not only will the accuracy of psychological experiments be increased, but also the simulation skill of the multiagent model will be enhanced. Moreover, the results of the experiments can suggest improvements to architectural design, such as better fire doors or stairways.

4 Virtual globe of the Chinese Family Tree

Another project, named the Virtual Globe of the Chinese Family Tree, is introduced in this section to explain that an RGSBVSE can also contribute to historical social research at the regional scale.

4.1 Building the Virtual Globe of the Chinese Family Tree

A family tree is a type of historical record that systematically documents the clan of the same ancestor, and contains a large amount of information about society and the economy, culture, population, history, geography, nations, customs, and religion (Ge, 1996). Family-tree mining will not only benefit the retrieval of familial changes (eg, migrations, and thriving or declining populations) from ancient times to the present but will also promote the development of society, the economy, politics, and culture (Nathan, 2011; Rose, 1996). Many recent projects related to family-tree building and mining have been developed (MyFamily, http://www.MyFamily.com; Ancestry, http://www.Ancestry.com; Genealogy, http://www.Genealogy.com; RootsWeb, http://www.RootsWeb.com; Myheritage, http://www.myheritage.cn), and an increasing number of researchers realise that geographical perspectives will greatly improve the research of family trees and related social issues (Kashuba, 2005; Longley et al, 2007; Timothy and Guelke, 2008).

The Virtual Globe of the Chinese Family Tree was developed with the aim of taking a comprehensive look at the historical evolutionary process of Chinese families from the perspective of the individual and the group, and exploring human evolutionary patterns. Real geographic scenarios, especially historically real geographic places and related geographic events play significant roles in this type of VSE for the following reasons: (1) in traditional Chinese family trees, the majority of the information recorded includes details of real historical geographical places; and (2) familial migration and other activities are often associated with real geographical events or phenomena, such as earthquakes and floods, that are also recorded (Douglas, 2006; Otterstrom, 2008; Otterstrom and Bunker, 2011). Organising and utilising the real geographical places, events, and phenomena derived from historical and geographical records will help to reveal the potential information hidden in family evolution, and further enhance social analysis (Dallen and Jeanne, 2007).

The framework of this project is shown in figure 12. The priority is in developing a virtual globe with real ancient geographic names and related geographic phenomena for locating information derived from the family tree for further analysis.

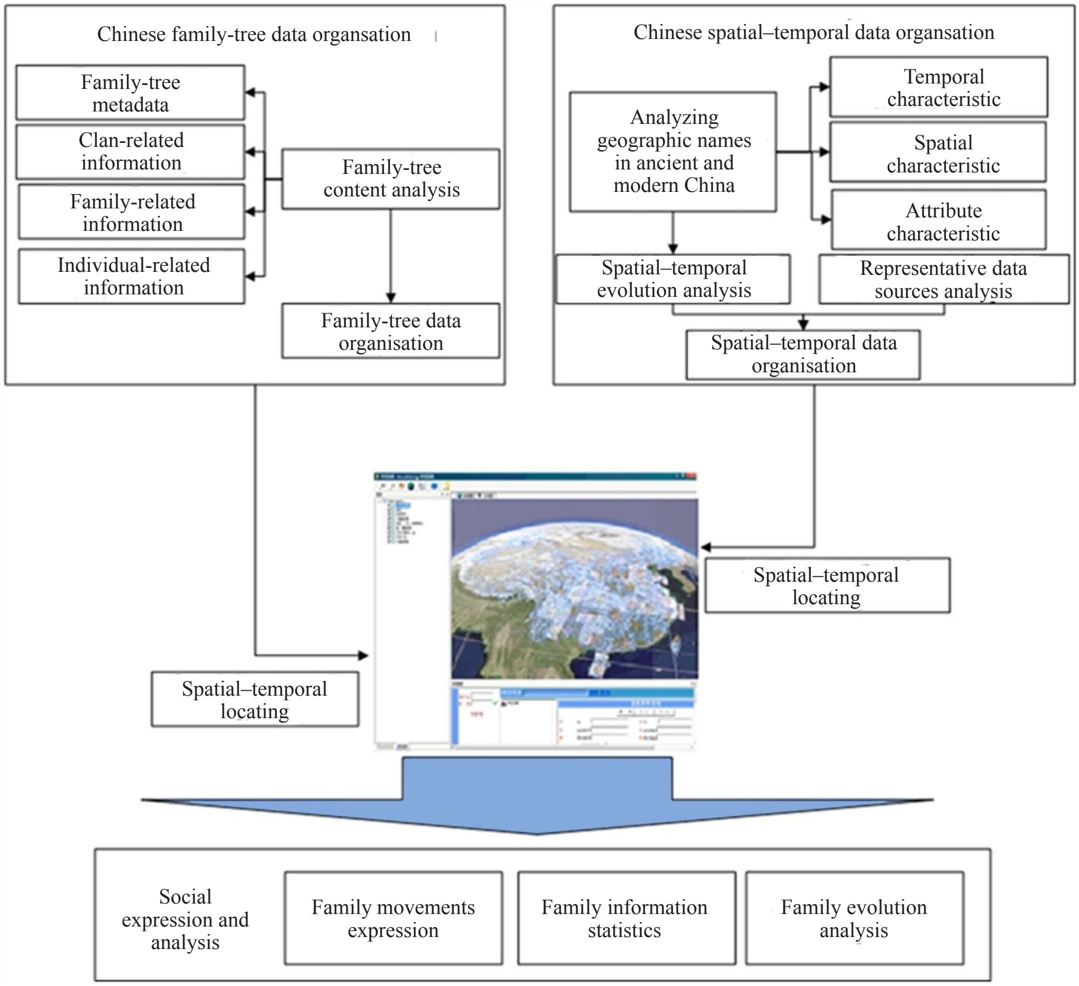

Figure 12. [In colour online.] The framework of the Virtual Globe of the Chinese Family Tree.

The independent virtual globe is developed by referencing an open source project named World Wind (http://worldwind.arc.nasa.gov/java/) and an open source render engine called Irrlicht (http://irrlicht.sourceforge.net/). The programming platform of this project is Visual Studio 2008, and the programming language is C++.

Since it is difficult to acquire ancient terrain data, especially those of hundreds of years ago, a current terrain map is used as the base map. However, the crucial part of this project is organising a vast number of historical geographic names and places as well as tracking their changing processes. The major steps can be summarised as follows: (1) designing a spatial–temporal data model for organising historical geographic names according to the characteristics of the representative data sources (historical maps and gazetteers); (2) developing easy-to-use tools for collecting and processing amounts of data derived from these two types of data sources, where the required data include not only names of ancient geographic places and the changing processes, but also the related geographic events or phenomena that greatly impact the changing processes (eg, wars or natural disasters); and (3) locating all the collected geographic places and related phenomena within the basic terrain map according to their time and locations by automatic or artificial matching. The details of this last process are illustrated in another article (Chen et al, 2011).

4.2 Expressing and analysing social phenomena in the Virtual Globe of the Chinese Family Tree

Human migration is the movement of humans from one area to another, sometimes over long periods during which the geographic names have changed (McNeill, 1984). Without real ancient geographic names, the path of migration cannot be determined accurately or traced easily. In this case, a number of confusing questions may be posed, for example, “Where’s my family’s ancestral home?” or “How far have my ancestors migrated from Ying Tian Fu (an ancient town of the Ming dynasty, corresponding roughly, with some differences

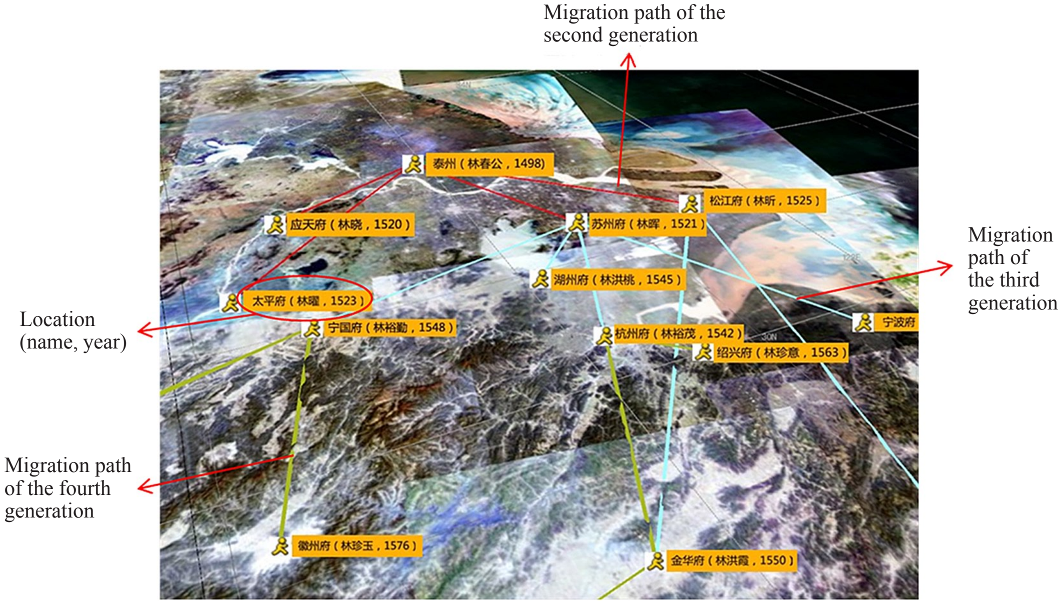

Figure 13. [In colour online.] Spatial–temporal expression of family migration.

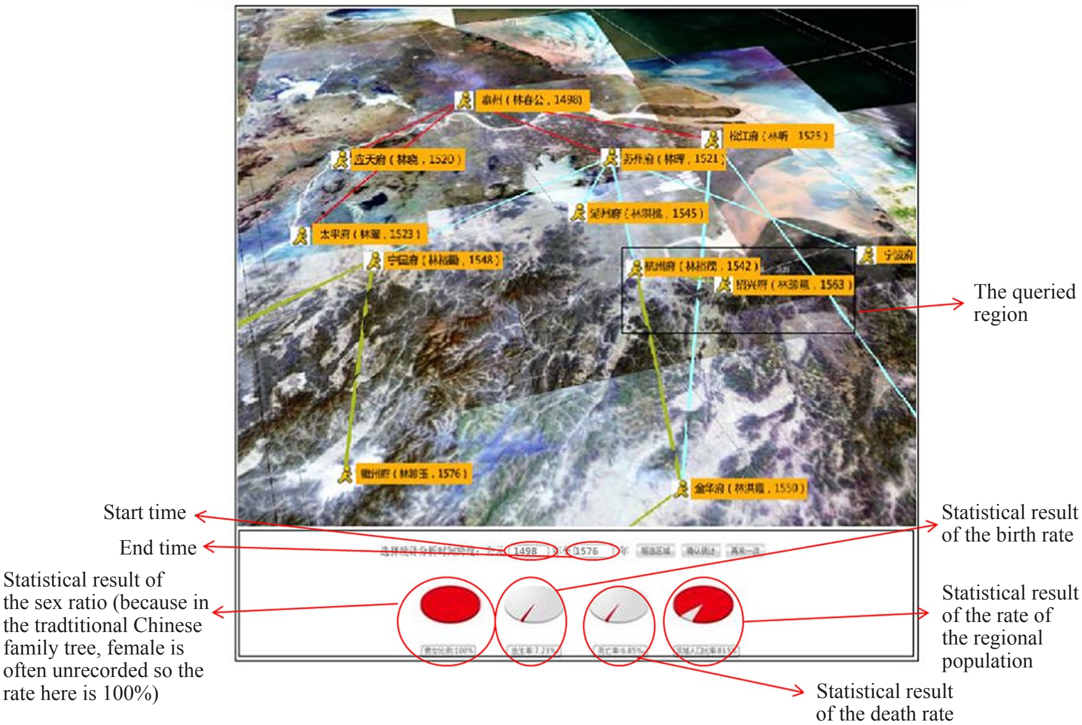

Figure 14. [In colour online.] Spatial–temporal statistics of a family during its migration.

Figure 15. [In colour online.] Spatial–temporal analysis of the migration of a family with real geographic phenomena.

in boundaries and area, to present day Nanjing) to Chang Zhou Fu (another ancient town in the Ming dynasty, corresponding to present day Changzhou, also with boundary and area changes)?" To help answer such social questions visually and precisely, real ancient geographic names should be integrated into the virtual globe. Figure 13 illustrates, in detail, the primary path of a family's migration. The nodes represent ancestors in different places, and the segments represent migration paths. The different colours of the paths are used to track different generations. In this way, all the events of the migration can be acquired visually using location markers, which are much easier to understand.

Furthermore, most users' queries require analysis beyond straightforward visualisation. With such a tool, certain information (eg, birth and mortality rates) about a clan can be statistically analysed according to the geographic area and time period. Figure 14 illustrates a representative case: by dragging a black box, the queried region is selected and related statistical results are shown in the pie charts.

An additional problem is how to explore the potential reasons behind a family's migration. Although information about a family's evolution may be recorded in their family tree, some obscure changes may occur without any apparent reason being given in the text. In this case, related real geographical events and phenomena recorded throughout the processes of geographic name evolution may provide potential clues. They can be matched using marked spatial–temporal information and then used as possible explanations for migration patterns and to enhance research concerning social evolution. Figure 15 illustrates this concept: a related geographic event (an earthquake) occurred in 1856 near Chongqing, as shown in the yellow box, and this provides a clue to the family's migration at that time.

5 Conclusion and future research

Compared with virtual scenarios, real geographic scenarios can not only provide reliable geographic data and dynamic scenarios for building a VSE, but, more importantly, also realise a special interaction through a mix of virtuality and reality. Real geographic scenarios promote VSE as a specific research platform of special significance to serious sociological research.

The characteristics of an RGSBVSE are analysed in detail in this paper. Two representative cases, at a local and a regional scale, are employed to expound how this type of VSE can be employed as an effective supplementary tool to help users to communicate and interact directly with society through a mix of virtuality and reality, and to assist sociologists and other related researchers in performing serious research and analysis.

However, several shortcomings remain to be addressed in future research. (1) Building such a VSE may be expensive and will require professional knowledge due to the importance of modelling real geographic scenarios, organising the data structure, and conducting further analysis of social issues. The collection and organisation of the data requires advanced methods; thus, an exploration of the technologies of image and video recognition and 3D automatic reconstruction is essential. In terms of the concept of VGI (volunteered geographic information) (Goodchild, 2009; 2010), integrating these technologies into terminal devices will encourage users to collect data voluntarily and to contribute to building the VSE so as to reduce the heavy cost. (2) The problem of limiting users' creativity remains. Because of the significance of real and reliable data in VSE for serious social research, and to prevent unexpected problems, users are currently not allowed to create nonexistent geographic objects; thus, users' creativity may be restricted and this kind of VSE may not be as attractive as the game-like virtual world. Consequently, greater emphasis should be placed on exploring an eclectic mode to harmonise the serious purpose of VSE with user's potential creativity, so that more participants can be encouraged to join in the environment for communication and serious research.

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