LANDSCAPE EVALUATION SYSTEM USING A 3D SPACE MODEL AND A CELLULAR PHONE WITH GPS CAMERA

ATSUKO KAGA, ATSUSHI MIYAGAWA; MASAHIRO KAWAGUCHI; WOOKHYUN YEO, TOMOHIRO FUKUDA,
Graduate Schoolof Engineering, Osaka University
{kaga_atsuko, miyagawa, kawaguchi, yeo, ,fukuda}@env.eng.osaka-u.ac.jp

Abstract. In recent years there has been a demand that local residents take part in the planning of environmental designs from the initial stages. On the issue of understanding the local environment, it is desirable to accumulate and share information and to enable it to be reused. To this end, attention has been focused on the cellular phone which can provide position information and picture information in addition to serving as a tool of general communication. For several years now it has been increasingly common for cellular phones to be equipped with an E-mail function, a web browsing function, a camera function, a GPS function, etc. Using such cellular phones, it will become possible to quickly accumulate local information with detailed picture information and position information. On the other hand, it is desirable to look at and understand an environment interactively from various points of view from the initial stage of a project. For that purpose, examination using 3D space which makes real-time simulation possible is required. In this research, using a cellular phone with a GPS camera, scene image data is collected with the aim of constructing a local scene evaluation system which can perform a picture display using a 3D space model.

1. Purpose

In recent years it has been required for local residents to take part in planning from the initial stage of an environmental design. Regarding the data needed to understand the local environment, it is desirable to accumulate and share information and to enable it to be reused. Therefore, attention has focused on the cellular phone, which can provide position information and picture information as a tool of general communication. Cellular phones over the past several years have come to be equipped with functions for e-mail,

web browsing, photography, and GPS. GPS is a satellite-based system. With the help of an array of 24 satellites, any position can be located worldwide. If such a cellular phone is used, it is possible to accumulate local information quickly with exact picture information and position information. On the other hand, to look at and understand an environment interactively is desired from the initial stage of a project. For that purpose, examination using a 3D space which makes real-time simulation possible is required. In this research, using a cellular phone with a camera and a GPS function, scene image data is collected with the aim of constructing a local scene evaluation system which can create a picture display using a 3D space model.

2. Position of this research in relation to previous research

Motoe and others are developing a system called JIKUKAN-POEMER. This is a geographic information system using a camera phone equipped with GPS (Ueda,2004). MANABE is developing the "KAKIKO map", which is an area information bulletin board with a picture (Manabe,2003). Although the linkage of GPS information, picture information, and a 2-dimensional map is seen in the above previous research, linkage with a 3D space model is not featured. In order to examine an environmental design, the examination in a 3D space model in which the stage of understanding the environment with real-time simulation is required. However, the systems development to enable scene evaluation linked to picture and position information in a 3D space model has not been developed yet.

3. System configuration

3. 1 VIEWPOINT REQUIRED SYSTEM

The functions required for realization are as follows.

- The display of the evaluation of every scene recognition item of a local resident
- A function for easy sharing of scene information among all persons involved, such as local residents, specialists
- The input and transmission to the system of required information about scene evaluation points, such as position information (latitude, longitude), time, photography and comments
- Matching with the data of the photography position in the 3D space model for a real-time simulation

If a system equipped with the above-mentioned functions is built, it cannot be limited to a specific place like a workshop for community renovation, but information about a scene can be referred to and information and space can be understood easily.

3.2. HARDWARE

The hardware components that have the greatest influence on rendering speed of a real-time simulation are as follows:

on the server side - CPU and memory;

on the client side - CPU, memory, graphics card, and video memory.

In this system, the following relatively low spec. items were used for a clients PC from the premise that many people use this kind of system.

<Server > CPU:Pentium4 3.0GHz, Memory:1GHz
<Client>CPU:Pentium3 600MHzx2, Memory:1GHz,
Graphic card: GeForce2, Video memory :32MB

3.3. SOFTWARE

In this system, data, such as GPS information and picture information, needed to be extracted from an e-mail from a cellular phone with a GPS camera and then had to be registered with on a database. Therefore, in order to realize the function, a program was created using Perl. The reasons for choosing Perl were that it is free software, and it allows the creation of executable code files, the CGI functions are substantial, and registration to the below-mentioned MySQL from a homepage is also possible.

In this system, it is necessary to read from a cellular phone the data registered into a certain DB before final output. Therefore, MySQL of the open source Relational Database Management System, which allows multi-user and multi-thread operation, was adopted.

In order to make it possible to create a local environment in 3D space using real-time simulation, VirtoolsDev was used as the base software.
DirectX API which realizes real-time rendering is used for this on the PC, and it is equipped with Player which can work by a Plug-in on a web browser. It enables visual programming which connects the programs put together as an event flow for every function of the series "Behavior Block."
Furthermore, about Building Block which is not beforehand prepared by software, a user can newly develop using C++ language.

3.4. SYSTEM FLOW

In order to realize the system flow, the following function was developed in this system. (Figure. 1)

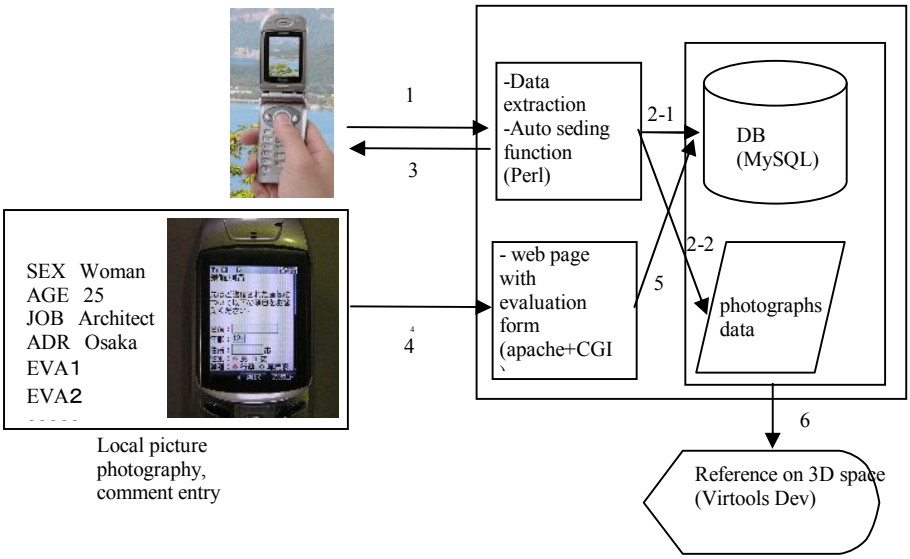

Figure 1. System Flow

1. A picture with GPS information is transmitted by e-mail.
2-1.Registration to the DB of the extracted GPS information
2-2.Preservation of the decoded picture
3.The automatic reply of the URL of a web page with evaluation form
4,5.Photographer information, evaluation criteria, transmission of comments and input to the DB
6.2D image of the object area using maps and aerial photographs, 3D display perusal. The display of photographs and illustrations of photographed places

4. Developed Function

In order to build a prototype system, the functions of the following contents were newly developed.

4.1. REGISTRATION TO DB OF EXTRACTED GPS INFORMATION

Various types of information, information called exif information, such as time, the camera name, and focal length, is added to a photograph taken with a pocket camera or a digital camera. GPS information (position information on latitude and longitude) is included in the exif information on the photograph specially taken with a cellular phone including a GPS camera. In this system, GPS information, such as "From", "Subject", " path of picture file", "file name", etc. which are extracted from image data, is registered. Then, when a POP server is accessed once first at one second, new mail is acquired and e-mail arrives, a Perl script which extracts "From" and "Subject" and is registered into MySQL is created.

4.2. PRESERVATION OF DECODED PICTURE

A picture is decoded, and a name is given and saved in a specific folder. Therefore, the Perl script which enables the following function was created. First, regarding the attachment picture, the ASCII data based on Base64 is decoded to jpeg using "Base64 decoder" free software, and the file name made in agreement with the path of the preservation place and ID is registered into MySQL. Next, using the library currently exhibited in exif information incidental to the decoded jpeg data, position information is acquired and registered with MySQL..

4.3. AUTOMATIC REPLY OF AN URL WHICH CAN ACCESS AN EVALUATION FORM WEB PAGE

The function to answer a letter automatically in the URL of a web page with an evaluation form was created. Therefore, the following Perl scripts were created. When there is neither GPS information nor an attachment picture, a letter is automatically answered in an error message. Moreover, when sent normally, a letter is automatically answered in the URL of the evaluation form that accompanied the information on ID, which is the primary key of MySQL.

4.4. TRANSMISSION OF PHOTOGRAPHER'S ATTRIBUTE INFORMATION AND SCENE EVALUATION CRITERIA OR COMMENTS TO DB

The name and age, which are information about the photographer, the address, occupational description, occupation, evaluation criteria, and comments are transmitted and registered with the DB(Figure 2). For this reason, the following Perl scripts were created. First, the data provided by the evaluation form is registered into the field that is in agreement with the ID in

MySQL. Next, the reply from the URL of an evaluation-criteria web page. Evaluations are entries of cities, towns, or villages of residence, age, sex, occupational description and occupation, five scene evaluation criteria, and free description. The table of the evaluation criteria of the DB is added along with the sent evaluation-criteria form(Figure 3).

4. 5. 2D OF OBJECT AREA AND 3D DISPLAY PERUSAL BY MAP AND AERIAL PHOTOGRAPH

Maps and aerial photographs using 2D and 3D space models respectively can be chosen so that information can be perused in suitable media and a suitable view as a display picture used as a base. Direction is displayed so that it is easy to recognize the direction of a look. In order to display and peruse in the case of a 2D map, the function of scrolling by keyboard or mouse operation and expansion reduction was added. On the other hand, when using a 3D space model, which transfers the map and the aerial photographs to a 3D geographical feature model, flyby examination with a free viewpoint is attained. Therefore, in the case of the 3D space model, in order to display and peruse, various functions were added such as rotation using the keyboard and target movement by zoom-in & out and mouse click.

4.6. DISPLAY BY ARRANGEMENT AND MARKER OF PHOTOGRAPHS TAKEN

In order to show a photograph location easily, a spherical marker is arranged and displayed on the photography point in the object area expressed by 2D or 3D.

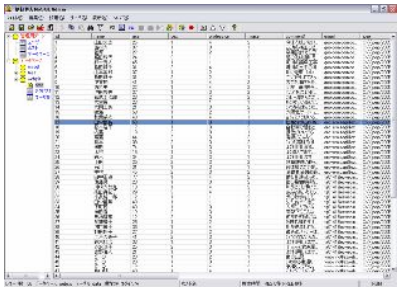

Figure 2. Database by MySQL

Figure 3. Evaluation-criteria form

4.7. ARRANGEMENT OF GPS INFORMATION TAKEN OUT FROM DB

From MySQL of another machine on a network, the GPS information of a photograph and photographer information are acquired, and a marker is placed at the point where the photograph was taken. Furthermore, classification division is carried out according to photographer (executive official administrator, specialist, citizen, guest) and evaluation, and the GPS information on a photography point is changed into XY coordinates, and a marker is arranged.

4.8. CONVERSION OF COORDINATES ON VIRTOOLS OF GPS INFORMATION

Latitude longitude is converted for the portion which hits the starting point of the coordinates of Virtools using ez navi-walk which is. In the range of the region, the error of latitude longitude is made into few things, and sets up latitude longitude and the distance per second as a fixed thing. The distance for two points used the existing algorithm.

4.9. DISPLAY OF DISTANCE AND AREA

The distance between two points clicked with the mouse is calculated and displayed. The area of the range enclosed with arbitrary points is calculated and displayed. Moreover, in the case of a 2D map, change of a scale is enabled, and the display range can be changed arbitrarily.

4.10. PRESENTATION OF PHOTOGRAPH DATA AND PHOTOGRAPHER INFORMATION

Selection of a marker displays the attribute information of the Photograph location, and the photographer. Detailed photography information can be referred to.

5. Actual Proof Experiment

In order to verify the effectiveness of the functions needed by the constructed system, the following actual proof experiments were conducted.

5.1. EXPERIMENT OUTLINE

In a road scene design project in the Kochi Tosa national road in Japan, an empirical study of this system was performed as an actual proof experiment for configuration of a Web type DB system for understanding environment

information. Specifically, the two project persons concerned performed employment and evaluation of this system in the region over about 3 hours.

Figure 4. Interface of the system

5.2. EXPERIMENT RESULT

The result of the experiment was that the picture to be considered for a scene could be taken, transmitted, and registered by about 50 places on the server. By employing this system, attribute information, such as photograph location, photography, sex, age, and comments could be displayed on the system in 2D or 3D space, as shown in Figure 4, and operation of the system could be checked. Moreover, by improving this system, information about a scene was understood smoothly and the knowledge that information sharing was possible was acquired.

6. Conclusion

In this research, using a cellular phone with a GPS camera, scene image data was collected and configuration was performed of a local scene evaluation system that can perform a picture display using a 3D space model.

An actual proof experiment was performed to verify that the developed system could perform all its required functions.

A future subject will be the employment of this system using local environment information. For example, it is possible to transmit automatically the picture created using GIS to this system, and to peruse information in integration using a layer function on this system. Then, it becomes possible to peruse simultaneously various types of local information and perform on-scene evaluation of the information using a 3D space model. Next, this problem requires several minutes for replies to e-mail transmissions or scene evaluation criteria.

A common opinion of system users was that this time should be shortened. To shortening registration time, consideration can be given to registration of user attributes using simple input methods. Moreover, there is the addition of a function for analyzing the registered data, such as the addition of an occupation search and a comment search function.

Acknowledgements

This research was partially supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Scientific Research (B), 15360321, 2005 and the Ministry of Environment, The authors express their sincere thankfulness to the Ministry of the Environment, Japan for their financial support to carry out this study, 2005

References

J Noriyuki Ueda, Yasuto Nakanishi, Shohei Matsukawa, Masasige Motoe, Geographic Information System Using a Mobile Phone equipped with a Camera and a GPS, and its Exhibitions, IEEE Fourth International Workshop on Smart Appliances and Wearable Computing (IWSAWC 2004)

Rikutaro, MANABE, "KAKIKO Map" - An Internet Mapped Information Board System, Reviewed Papers, CD-ROM, The 8th International Conference on Computers in Urban Planning and Urban Management 'sendai mediatheque', Sendai, Japan

Petschek, Peter, GPS rt 3d p – GPS and Real-time 3D Planning, Digital Design: The Quest for New Paradigms , 23nd eCAADe Conference Proceedings, Lisbon (Portugal) 21-24 September 2005, pp. 737-741

Yukiko Nomura, Tatsuya Kishimoto, Visualization of Tourists' Behavior and Activity Using GPS and GIS in Kamakura City, Proceedings of the 10th International Conference on Computer Aided Architectural Design Research in Asia, New Delhi (India) 28-30 April 2005, vol. 1, pp. 320-327

Todspol Tedrumpun, Walaiporn Nakapan, Site Measurement With Combination of Pocket PC and Global Positioning System for Preliminary Architectural Design Process, Proceedings of the 9th International Conference on Computer Aided Architectural Design Research in Asia, Seoul Korea 28-30 April 2004, pp. 717-726

Wookhyun Yeo, Yasuyuki Yuda, Sooyeon Oh, Atsuko Kaga, Tsuyoshi Sasada, Reika Sato, The Development of an Environmental Design Helping System Using Real-Time Simulationguide, Proceedings of the 9th International Conference on Computer Aided Architectural Design Research in Asia, Seoul Korea 28-30 April 2004, pp. 947-956

Naoji Matumoto, Takashi Utunomiya, Evaluation of a City Space Presentation System on Website using GIS-VRML , AIJ J. Technol. Des. No.15, Jun 2002, pp. 269-274