VISUAL RECOGNITION ORIENTED SPATIAL PRESENTATION IN CAAD SYSTEM

KIICHIRO KOMATSU
Doctoral Program in Policy and Planning Sciences
The University of Tsukuba
ten-ou dai 1-1-1, Tsukuba 305, Japan
email:komak@wright.sk.tsukuba.ac.jp
fax:+81-298-53-5070

NOBUTAKA KANDA
Graduate school of Environmental Science
The University of Tsukuba
email:nobu@wright.sk.tsukuba.ac.jp

Abstract. Computers have established themselves as indispensable tools in the practice of urban and architectural design. As they have become more and more popular, various presentation means to support computerized design tools, such as CG and VRML, have been developed and put into practical use. They have been inclined to be regarded as tools for photorealistic presentation, or as a mere shape previewer. However, considering the recent demand to esteem multi-aspects of space design, the importance of understanding and transmitting multi-aspects in space aided by visual recognition is expected to increase undoubtedly. In order to realize such assistant procedure in design, we must identify the requirements of spatial presentation in design, and apply it appropriately to visualizing process. By virtue of that, it can be said that visualization itself has possibilities to open some innovative styles of urban and architectural design.

1. Introductions

The purpose of this paper is to propose visual recognition oriented spatial presentation in CAAD system, and to discuss its possibility through some case studies.

Computer utilization in the field of Urban and Architectural Design have spread widely, and have established themselves as indispensable tools for various phases in design, from individual work to collaborative group design work. The variations of computer aided tools, such as drafting CAD, 3D-CAD and GIS, also have increased. Reflecting these movements, several

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attempts to explore innovative design steps, such as the virtual design studio and the digital design competition, have become to be held. The urban and architectural design world has learned, and put into practical use, these complex and various computer utilizing technology in a relatively short term. In that process, it can be said that CG technology has played a very important role in assisting the progress of computer utilization as their interfaces, or as their final presentations.

The role of CG in the urban and architectural design process can be classified into simulation and presentation. From the view point of realizing the presentation, major purpose of CG was to pursue photorealistic imaging technology which emulates optical rules, such as light and shadow, or texture and appearance. On the contrary, from the view point of realizing the simulation, major and indispensable ability of CG was to illustrate invisible entities which inform the amount and quality in architectural and urban space, rather than superficial information. For example, in the simulations which are frequently performed in design process (e.g. building shadow simulations, emergency refuge simulation, etc.), the technology to abstract phenomenon and to represent elements that are essential for the understanding of each objective is in demand.

It can be said that urban and architectural design consist of various simulations of relations between human and space, and hence trial and error of each simulation and interaction of them affect and determine much of the design quality. From this point of view, the processes and results of the simulations must be shared among designers and persons concerned. In aspect of sharing in design, what is important is the media for sharing. The enormous amount of drawings and materials at practical design office indicate that exact point. We should notice that almost all simulations in architectural design treat space-related phenomenon. Accordingly, to visualize processes and results of the simulations in connection with spatial objects in design, can be regarded as an essential procedure for understanding and communicating in design. Instead of the situation mentioned above, simulations about human cognition in the space, though their importance in space design is already acknowledged, have not been performed with visual assistance, and still depend much upon designers' experiences and numerical results of simulations. It will open new possibility for computer aided urban and architectural human-space design to perform simulations visually, and to give normative of evaluation from that.

2. Visual Recognition Oriented Spatial Presentation

It can be said that the pursuit of desirable space for human activities is the universal purpose of urban and architectural design. In order to realize that

and to perform studies about space design from the human-scale point of view, human behavioral researches based on the human cognition in the space have been attempted in the field of architectural planning over these years. In this field, various approaches to explain and simulate human behavior in connection with architectural space, such as investigation of personal trip and human behavioral simulation, have been examined. Although large effort was put into it, it was not enough to reflect the results into design process directly. The reason is that, since human behavioral factors are complex and largely depend on the spatial design itself, the spatial configuration is difficult to determine by the reductional way of behavioral analyses. It is not indicated that we cannot reflect the results into design process, but here it can be said that it is possible to realize human-space design through the human behavioral referring process by the assistance of visual simulation. From the point of view mentioned above, it is an essential issue for human-space design to introduce the visualizing method what we call "visual recognition oriented spatial presentation".

3. Spatial Presentation in Simulation

What points are required for visual recognition oriented spatial presentation? In this chapter, we discuss the requirements for visual recognition oriented spatial presentation from usage view of visualization in some spatial simulations. The characteristics of the visualizations at each spatial simulations referred are presented in TABLE I. below.

TABLE I. Characteristics of visualization in spatial simulations

kind of simulation	general characteristics
Walkthrough simulation	importance of photorealism, sequential presentation
Landscape simulation	importance of scale impression in objective space
Refuge simulation	effective presentation of sequential prediction
Shadow simulation	simple and effective presentation of time-series analysis
Construction simulation	presentation of procedure

As a general tendency, almost all cases visualize the relations between time and space in objectives by using animations or still images. In addition to that, there are three core requirements to spatial presentation. Following are

their explanations in connection with visual recognition oriented spatial presentation.

3.1. IMPORTANCE OF SPATIAL SCALE AND TIME-SERIES SCALE

How to treat scale in presentation is essential for spatial simulations. The scale we must treat in design is classified into spatial and time-series. The former must cover a broad width from unit space to urban space, and is usually presented by adding a scale bar or comparison objects such as people and trees. The latter also must cover a wide span from a minute to hundreds of years; in other words, from human activity level to building's life cycle level. Therefore, in addition to real-time and linear presentation, various methods such as compression of time spun and hybrid presentation of different time-slices have been attempted. For the purpose of visual recognition oriented spatial presentation, the ability to treat spatial and time-series scale is also required, especially in connection with human sensory mechanism and behavioral characteristics.

3.2. RECONFIGURATION OF OBJECT IN STUDY

From the point of view that visualization is an analysis and communication medium, it is necessary to do proper reconfiguration of space to be visualized by reducing excess information and emphasizing the points of study which are to be focused on. Actually, in the process of many simulations, various effective visual ways that enable proper reconfiguration of object in simulations have been developed and put in practical use. In human behavioral research and design based on recognition also, such methods that emphasize individual elements such as signs and sense of depth are likely to be effective.

3.3. VISUALIZE INVISIBLE INFORMATION

In addition to visualizing technology which emulates optical rules in the actual world, there is another one which visualizes invisible entities. It offers us an effective means to directly see and understand elements in objectives, such as temperature and flow. Although it is already regarded as indispensable supportive technology in the field of science and engineering, few attempts have been made in the process of human-space design. When we try to study and communicate about human-space design supported by visualization, it is not enough to visualize in an ordinary way. The reason is that the elements treated in the study relied mainly on human sensory organs and consciousness. These are essentially invisible. In order to solve this problem, it is required to utilize visualizing technologies which enable us to handle important invisible elements in design.

4. Visualizing System in CAAD

We discussed the importance of space design based on behavioral sciences and visualizing technologies which support smooth interaction between physical design and its simulation in the chapters above. Next, we propose CAD system which is aimed at realizing the points mentioned above. The essential ability of this system is that it can provide the designer means of visual study by utilizing the visual recognition oriented spatial presentation. The system is a loosely integrated one, and components of the system are three sub-systems, MODELER, SIMULATOR and VISUALIZER. The meaning of loosely integrated is that actual sub-systems are undetermined uniformly. This time we adopted the form-z, ready-made 3D modeling application, for MODELER, and programs developed on smalltalk environment for SIMULATOR. Whatever system can be used as sub-system, so long as they satisfy the requirement bellow. By virtue of that, the system can have two merits; the system can utilize ready-made environment and component of system can be changed depend on cases.

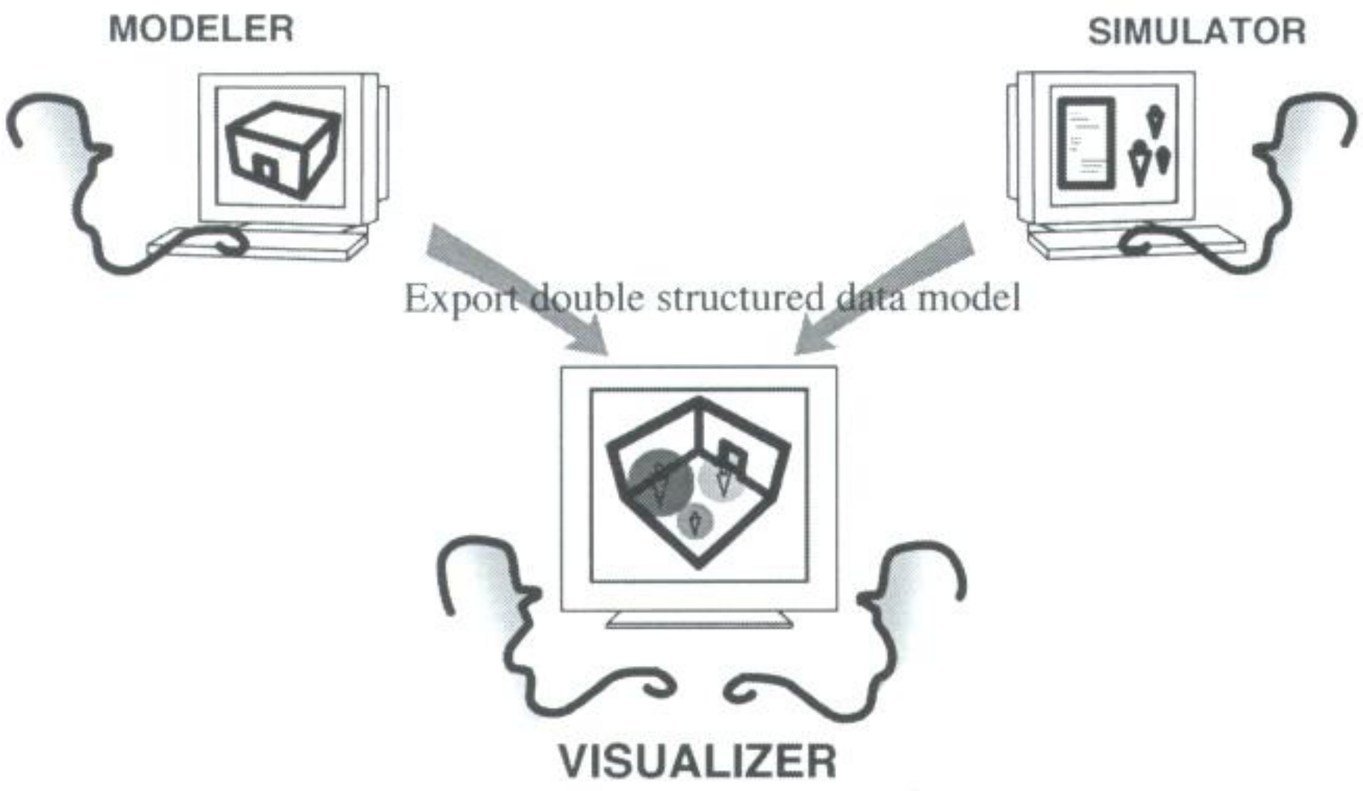

Figure 1. The outline of Visualizing System.

The MODELLER is for physical space modeling, and SIMULATOR is for the simulations based on behavioral sciences. The role of VISUALIZER is to support the understanding and analysis in interactions of these sub-systems by providing visual means for simulations in connection with physical objects in design.

In order to visualize the objects in design appropriately, data models exported from the MODELER and the SIMULATOR must have both the physical structure for modeling and the semantic structure for simulation.

(e.g. a polygon and a wall in physical model, coordination value and current human position in behavioral simulation model.) This double description enables the system to visualize objects in simulations in connection with objects in physical design. The data models are transmitted from MODELER or SIMULATOR to VISUALIZER by means of ASCII text file. Then, the VISUALIZER interpret and confine them into description for imaging.

The VISUALIZER manages the configuration of images to be visualized based on data sent from the MODELER and SIMULATOR, and generates actual images for study. Following are the points of the system's functions required to cover the requirements of spatial presentation mentioned in previous chapter.

<1. function to present both spatial and time-series scale appropriately >
Almost all studies based on behavioral sciences relate to both space and time. Therefore, the output of the system is basically in the form of animation or images which include time related contents.

<2. function to reconfigure the spatial configuration>
The system has an interface and a library to reconfigure the spatial configuration of design object from the cognitive view. It enables the system to effectively perform spatial presentation which is reconfigured for the purpose of study.

<3. function to visualize invisible information>
The system visualizes not only physical objects of design but also human environment, which is generally difficult to be handled in former manner and tend to be overlooked because of its invisibility, from the cognitive view point.

5. Case Studies

In this chapter, we discuss how the visual recognition oriented visual presentation can be applied into the process of study, and discuss its effect and possibility in design through two case studies.

5.1. THE SEQUENTIAL STUDY OF APPROACH SPACE

In this case, we propose the spatial study method by visualizing sequential shift of distance from standing position to architectural elements. This method focuses only on visual distance between human and space in order to perform the simple study about sequential shift of scale in the preliminary stage of design. The sequence of approach space is presented as animation.

Each images of animation sequence is a grayscale image, and each pixel in it represent the distance between viewing person and architectural element such as wall and floor. The meaning of each pixel color is the whiter the closer. The value of pixel is determined by exponential attenuation model which simulate human cognitive distance. (Figure 2) The study was practiced in primary approach space of several museums in Japan.

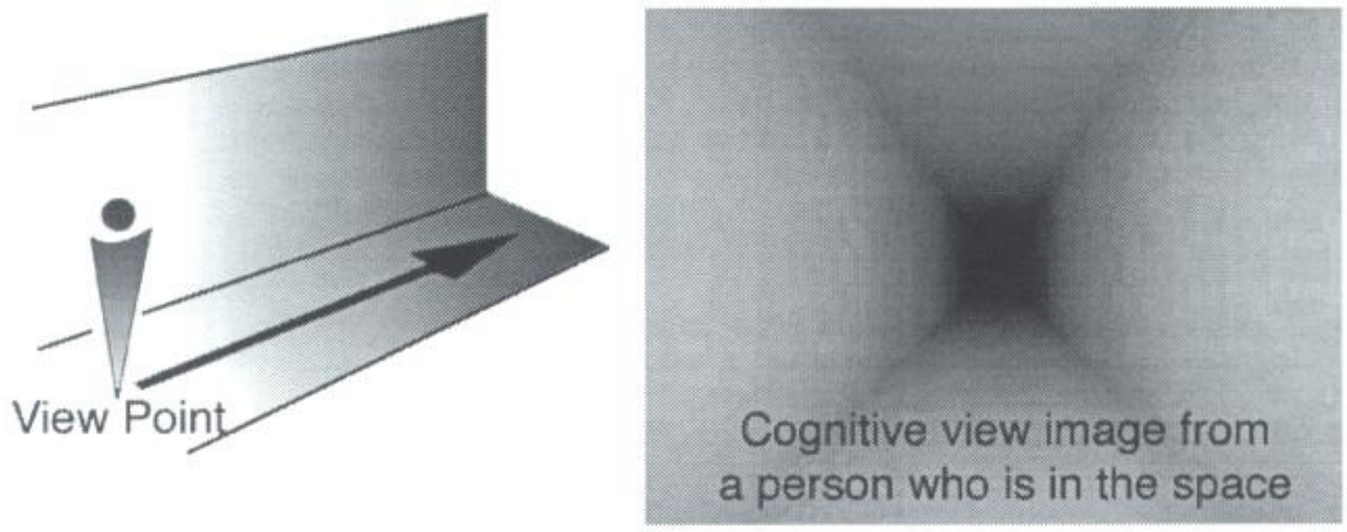

Figure 2. The visualization of cognitive distance utilizing grayscale image.

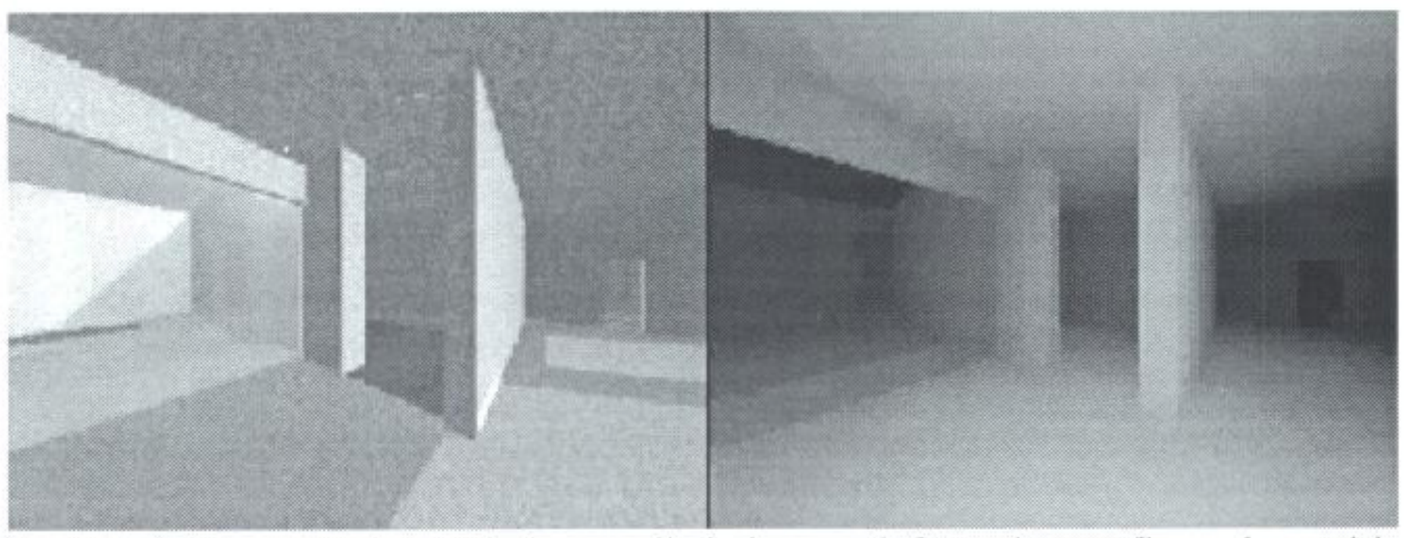

Figure 3. The comparison of photorealistic image (left) and reconfigured cognitive distance image (right). The right image illustrate global structure better than the left one.

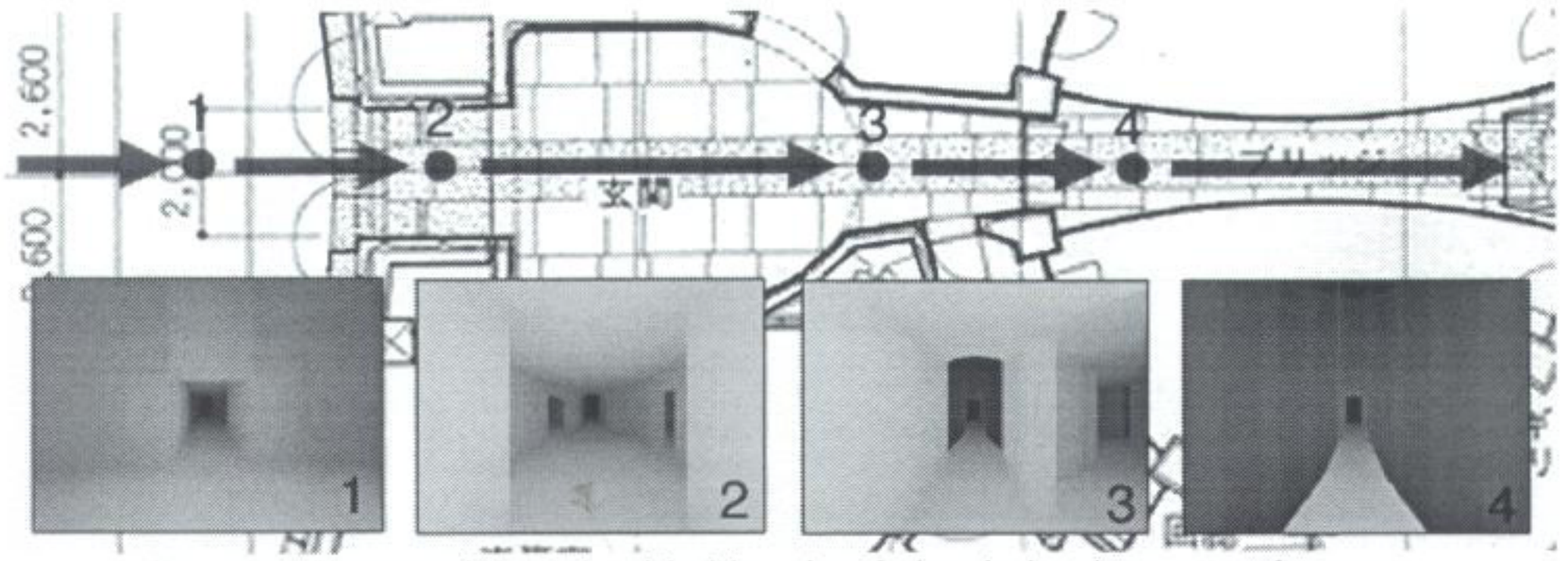

Figure 4. Sequential study aided by visual simulation in approach space.

The benefits of this method are as follows;

-The method provide the possibility to study the spatial characteristic which is essentially difficult to handle in ordinary way because of its invisibility.
-Because of simplification and characterization in spatial presentation, this method makes understanding of approach space easier, especially in its whole rhythm.

5.2. THE STUDY OF SPACE-HUMAN RELATIONSHIP IN HUMAN FLOW

In this case, we propose the visualizing method to illustrate the space-human relationship, in the result of a human behavioral simulation in flow activity. The sequential shift of individual's relationship and visual environment are focused on to be visualized. We practiced the study on a virtual street crowd model. The simulation program is developed on smalltalk environment. The program export positions and attributes of each person on virtual street, and the exported data are interpreted and reconfigured into description for visualization. The final output form is a series of animation. Followings are still image from visualized animations which demonstrate several ways of visualizing personal environment.

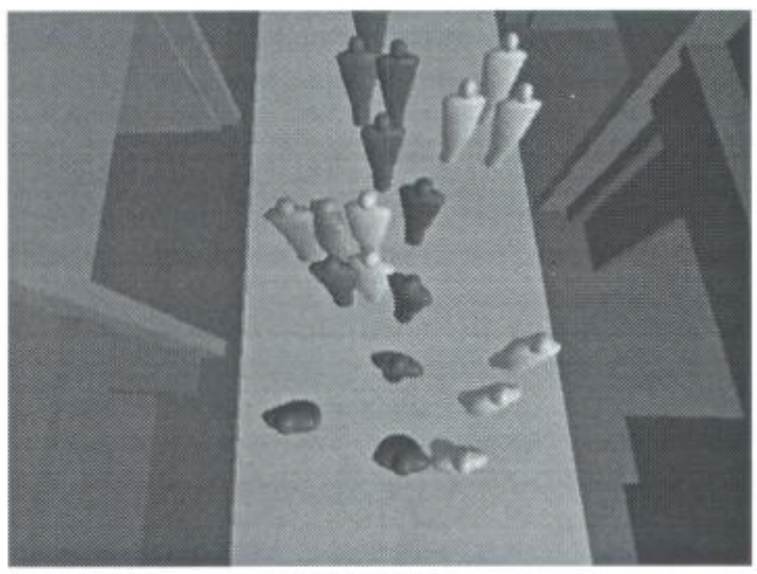

Figure 5. Visualization of human behavioral simulation on the virtual street.

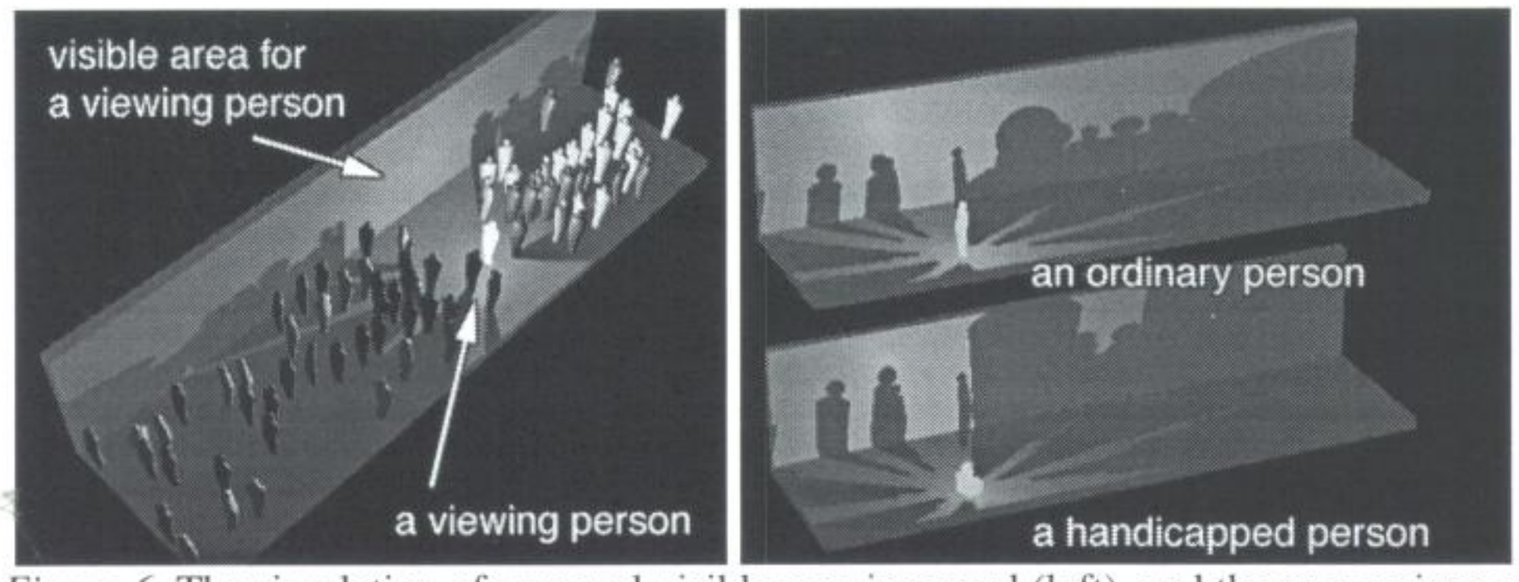

Figure 6. The simulation of personal visible area in crowd (left), and the comparison of visible area between an ordinary person and a handicapped person on wheelchair (right) . The blight area is the visible area for a person who is in the crowd.

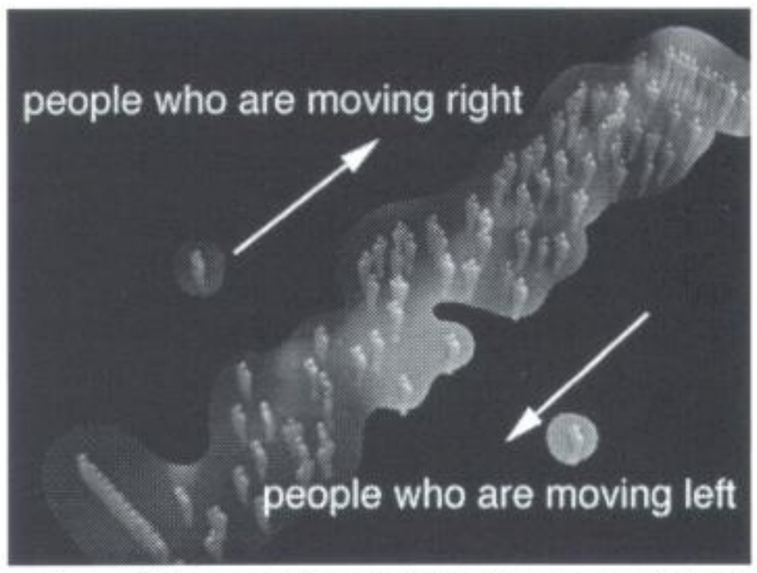

Figure 7. The visualization of the relationship between each person's conscious area in the crowd. White area is the collection of personal are of people who are moving left, and dark area is the one of people who are moving right.

The benefits of this method are as follows;
-To illustrate spatial simulation in order to help researcher or designer to understand his integrated work (design, simulation, and analysis) and explain his work to other people.
-This method realizes the human-scale visual analysis using 3D-model and simulation program, which had been difficult to perform.

6. Conclusion

Through the two case studies, it can be said that the recognition oriented spatial presentation can contribute to spatial understanding and communication in human-space design aided by computerized tools. This kind of simulation cannot be performed without CAD/CG technologies. Until recently, this kind of approach has had several difficulties to overcome. But it can be said that difficulties in technology and cost has already been cleared, or will be cleared in near future. Instead, the difficulties we must consider are the understanding and skills of the designers, who are to use the tools. The effect of CG utilization depends much upon that, because CG is also nothing but a tool. For the effective use of CG in the process of design, to have a new understanding of CG as basic literacy for idea transmission and to educate the literacy in the curriculum of design are both very important. Fortunately, the necessity of CAD/CG literacy is recently regarded as an essential issue in the practical scenes of design education. As a result, when designers who use CG understand its value as an idea transmission tool, CG technology can have a new direction of utilization in the process of design.

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