DEVELOPMENT OF LANDSCAPE PLANNING SUPPORT SYSTEM USING INTERACTIVE 3D VISUALIZATION

A case study in Malang, Indonesia

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This study is an extension of a previous study on the visual evaluation of commercial areas in Kayutangan Street, Malang. This study focuses on the development of an interactive 3D visualization system to help decision-makers improve the quality of the Kayutangan streetscape. An interactive 3D visualization is an important part of an urban streetscape 3D simulation that presents various alternatives for landscape changes. It also facilitates interaction between users and 3D models. Considering that this system is new and has not been widely used in Malang society, as well as to assist people to understand the system, this paper proposes a user interface design that combines three models of 3D simulation: passive observation, active navigation, and active interaction. The diversity of this 3D simulation is expected to be easy to use and encourage public participation. This paper also emphasizes the utilization of a multimedia application authoring platform in order to produce an effective prototype application. A pilot workshop was conducted to promote the system to the academic community and experts in Malang.

Keywords: Computer applications, 3D simulation, User interface, Historic streetscape, Workshop

1. Introduction

Architects and urban planners have a responsibility to create urban spaces that ensure that an urban experience is comfortable and satisfying for the community. The evaluation of urban images is an important way to ensure a valuable aesthetic experience. Because the evaluation process is closely related to humans and the environment (Nasar, 1998) and in order to obtain an adequate evaluation results, the process of urban planning should involve effective public participation.

On the other hand, the government should be anticipate urban growth through proper urban planning. Further, the community requires the delivery of design ideas through a process of public participation in a medium that is easily understood by them (Laing, 2011). Public participation activities should be conducted in the initial stages of the urban planning and design. The earlier and more intensively the public are involved in an urban planning project, the more likely the project will be to succeed (Wu et al., 2010). Hence, governments require proper advice and an effective response from the community regarding any city spatial planning efforts.

According to Paar (2006), the demand for 3D visualizations for landscape and environmental planning depends on country-specific planning procedures, economic situation, and the level of public participation. Computer visualization can be optimally used in the planning process to build an environment through community involvement if the method is popular in the community and these technologies are easily accessed and operated.

Indonesia is a developing country that requires expert help and better techniques to design city plans more effectively. The urban landscape has grown rapidly and uncontrollably in Malang, especially the Kayutangan streetscape, an important historic corridor in Malang. The Kayutangan streetscape had undergone some significant changes that include the demolition...
of some historic buildings, an emergence of unbalanced modern buildings, a narrowing of the sidewalk, original building façades that have been covered or changed color, and a disorderly abundance of commercial boards along the street.

The conventional method of urban planning that involves direct meetings with the public is perceived as incapable of handling the rapid growth of Malang. Images and other 2D media presentations are also less favored because of the varying levels of public understanding of technical drawings. On the other hand, advanced computer technology and Internet communication have spread quickly throughout Malang society. This is an opportunity to develop online public participation utilizing web technology. Further, virtual environments in planning support systems require user interaction for observation and navigation. Through interaction, the user is expected to freely explore the space as well as assess it. Therefore, it is necessary to develop an interactive 3D simulation system for urban planning that can be distributed via the web.

With respect to the development of interactive 3D simulation, there are many studies in Japan that use Virtual Reality (VR). Honjo and Lim (2001) studied the visualization of landscape in a garden and introduced an interactive simulation for various design scenarios. Koba and Kishimoto (2009) examined desirable building forms and façades in Marunouchi. Further, several researchers have developed VR systems and user (web) interfaces for building consensus. Kawakami and Shen (2006) assisted consensus in public participation by developing a decision support system for district planning in Kanazawa city. Koga et al. (2008) developed a landscape planning support system for public participation that also used models as an analog tool. Takiguchi et al. (2009) developed multi-media tools to support town-planning workshops. Shen and Kawakami (2010) developed a visualization tool on a multi-user platform to represent design alternatives and supplement traditional presentation material for reaching a consensus on townscape designs.

Many studies have developed, tested, and proved various visualization models, including web-based interfaces. Almost all these user interfaces directly focus on the interactive 3D simulation and comprise a wide range of interactions panels from simple to complex. However, no one has emphasized the need for adequate design of the user interface for the interactive 3D visualization, nor considered the diversity of user understanding in developing countries. Especially for developing countries, not everyone is able to operate the system properly. On the other hand, a user interface design should encourage people to engage in decision making. Therefore, it is necessary combine an interactive 3D simulation with an appropriate user interface.

Furthermore, the use of interactive 3D visualization to facilitate public participation is most likely a genuinely new approach for Indonesian countries. Therefore, this system is most probably the first one in Malang. In addition, the most of the participants will have never seen or used a similar system. Hence, in order make it easy for participants to utilize the system, we propose a strategy for interactive 3D simulation that embeds three types of 3D simulation: passive observation, active navigation, and active interaction.

2. Previous Work: A Visual Evaluation of The Kayutangan Streetscape

This study focused on a commercial building streetscape in a historical district, the Kayutangan Street corridor, which has been a commercial area in Malang since 1914, during the Dutch colonial period. The urban image of the Kayutangan streetscape is a symbiosis of the *Nieuwe Bouwen* style, with wide sidewalks and trees arranged along the street. Overall, it embodies the concept of a Dutch tropical city that has been adopted as the basis for the conservation of the Kayutangan area.

![Fig. 1 Map of Kayutangan Street](image)

TheKayutangan streetscape is conserved by control of the buildings and environment through regulations for building coverage (KDB), floor ratio (KLB), floor height (TLB), green coverage (KDH), and building setback (GSB). Based on regulatory reviews between 2001 to 2011, the rules were changed regarding the development of new commercial buildings in the Kayutangan area as follows: building coverage decreased by 10%, maximum floor ratio limit increased to 3.0, building height increased between 4–20 floors, green coverage was 40%, and building setback now ranges between 4–13 m. The sidewalk width also was narrowed from 4 to 2 m to widen the street. There is not much awareness of the need to preserve the unity of the sidewalk width with the historic buildings along Kayutangan streetscape.

Recently, the Kayutangan streetscape has gradually degraded in visual quality because of the inability of weak city regulations to preserve historical and cultural assets (see Fig. 2). The Kayutangan streetscape had undergone some significant changes that include the demolition of some historical buildings, emergence of unbalanced modern buildings, narrowing of the sidewalk, covering of original building façades, color changes of building façades, and the disorderly abundance of commercial boards along the street.
A visual evaluation of Kayutangan streetscape investigated the physical characteristics of the streetscape elements consisting of building setback, setback profile, sidewalk, trees, and building façades. The investigation determined three typologies of commercial building streetscapes (Santosa et al. 2013), as follows:

1. Dutch style (see Fig. 3)
   a) The building styles are dominated by the *Nieuwe Bouwen* style, characterized by horizontal and vertical shapes, flat roofs, and white paint.
   b) Sidewalks are positioned adjacent to the building frontage, creating a shopping arcade.
   c) The presence of trees in general functions optimally as shade and an aesthetic.

2. Modern style (see Fig. 4)
   a) The building styles are dominated by contemporary styles, characterized by an irregular building form and the use of various shapes and colors.
   b) The sidewalk position is almost always separated from the building frontage by parking lots.
   c) The presence of trees in general is intended more for aesthetics than for shade.

3. Indonesian style (see Fig. 5)
   a) The building styles are divided into two styles, modern and traditional. The building form is characterized by a simple shape, the use of natural materials, and a gable roof.
   b) The sidewalk position is almost always separated from the building frontage by a parking lot or open space.
   c) The presence of trees in general optimally functions as shade and an aesthetic.
The results of this study were utilized as a basis for the 3D visualization that consists of six concepts, i.e., the identification of streetscape elements, determination of 3D object types, geometry optimization, texture selection, division of streetscape areas, and adjustment of the variables. The six concepts of the 3D visualization determined the development of an interactive 3D simulation in order to create constructed interactive types for each of the streetscape elements.

3. Method of System Development

3.1 Concept of 3D visualization

The 3D visualization concepts consist of six basic 3D modeling construction concepts to guide the development of the 3D simulation. Each of the concepts are defined as follows:

1. Identification of streetscape elements
   Streetscape elements were divided into primary and secondary elements. The primary element is the main 3D object for the simulation such as building, sidewalk, billboard, and tree. While the secondary elements are the supporting objects of the simulation such as street and sculpture.

2. Determination of 3D object types
   This concept divides 3D objects into adjustable (non-fixed) and non-adjustable (fixed) objects. The determination was based on the targeted object of the simulation.

3. Geometry optimization
   The geometry was optimized by reducing the number of polygons (polygons with fewer vertices) and constructing a single entity for each object. This strategy reduces the file size and affects the access and interaction speed.

4. Texture selection
   Texture types were divided into fixed and non-fixed textures. Fixed textures are permanent texture that cannot be changed, while the non-fixed textures are changeable.

5. Division of streetscape area
   Because of the complexity as well as the vast area of the simulation, it was necessary to divide the streetscape area into two types: the division of the streetscape into public and private zones and the division of the Kayutangan street into three zones (zone 1, zone 2, and zone 3 in fig.8).

6. Adjustable variables
   The alteration or adjustments of 3D objects are categorized into three types: the changes in position, height, and texture.

3.2 Development of the 3D simulation

Almost none of the participants will be familiar with the system, and therefore, well-designed visualizations and interactive tools can help to improve their participation in the urban planning processes (Wu et al., 2010). The development of effective navigation in a 3D simulation can also help determine a strategy, direction, and course (wayfinding) to achieve a desired goal (Volbracht and Domik, 2000). Moreover, the user interaction capability of navigation is essential for assessing the spatial qualities of a 3D simulation. Therefore, the development of various navigation and 3D simulations were designed to ease understanding and improve the ability of the user to interact.

Given the diversity of understanding and ability to interact with a 3D simulation as well as fostering familiarity with the system, three types of 3D simulation were developed in order to stimulate a rich understanding and interest the public. The three types of 3D simulation were categorized at three levels of interaction, characterized by the capability of the simulation to interact with the user (see Fig. 6). The three categories are as follows:

1. Type 1: Basic interactive level
   The basic interactive level is the lowest level of user interaction with the system. The 3D simulation at this level is passive observation. It offers a walkthrough animation of various streetscape compositions, and users observed the model during the predefined animation. Users could score the animation on a scale of 1–7.

2. Type 2: Intermediate interactive level
   The intermediate interactive level is the second level of user interaction with the system. The 3D simulation at this level is active navigation. It offers a VR of various streetscape compositions. Users perform a walkthrough and affect their motion in the virtual environment through navigation aids. Users can also score the simulation on a scale of 1–7.

3. Type 3: Advanced interactive level
   The advanced interactive level is the highest level of user interaction with the system. The 3D simulation at this level is active interaction. It offers a VR for various streetscape compositions. Users perform a walkthrough, affect their motion, and interact with 3D objects in the virtual environment through navigation aids and a number of provided control panels. The user can save the results of modifications to a file for the benefit of decision-making.
The system development utilized three software applications\(^6\) consisting of 3D modeling software, 3D visualization software, and a multimedia application authoring platform. The 3D modeling software was used to produce various types of 3D modeling. The 3D visualization software was used to produce a predefined walkthrough animation. Both types of data, 3D modeling and animation, were processed using a multimedia application authoring platform (see Fig. 7).

The multimedia application authoring platform has an advantage in that in the design of the graphical user interfaces is supported by a scripting language that can interact with external files. In addition, this application is able to work with 3D objects (Shockwave 3D)\(^6\) using a scripting 3D language\(^6\) that can import, manipulate, display, and interact with 3D objects.

The graphical user interface that combined the external data of the passive 3D simulation with the 3D interactive simulation formed the prototype system called the Landscape Planning Support System. This system can be published as a standalone executable or as HyperText Markup Language (HTML) files on the web. The overall system development process is shown in Fig. 7.

During the development of the interactive 3D simulation, 3D navigational aids were developed as a user interaction tools in the virtual environment. System navigation strategies should consider the type of user interaction required in the virtual environment. The system must be easy to use, should not confuse the user, and must be customized for user interaction.

\subsection*{3.3 Development of the user Interface}

According to many studies on web applications, user interface design is highly important for successful user interaction. Some principles of good user interface design are user compatibility, task compatibility, workflow compatibility, consistency, familiarity, and simplicity. The lack of understanding about adequate user interface design undermines a user's desire to interact with a system. The Indonesian language is one part of the culture of communication\(^7\) in the Malang community and was used in all of the instructions and user interface information. Thus, the system was expected to be more easily understood and operated by users in Malang.

The user interface integrates passive and interactive 3D simulation into a complete prototype application. It was designed to be a media solution and communication tool for users. With an appropriate user interface, the system was expected to attract public interest and elicit more contributions and input into urban planning.

Because of the large number of buildings and variable settings for each element, the interface panels constitute many interactive panels and navigational aids. Clearly, this will create a reluctance to operate the system. Therefore, the interactive panel and navigational aids should be made more simple, interesting, and easy to understand. Moreover, in order to create a system that is easy to run, the user interface was divided into three zones of the Kayutangan streetscape (see Fig. 8), and also separated between the public and private zones, especially at the advanced interactive level.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Fig8.png}
\caption{Zoning of Kayutangan streetscape}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Fig9.png}
\caption{Scheme of user interface design and diagram of interactions}
\end{figure}

The user interface was divided into four primary sections (see Fig. 9) as follows:

1. Main interface
   The main interface functions as a gateway to the system that contains introductory information.
2. User interface of the basic interactive level

At the basic level, the user interface is divided into four sections consisting of a 3D simulation panel, guidance map, street profile type selection button, and scoring panel (see Fig. 10). The 3D simulation panel shows a predefined walkthrough animation of the Kayutangan streetscape. This animation was categorized as a passive interaction or observation because the user only observes the various simulated types of streetscapes as a movie. On the right panel, there are four types of street profile that can be selected and linked to the 3D simulation panel as follows:

1. Type A: the existing street profile of Kayutangan Street characterized by the presence of a sidewalk, on street parking, and street divider.
2. Type B: the street profile characterized by a setting of the sidewalk, small garden, and on street parking as a unified design.
3. Type C: a street profile characterized by the integration of greenery in the street median.
4. Type D: a street profile that combines types B and C.

The guidance map panel gives directions to the streetscape zone position on Kayutangan Street. To evaluate each type of streetscape choice, a scoring panel is provided at the bottom into which a user can input a score. The range of scores from 1 to 7 indicates agreement to disagreement.

3. User interface of the intermediate interactive level

At the intermediate level, the user interface is divided into four sections consisting of a 3D simulation panel, interaction guide, selection panel for 3D simulation types, and a scoring panel (see Fig. 11). The 3D simulation panel presents the virtual environment of the Kayutangan streetscape. This simulation is categorized as an active navigation because the user has the opportunity to subjectively observe various simulation types of the Kayutangan streetscape. On the right, there is a guide that describes the use of a keyboard and mouse to assist the user’s navigation through the 3D simulation. Meanwhile, the selection panels of the 3D simulation types present choices based on the four types of street profile. For the evaluation, a scoring panel was also provided at the bottom of the interface. The evaluation method was similar to that of the interactive basic level.

4. User interface of the advanced interactive level

At the advanced interactive level, the user interface is divided into two groups, namely interactive 3D simulation in a public zone, and interactive 3D simulation in a private zone. Both simulations are categorized as active interactions because the user has the opportunity to visually observe as well as interact with a number of elements in the virtual environment.

The user interface of the public zone is divided into six sections consisting of a 3D simulation panel, interaction guide, streetscape element control panel, tree height control panel, sidewalk material control panel, and a button to reset or save the model (see Fig. 12).
The 3D simulation panel presents a virtual Kayutangan streetscape. On the right side there is a guide that describes the use of a keyboard and mouse to assist the user’s navigation and how to alter streetscape elements using the control panel. Using the control panels, the user can easily hide or show streetscape elements, change tree height, or change sidewalk material.

Meanwhile, the private zone user interface is divided into nine sections consisting of a 3D simulation panel, interaction guide, link for editing façade color, building code information, building height control panel, building presence control panel, building setback control panel, a button to reset or save the model, and a guidance map (see Fig. 13). The 3D simulation panel presents the virtual Kayutangan streetscape. Using the control panels, the user can easily adjust the building height, presence, and setback as well as the façade color. Especially for the adjustment of façade color, there is a separate control panel that links to the other interface. A user can easily set the color on each building façade.

4. Testing the system in a workshop setting

In order to test the system, a workshop was conducted on 5 – 7 December 2013 in Malang, Indonesia. A total of 22 people participated. The participants consisted of a lecturer, undergraduate and master students from the Architecture and Urban Planning Department of Brawijaya University, also experts and the public. The composition of the workshop participants is listed in Table 1.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Number of people</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecturer of Architecture and Urban Planning Department</td>
<td>9</td>
<td>40.91</td>
</tr>
<tr>
<td>Undergraduate &amp; Master students</td>
<td>8</td>
<td>36.36</td>
</tr>
<tr>
<td>The Experts</td>
<td>3</td>
<td>13.64</td>
</tr>
<tr>
<td>Public</td>
<td>2</td>
<td>9.09</td>
</tr>
</tbody>
</table>

The workshop involved several events consisting of a lecture, site investigation, clarification of issues, system operation, and evaluation (see Fig. 14). This series of activities was devised to provide an understanding of the issues at the site before system operation and evaluation.

First, a lecture presented the history and development of Malang City from the Dutch colonial period to the latest
developments. It also described the experience of using the landscape planning support system and technical details of the system operation.

Second, participants were subdivided into three groups and investigated the site. Each participant investigated the issues and filled out a questionnaire regarding their impressions as well as any issues identified during the site investigation. The questionnaire was adjusted according to the method of Analytic Hierarchy Process (AHP) and intended to help participants determine the importance level of emerging issues. This questionnaire was divided into two categories: public and private zones. The private zone consisted of building height, setback, materials, advertising, and colors. The public zone consisted of street width, street median, sidewalk width, sidewalk materials, street lights, banners and billboards, trees and plants, and the parking area. The questionnaire was completed in two stages. First, participants determined beforehand the criteria that they considered more important between two choices. Then, participants determined the importance level on a priority scale. The priority scale was divided into nine categories, from 1 to 9 (equal to extreme importance).

Thirdly, participants clarified issues through prioritization using the AHP software. In this software, all the choices and priority scales were inputted and automatically evaluated for consistency of values or choices. The AHP software also calculated priority scale issues. The results in each group were compiled and are listed in Table 2.

Table 2 AHP scores based on the percentage of priority

<table>
<thead>
<tr>
<th>Zone</th>
<th>No.</th>
<th>Issue</th>
<th>Weights (%)</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private zone</td>
<td>1</td>
<td>Building heights</td>
<td>18.6</td>
<td>6.1</td>
<td>15.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Building setback</td>
<td>14.9</td>
<td>1.4</td>
<td>13.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Building material</td>
<td>14.9</td>
<td>1.4</td>
<td>13.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Building advertisement</td>
<td>21.3</td>
<td>2</td>
<td>19.3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Building colors</td>
<td>20.7</td>
<td>2</td>
<td>19.3</td>
<td>2</td>
</tr>
<tr>
<td>Public zone</td>
<td>1</td>
<td>Street width</td>
<td>9.2</td>
<td>9.3</td>
<td>11.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Street median</td>
<td>12.7</td>
<td>3</td>
<td>14.6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Sidewalk width</td>
<td>20.2</td>
<td>3</td>
<td>14.6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Street lighting</td>
<td>5.1</td>
<td>9.2</td>
<td>6.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Parking</td>
<td>5.2</td>
<td>7.8</td>
<td>12.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Billboard</td>
<td>14.3</td>
<td>3</td>
<td>5.8</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Tree Greenery</td>
<td>8.7</td>
<td>26.2</td>
<td>18.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Parking</td>
<td>19.4</td>
<td>26.2</td>
<td>12.3</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1 = 1st priority, 2 = 2nd priority, 3 = 3rd priority

It can be seen from this table that building setback, advertisement, and colors are the important issues in the private zone, while the sidewalk width, parking, and greenery are the important issues in the public zone.

Fourth, each group operated the system while discussing decision making. Every decision was tested using the system to observe the changes in the quality of the streetscape. Some examples of 3D simulations conducted by participants regarding priority issues are as follows:

1. Simulation of building setback and sidewalk width
The building setback was increased while simultaneously widening the sidewalk.

![Fig.15 Simulation of building setback and sidewalk width](image)

2. Simulation of building advertisement
The commercial signboard on a building façade was eliminated.

![Fig.16 Simulation of building advertisement](image)

3. Simulation of building colors
Building color was modified to a blend of monochrome and vintage colors.

![Fig.17 Simulation of building colors](image)

4. Simulation of tree (greenery)
Tree height was changed and greenery was added to a boulevard.

![Fig.18 Simulation of tree (greenery)](image)
After system operation, there was a presentation and discussion in order to review the performance of the system as well as other variables outside the system that were associated with improvements of the Kayutangan streetscape.

Finally, the system was evaluated using a semantic differential scale⁷ to measure attitudes regarding system evaluation. The scale consists of a series of semantic difference bipolar characteristics, from negative to positive. Each participant assessed each variable on a scale from 1 to 7. Scale 1 indicated a negative rating whereas scale 7 indicated a positive rating. The evaluation consisted of two types, namely the evaluation of system usability and the evaluation of variable adjustment.

The evaluation variables for system usability consisted of four groups and 15 variables, as follows:

1. General assessment
   General assessment relates to the basic assessment of the operating system. This assessment consists of three aspects: system understanding, system usability, and language and symbols.

2. Operating the system
   Operating the system consists of five aspects: system start up, termination, interaction, interaction accuracy, and speed.

3. Quality of visual elements
   The quality of the visual elements consists of four aspects: text, image, simulation, and button quality.

4. User interface design
   The quality of the user interface design consists of three aspects: visual interface, design layout interface, and manual availability.

Table 3 The evaluation of the system by semantic differential scale

The 22 participants completed the measurement and the results were compiled and tabulated (see Table 3). According to this table, the average value of each variable group ranged from 4.72 to 5.52. This result indicates that the system is easily understood, easy to use, has a good quality visuals, and has a clear and attractive interface.

The variable adjustment evaluation was intended to measure the difficulty of adjusting each variable (see Table 4). This measurement related to the seven adjustment variables, namely building height, façade color, building setback, trees and plants, billboards, sidewalk material, and street profile. The measurement consisted of five levels: very difficult, difficult, normal, easy, and very easy. The 22 participants measured these variables according to their respective experiences operating each one. Based on the tabulated results, the categories for which the highest percentage of participants considered the adjustments easy or very easy are in the following order:

- 1. Billboards and sidewalk material
- 2. Façade color and street profile selection
- 3. Building setback
- 4. Tree and plants
- 5. Building height

Table 4 Evaluation of the difficulty level in the variable settings

Another questionnaire was also given to support the system as tools for landscape planning and design in Malang City. The 22 participants gave their opinions to the originality and capability of the system in landscape planning and design. Almost all participants stated that this system had never been used in Malang. Moreover, the participants believed that this system was highly capable of supporting landscape planning and design (see Table 5).

Table 5 The opinion on the capability and originality of the system

5. Conclusion and Future Work

In summary, the contribution of this paper is the development of landscape support system that uses interactive 3D
visualization for the improvement of the Kayutangan streetscape.

The combination of an appropriate user interface and interactive 3D simulation by embedding a various types of 3D simulation is a strategy proposed to enhance the public interest in landscape planning, especially in Malang, Indonesia.

The testing of the system through a pilot workshop is an initial stage of system dissemination. The workshop involved lecturers, students, experts and the public to evaluate and assist the improvement of the system. This workshop also introduced the Landscape Planning Support System to the Malang academic community. Considering that the system is relatively new, several further workshops that include even more interested parties such as city government, stakeholders, and members of the local communities from various backgrounds are recommended. In future, this system should be piloted and made available online to the local communities of Malang, Indonesia.

Finally, we conclude that this system is not completely easy to understand and operate for the public in Malang. This pilot workshop was useful to spread the idea of a new system to the academic and expert community in Malang. The main purpose was to obtain feedback and suggestions for system improvements to produce an adequate system for the Malang community in the future.

For further research, first, the quality of real-time visualization in the 3D interactive simulation still needs to be improved in order for the system to be properly understood. Second, although the effect of cultural symbols in the user interface was not examined deeply in this study, their use (including the use of the local language) is expected to facilitate the user’s understanding of the system. Therefore, it is important to conduct further research related to the effect of cultural symbols on the development of the system.

References


Notes
a) Nieuwe Bouwen is regarded as a pioneer of building style of International Style, which emerged after the 1920s. Nieuwe Bouwen is a term for a several international architecture and a radical innovation of planning between 1915 until about 1960. Nieuwe Bouwen style was characterized by the use of flat roofs, horizontal gable, the building volume of a cube-shaped, as well as the use of white color.
b) The system development utilized three applications software consisting of SketchUp Version 8 for 3D modeling, Lumion 3D Version 3.0.1 for 3D visualization, and Adobe Director Version 11.5 for multimedia application authoring platform.
c) Adobe Director software provide a 3D Lingo scripting language instantly, which provides convenience for the user in applying the instant behavior on 3D object and button behavior.
d) Shockwave 3D is a 3D object format used in the Adobe Director software. 3D file sources can be developed from a variety of 3D modeling software, but the file must be converted into a w3d format.
e) AHP is a decision support models developed by Thomas L. Saaty. This decision support models describe the problem of multi factor or multi-criteria complex into a hierarchy. Through the hierarchy, a complex problem can be decomposed into their groups and organized into a hierarchical form.
f) Semantic differential is a type of a rating scale designed to measure the connotative meaning of objects, events, and concepts. The differential scale is a scale to measure attitudes. The scale consists of a series of semantic difference bipolar characteristics (two poles), between a negative to positive attitudes.
g) The presence of culture will influence the interaction of people with computers. User will assimilate the patterns of thinking, acting and communicating from a specific social environment when performing tasks to the computer. The culture will predetermine a person’s communication preference and behaviors. Thus, the user interface should facilitate users with the familiar communication styles.
和文要約

本研究は、インドネシア、マラジ市の商業地域であるカユタナ通りを対象とした都市景観の視覚的評価に関する研究である。カユタナ通りを対象として景観の質の向上を目的とした住民参加型の景観まちづくりを行う上で、その計画デザインのための協議を支援するインタラクティブな3次元可視化技術を用いた景観計画策定支援システムを開発し、その有効性を明らかにすることを目的としている。インタラクティブな3次元可視化技術の活用は、建築物の更新等による都市景観の変化を三次元映像を用いて検討する際に、ユーザー相互のイメージ共有による上で有効である。本研究は、様々な3次元可視化ミレーショーン機能を持つユーザーインターフェイスの開発手法を提案しており、これはアニメーションによる確認機能、仮想空間のワークスベース機能、それらの連携によって計画を検討する機能といった3種類の3次元シミュレーションモデルを有している。

インドネシアは発展途上国の一国であり、多くの都市で今後予想される都市化に対応するために、より効果的で適切な都市計画を創造するための技術と専門家を必要としている。特にマラジ市のように近年多くの開発が行われている都市では、急速な人口増加と技術革新によって都市景観が無秩序かつ急速に変化している。一方、住民参加のまちづくり活動は、計画の初期段階において行われることが望ましく、自治体は、それらの活動を通じて得られた住民意向や提案を都市空間のデザインに反映する必要がある。実際にマラジ市における従来の都市計画手法については、急速な都市化に対応したまちづくりが行えていないことが指摘されてきた。また、仮想環境を構築するコンピュータ技術及び3次元可視化技術の開発は、急速に進展している。開発途上国における仮想環境構築技術の活用は、都市計画分野においても多岐にわたり、このことが開発途上国において同様の技術を導入する機会となった。

計画策定支援システムにおける仮想環境の構築については、様々なユーザーのニーズと考え方に対応できるように複数の機能を連携し、それらを同一インターフェイス上において操作可能なシステムが求められている。これまでの3次元可視化技術の開発では、ユーザーが都市空間の地図、映像、案内情報の確認やそれら情報の評価を行うなど、より自由に操作に携わるように求められており、WEBを用いたユーザーインターフェイスを有する様々な可視化技術に関する研究が多く行われてきた。

これら、ほとんどのユーザーインターフェイスは、簡易なものから複雑なものまで幅広い領域をカバーするインタラクティブな3次元仮想空間の映像化に関する開発されたものである。しかしながら、インタラクティブな3次元可視化技術を開発することの重要性と同様に、特に開発途上国における居住者の住民が持つ知識や意向の多様性を踏まえた適切なユーザーインターフェイスをデザインすることの重要性について指摘している専門家は少ない。

マラジ市においても住民参加を促す3次元可視化技術を用いたユーザーインターフェイスの活用は、これまで全く行われていない新たな試みである。このシステムは、インドネシア国内でも広く導入されているものではなく、いくつかの都市で実施された試験的な取り組みについて報告があるのみである。そのため、本稿で記載したマラジ市でのシステム運用を通じて得られた知見は、前例のないものであるといえる。本システムでは、ユーザーにシステムを利用する機会をより容易に提供するために、アニメーションによる確認機能、仮想空間のワークスベース機能、それらの連携によって計画を検討する機能等の様々な3次元シミュレーション機能を埋め込むことによって、対話型の3次元シミュレーションを実現することが提案された。さらに、このようなシステムに対する親しみを深めながら、まちづくりに対する住民参加の意識を向上させることができるように、3次元可視化技術に対する理解、認識、興味の差異に応じて、基礎的な対話レベル、中間の対話レベル、高度な対話レベルの3段階の3次元シミュレーション機能を開発した。3次元モデリング・ソフトウェア、3次元ビジュアルソフトウェアおよびマルチメディア応用オーサリング・プラットフォームの複合的な活用は、様々な種類の3次元シミュレーションを開発する上で合理的かつ有効な手法であり、その手法を用いて開発した本研究の景観計画策定支援システムはそのプロトタイプとなった。

さらに、本システムは、マラジ市で開催した学識経験者、学生、建築及び都市計画の専門家を交えたワークショップにおいて試験的に運用した。ワークショップは、専門家による講義、まちあるい調査、調査の取りまとめ、システムを用いた景観デザイン案の検討及びその評価の順で進行した。このワークショップは、マラジ市における都市景観計画策定支援システムの有効性を確認させる機会となるとともに、ユーザーの意見を収集し、それを基にシステムの評価および改良が行えるよう意図して企画した。マラジ市のような将来のまちづくりに向けてより有効なシステムを開発するために、今後も行政、地域住民、その他利害関係者といった様々な主体が参加したワークショップの開催が望まれる。

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