VR SYSTEM BY THE COMBINATION OF HMD AND GYRO SENSOR FOR STREETSCAPE EVALUATION

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Abstract. In this paper, Virtual Reality System for Streetscape and Street space evaluation using the Virtual Reality system are concerned. Light and small VR system using the combination of HMD and 3 axes gyro sensor, which provides a view of stereoscopic environments and enables us to view all direction of streetscape, is presented. Next, the adaptability of this system for the streetscape and space evaluation is confirmed through two experiments. The sense of Height, Volume, Amenity, Depth, and Activeness of different stand points and those by different streets which have different width are investigated and several features of sense of Street space are clarified by the VR system.

1. Background and Purpose

The prevailing the image technology using VR, virtual simulation in architectural and urban space design will possibly be the general tool for decision making in streetscape and landscape design. Considering the spread of VR technology, the system is desired to be less expensive, small, and portable. The system needs convenience so that a large number of people experience VR space at a time if enough numbers of systems are arranged.

In this paper, at first the VR system with the combination of Head Mounted Display (HMD) and 3 axes gyro sensor are considered. Secondly, in order to confirm the usefulness of presented system, construct CAD models of streets with different properties, and investigate the correlations of perception and impression as the change of streetscape.

2. VR Space Experience System

2.1. SYSTEM CONFIGURATION

VR Space Experience System consists of three devices: (i) HMD (Display part, include HMD control box), (ii) Sensor, (iii) Graphic Workstation (Processing part). These are illustrated as Figure 1.

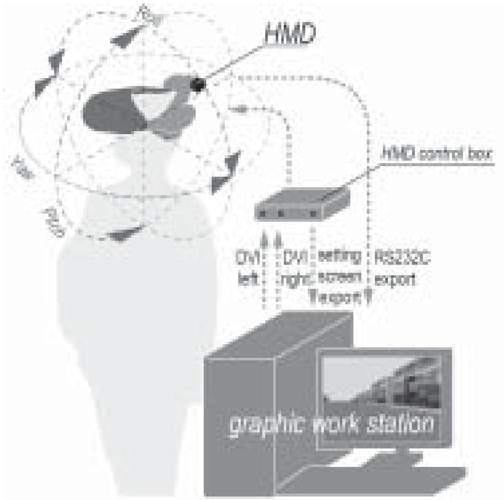

Figure 1. VR System Configuration.

CG images for right eye and left eye from rendering software on Workstation are output to each VGA size LCD in HMD by way of dual DVI port and HMD control box. From 3 axes gyro sensor set on the HMD, 3 rotation degrees of the HMD is transmitted to workstation in real time. Using the degrees' information, also VR rendering software controls the direction of camera angle in real time. Consequently, the system realizes the interactive-3 dimensional VR environment which synchronizes with the movement of the wearing head. It weighs less than 1 kg, is easy to carry, and easy to set up at any place.

2.2. CONSTRUCTION OF VR STREET SPACE

VR space model for testing is constructed as per following procedures.

1. Take pictures of façade of building, and trim them (Figure 2).
2. Geometrically correct façade images. Transform trapezoid to rectangle so that tilted lines become vertical. Adjust the height of each floor to correct the compression of vertical scale (Figure 3).

Figure 2. After trimming the image.

Figure 3. After geometrically correcting the image.

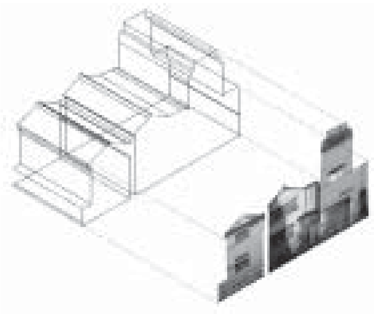

Figure 4. Mapping the image.

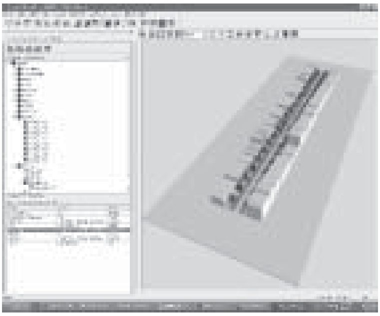

Figure 5. Integrate and import the 3D street models.

3. Construct building 3D CAD volume model which fits façade image using 3D modelling software and map the façade image file on the model (Figure 4).

4. Integrate 3D models constructed in procedure 3. Assemble them with staffages such as roads, street signs, trees, cars, etc. (Figure. 5).

5. Import constructed 3D street models in a single project file on VR software. The models have different properties for the purpose of experiments (Figure 6).

6. Make initial settings of parameters: view points, parallax, view angle, view port size, etc. (Figure 7).

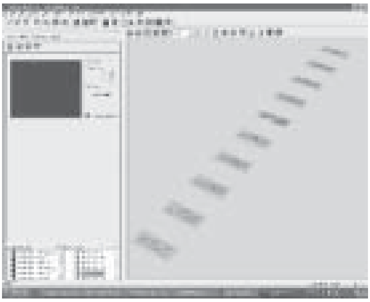

Figure 6. Layout several 3D models same VR space.

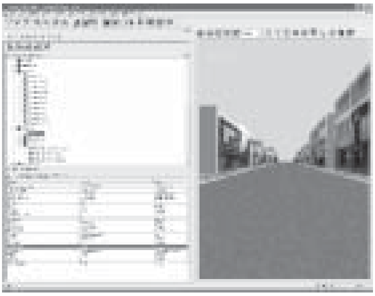

Figure 7. Screen for initial setting of on parameters.

7. Describe scripts in VR software to switch over view points by pressing selected keys.

Thus, VR environment, such that viewers can look around by 3 axes, 6 directional, and stereoscopically and street spaces can be switched over quickly, is realized.

3. Experiments for impression and perception.

Using the VR system, perception and impression values on different street spaces are investigated by questionnaires. Figures 8 and 9 show examples of VR streetspace.

Concretely, through the experiments, the change of perception value and impression value by the change of 1.standing points and 2.street widths are quantitatively analyzed, and those relations are investigated. As a term of impression, “Width impression”, “Depth impression”, “Height impression”, “Volume impression”, “Activity”, “Pleasantness”, are adopted. Virtually modelled street is a part of “Cat Street” which is a street from “Harajuku” to “Shibuya”, centre area of Tokyo, Japan. In experiment 1, compare the changes of perception and impression value as viewer moves from centre to building side by 1m. In experiment 2, compare the value of them in every case of street which width are 5m to 27.5m by the interval of 2.5m.

Figure 8. Example of reference space.

Figure 9. Example of comparing space.

4. Experimental Results

Firstly, the accordance of perceptual scale and physical scale in VR environment is verified. Secondly, impression values in VR environment by 11 people are plotted on 2D graphs, then the following two graphs (Figures 11 and 12) are lead.

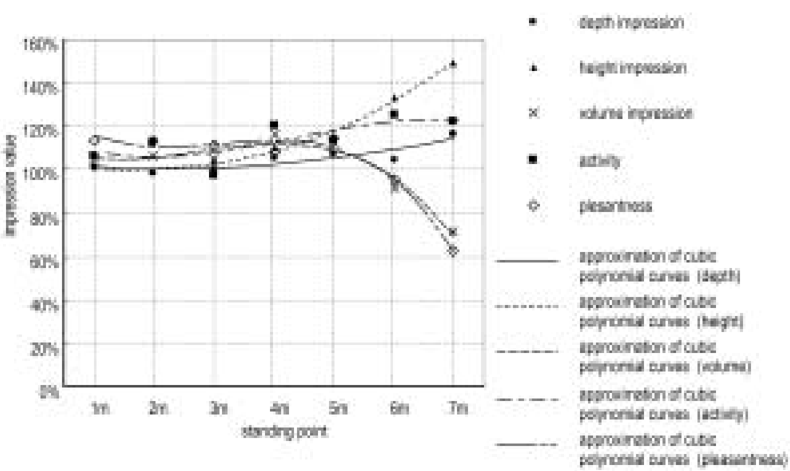

Figure 10. Impression value of standing point.

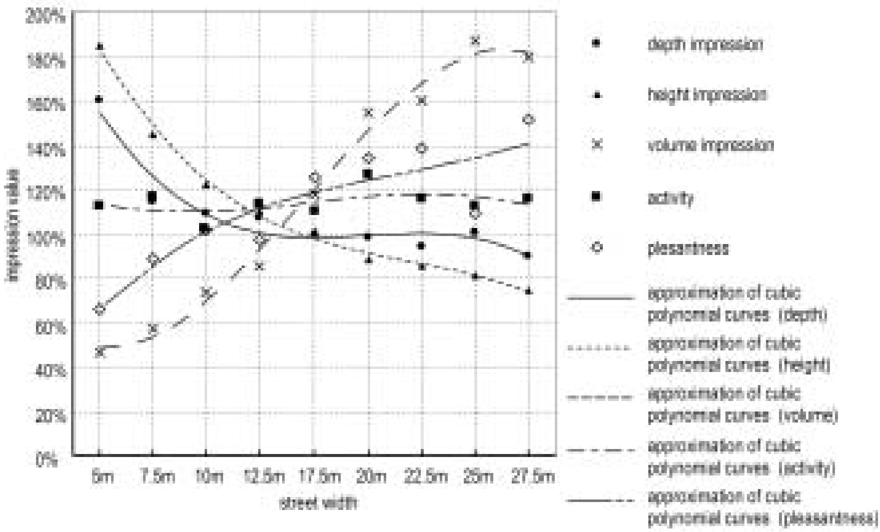

Figure 11. Impression value of street width.

These graphs show the following information.

1. Volume impression and pleasantness have a strong correlation and those values are higher as standing points are closer to the centre of street.

2. Height impression is higher as standing points are closer to the building and the street is wider.

3. Activity has no relation with street width and becomes higher as the street is wider.

4. Depth impression is not influenced by standing points and is higher as the street is narrower.

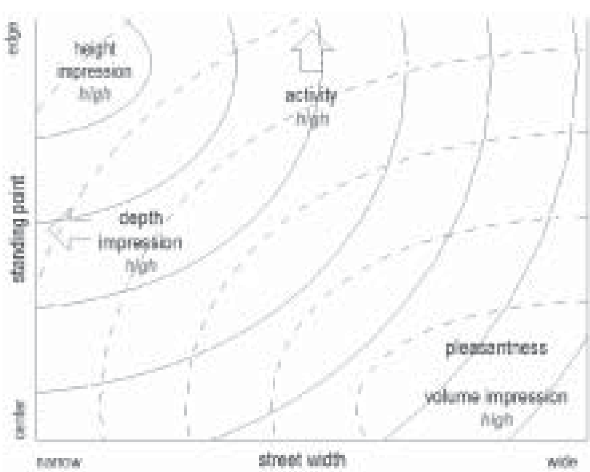

Figure 12. Correlation of street width and standing point.

This knowledge of impression is integrally explained by Figure 12 which shows impressions' properties on standing point axis and street width axis's plane.

5. Conclusion

In this study, a convenient VR system for streetscape simulation with HMD and 3D gyro sensor was presented. Furthermore, using the system, the relation with perception value and physical value of streetscape are analyzed and their properties are investigated. As a future application of presented way to find guidelines for better streetscape should be an important subject. Besides, the development of a computer-aided design system which automatically produces optimal street designs using the human perceptional properties should be our next subject.

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