

# Optimizing Image Enhancement Method for 3D Visual Simulation of the Historic Streetscape in Kayutangan Street, Malang, Indonesia

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**Abstract**—Recently, the 3D simulation in Virtual Environment (VE) is useful performing a communication tool in public consensus to facilitate online public participation in planning and design development review of the historic urban streetscape. Computer simulations method allows the public to experience the sense of place through the navigation tools in the virtual environment and contributes the suggestion to the improvement as well as the alteration of the historic urban preservation through the public appraisal mechanisms. The duration of visualization stage of making a 3D modeling in virtual environments depends on the complexity and diversity of 3D models formation. Scenario visualization is closely related to the development of the level of detail geometry as well as the navigational aids system. Genuinely, the development of a detailed 3D geometry modeling is essential to fostering a sense of place to apprehending the historic urban space, especially for the historic streetscape in Kayutangan Street. Nevertheless, the detailed geometry will correspond to the use much polygon; then the 3D model data will be so incredibly heavy. Many studies have proven successful carried out a combination of mapping and panoramic photo capturing to simplify the 3D model geometry. Therefore, this study attempts to reinforce the important role of image enhancement in the picture capturing technique for visualization in historic buildings, particularly in the case study of Kayutangan Street, Malang, Indonesia.

**Index Terms**—historic building, computer modeling, streetscape simulation, virtual environment, technical approach

## I. INTRODUCTION

This paper will present a technical approach of computer simulation strategy for better interactive 3D simulation through Virtual Environment (VE) in the historic urban streetscape. This article is based on literature review and related with research-based software application modeling. This development scenario is aimed as a guide steps in making a modeling simulation of 3D historical buildings that will be inserted in Virtual Environment. Case study located in Kayutangan streetscape in Malang. This study is an early development stage of Historic Urban Visual Planning System for the urban visual evaluation of Kayutangan streetscape through online participation (e-participant).

### A. Visual Evaluation of Historic Urban Streetscape

According to Nasar [5], the assessment of urban image is associated with the people and environment. It is extremely diverse and depends on the number of attributes inherent in people, such as biology, personality, sociocultural experience, adaptation levels, goals, expectations, and also internal and external factors. Nasar [5] also stated that human also possesses a feeling and meaning to the environment surrounding and to the imageable element, both negative and positive. The feelings and meanings will construct the evaluative image of the city. Respectively, feelings and meaning are a central part of the perception and reaction of the people to the environment. Moreover, visual evaluation of the urban streetscape depends on the perception of the public to the values that embodied in the formation of the streetscape, especially in the context of physical features.

The physical character of the streetscape, one of the prominent features that forming the city space [7], contains the visual appearance that configures the streetscape, such as building, facade, street, and sidewalk. Meanwhile, non-physical features emerged from the social conditions of the urban environment [5]. Related to the historic building on the urban streetscape, the element of architectural style, material, and shape undoubtedly will influence the visual richness of historic building facades images. These visual elements are considered to contribute the enhancement of the historical images in the streetscape. Among all aspects, architectural style was considered as the most influential element for the preserving of the historic character and maintaining the visual richness [3].

### B. Computer Visualization for Public Assessment

The advancement of computer-based visualization techniques is undoubtedly a significant contribution to the evolution of public assessment in the visual evaluation, especially for the historic urban streetscape. Thus, it also an advanced development of the art of designing with the community [1]. The computer visualization is useful for the dissemination of public data of urban planning, as well as urban design, and also capable of representing the first stage of decentralization and broader inclusion in a participatory process. Furthermore, the internet is undeniably become the best way of sharing as well as

public engagement to the urban planning information and evaluation also [11].

By the advancement of computer visualization, there are high expectations of new visualization software tools that increase the effectiveness of communication and encourage the awareness of the benefits of using landscape simulations during the public engagement. Computer visualization is utilized as a medium for visual evaluation, and also as an integral component of public engagement processes, in the future [6].

Recently, the advancement of computer visualization techniques, such as Virtual Environment (VE) or Virtual Reality (VR), is capable of creating 3D modeling of urban streetscape which can stimulate and arouse the interest of public assessment [10]. According to Langendorf as cited in Shen & Kawakami [9], he stated that the virtual image's persuasive powers build trust more effectively than traditional measures such as documents of planning. In the future, the development of a virtual reality technology and augmented reality technology will be more widespread and useful for landscape visualization [6]. The development of virtual reality technology is considered very helpful to provide a better understanding of the visualization of heritage urban streetscape at the macro and micro scale. Due to the need for public involvement from a variety of backgrounds, heritage streetscape visualization in Virtual Environment (VE) is indispensable in helping the various stakeholders to be able to understand a historic preservation planning and capable of contributing to decision-making. Moreover, due to the majority members of the general public usually are not urban planning professionals, well-designed urban visualization and interactive tools can help expand their participation in decision-making [2], Wu et al. [11]. Also, the cost of using simulation technology in public involvement activities perceived still affordable and relatively inexpensive when compared to conventional methods.

Considering about the accuracy of making a 3D simulation using a graphical software, Leavitt as cited in Kim [4], stated that an amount of geometrical details do not necessarily reflect the real level of the 3D model. Texture mapping and panoramic capturing are a rapid and inexpensive modeling technique, and also have proven successful with the public audience. However, it should be considered that the demand for 3D visualizations for landscape and environmental planning depends on the country-specific planning procedures, the economic situation and the level of knowledge and understanding of the participants include the type and level of computer visualization for the planning of the built environment [6].

### C. 3D Visualization Strategy of Historic Urban Features

The modeling processing of landscape architecture is very complicated, and it requires high effort for constructing of interactive modeling. The development of 3D interactive visualization requires a high-performance computer to compromise with the complex modeling

structures in real-time. Consequently, it demands a proper strategy to reduce the level of complexity of the 3D model structure without reducing the quality of model representation in real time. Moreover, it also has been widely discussed that there are many strategies to overcome the complexity of the 3D modeling for landscape modeling. Some of them are the finding a proper balance between abstraction and reality; creating optimizing a 3D model, optimizing pixel size, reduction level of detail, and reduction of file size [8]. Further, one of which strategies to overcome the complexity of the 3D modeling without reducing the quality of real impression is using a combination of texture mapping and photo image capturing supported by image enhancement.

## II. OBJECTIVES AND METHODOLOGY

The study focuses on a historical streetscape in the Central Malang Region. One of the significant historical streetscapes is the Kayutangan Street corridor, which is the starting point for the development of commercial streetscape areas in Malang since 1914, during the Dutch colonial period.

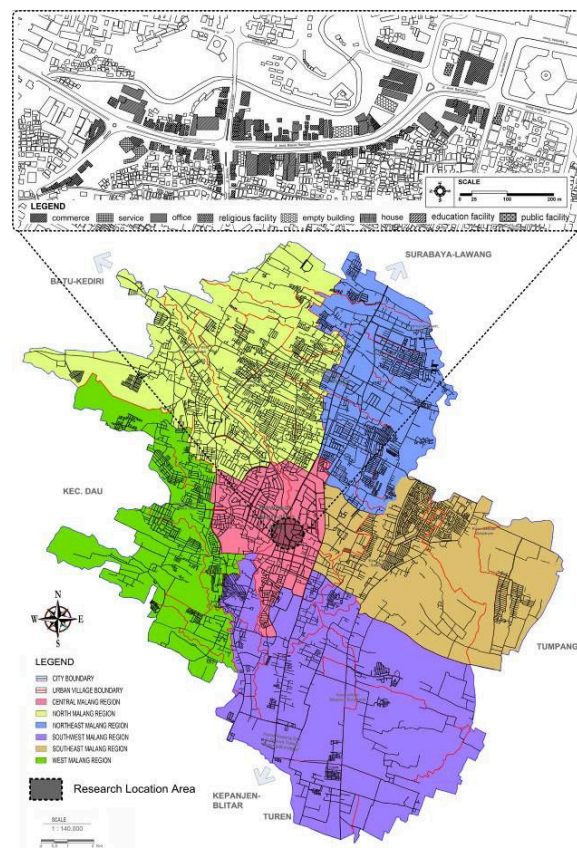


Figure 1. Map of Kayutangan Street in Malang, Indonesia (Source: Urban Land Use Plan 2008 - 2028)

Recently, the present historic building's streetscape in Kayutangan Street is gradually being transformed by new buildings owing to the lack of the historic building preservation regulations (see figure 2). It seems that the

rapid and uncontrolled development in the historical streetscape has led to the construction of a city streetscape simply for economic interests and has disregarded structuring qualified historical urban space. Hence, the reflection of the historical urban space should be able to become the groundwork for city planning and design.



Figure 2. Comparison of the historical urban space in part of Kayutangan Street between around 1936 and 2012

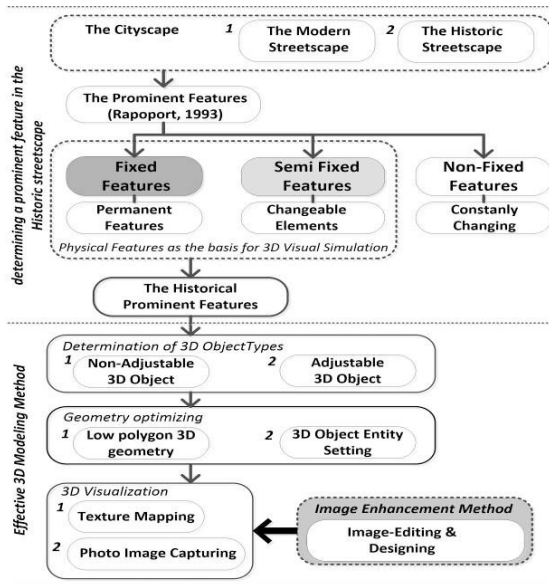


Figure 3. Research methodology

This study aims to present the technical approach of the effective 3D modeling method to optimize the geometry visualization using a combination of texture mapping and photo image capturing supported by image enhancement method (see figure 3).

### III. RESULT AND DISCUSSION

#### A. Scenario of 3D Visual Simulation Development

The development of 3D visual simulation contained three stages, namely the 3D modeling of a historic streetscape, the constructing of interactive 3D simulation through the multimedia application authoring platform, and the producing of Virtual Environment (VE) of the

historic urban streetscape as the executable file or web file.

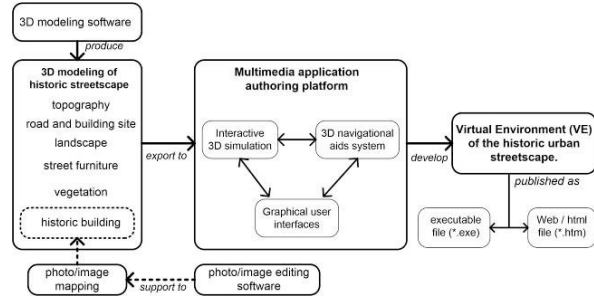


Figure 4. The development stages of 3D visual simulation

In the first stage, the production was concentrated on 3D modeling of all physical elements in the Kayutangan streetscape, including topography, road and building site, landscape, street furniture, vegetation, and the historic building itself. The process of 3D modeling requires an adequate 3D modeling software and a reliable photo editing software. In particular, this study focused on the application of the picture/ image mapping technique in the 3D modeling of a historic building.

The second stage, after all the 3D modeling of the physical elements in the historic streetscape, was completed then one by one of the 3D models from each element were exported or inserted into a multimedia application platform. The multimedia application authoring platform capable of designing an interactive user interface supported by a 3D scripting language. In addition, this application embedded 3D navigational aids for 3D object interactivity in Virtual Environment (VE). Accordingly, this application is adequate to construct the 3D interactive simulation system.

The final stage was the finalization of building the 3D interactive simulation system. This stage is related to the objectives as well as by how the system will be published. This multimedia application authoring platform is able to produce two forms of system finalization, i.e., executable file (\*.exe) and web / HTML file (\*.htm).

#### B. Preparation stage

There were two preparations before starting the primary stage. First, it necessary to identify each building by code to overcome the enormous number of building along the street corridor. The building code was based on the building position to the point of compass year (north, south, east, west) and sorted by rows of buildings from end to end of the street corridor. Second, it also important to divide the region of Kayutangan street corridor into three zones to alleviate the running system of Virtual Environment (VE). The zone division also serves the segmentation of 3D interactive simulation system into three parts. This segmentation will help to lighten up the real-time of 3D object rendering in the web. Furthermore, 3D visual simulation systems developed through the division of street corridor zones will reduce the level of user complexity in understanding and interact in a Virtual Environment (VE) system. The zone division and a



building coding of the Kayutangan street corridor can be seen in figure 5.

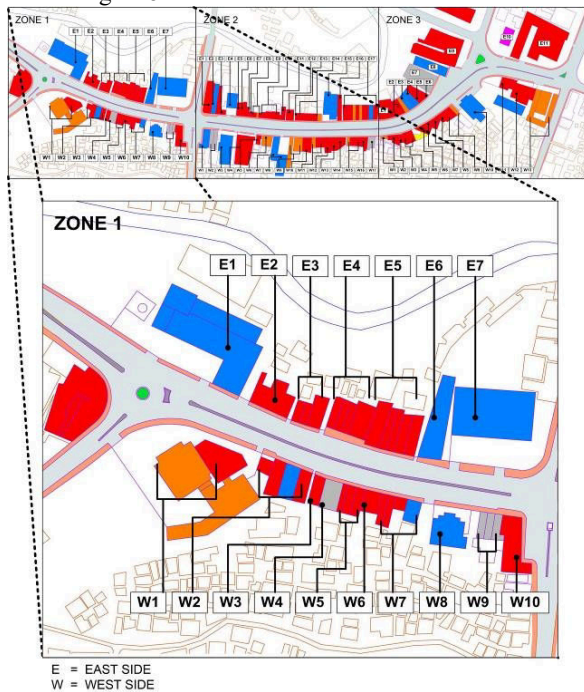


Figure 5. The zone division and a building coding of the Kayutangan street corridor

### C. The 3D modeling of streetscape

3D streetscape modeling is a construction of 3D visualization of the corridor space of Kayutangan street. In the first phase, a proper map of Kayutangan Street and surrounding area should be obtained to be a major baseline map for the foundation to the overall visualization of 3D streetscape modeling. The next stage is to generate the basic 3D shape of each building by the extent and height of each building.

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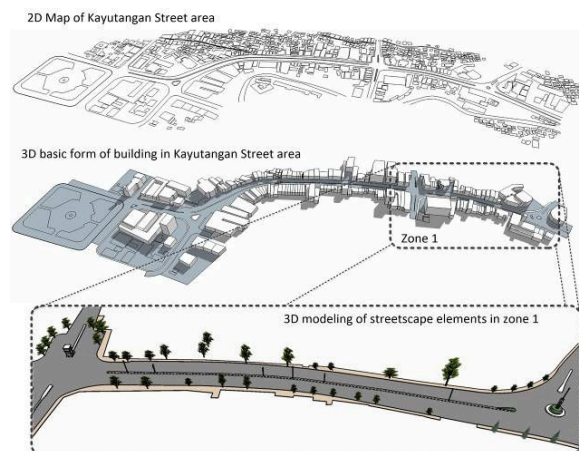


Figure 6. The stages of 3D streetscape modeling

The next stage is to create a 3D model of all the physical elements that make Kayutangan Streetscape as precisely as possible. The modeling of this physical element includes topography of the site, road and building site, landscape, street furniture, vegetation, and the other physical element that were forming the Kayutangan streetscape (see figure 6).

### D. The 3D modeling of historic building

The most important process in the 3D visual simulation is the 3D modeling of historic buildings because the historical identity of the historical region is largely determined by the existence of the remaining historic buildings. The process of constructing 3D historical building modeling consists of five stages, namely photo capturing, facade drawing, development of the 3D basic model, development of the 3D detailed model, and development of the 3D finished model (see figure 7).

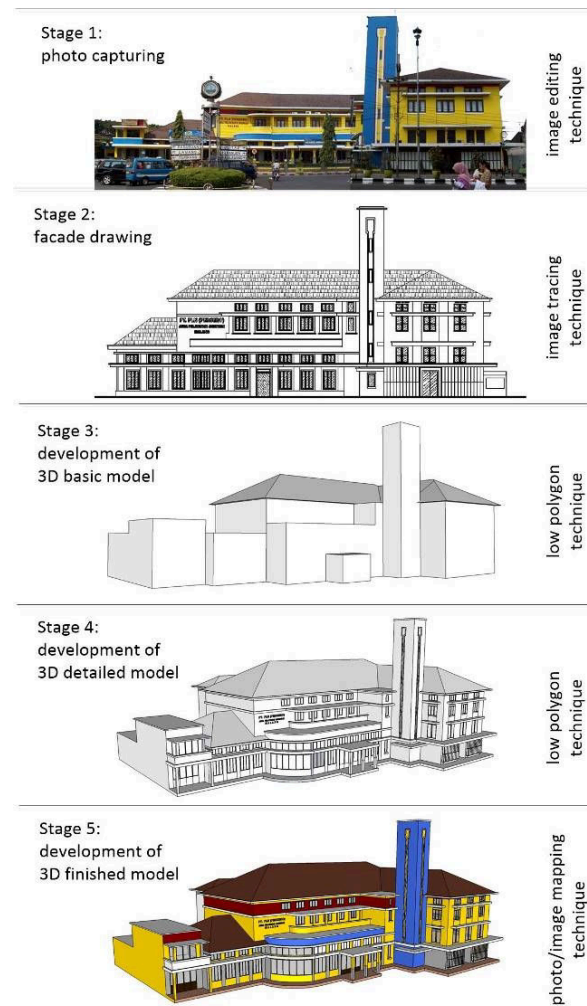


Figure 7. The stages of 3D historical building modeling

First, photo capturing is the stage of taking pictures of historic buildings. In fact, this process has many

challenges for taking photos related to field conditions that occasionally experience a difficulty to take good pictures. Therefore, taking a photo shoots require to be conducted from several angles. Furthermore, the results of this picture have to go through the editing process with the help of image editing software.

Second, the facade or building appearance is useful to identify the detail level of each building surface. The detail of the building surface will determine the detail level of 3D building visualization. Furthermore, the detail of the building surface can be constructed as an image mapping to lighten the size of the 3D building file. The process of facade drawing requires an image tracing technique with the help of vector drawing software.

Third, the 3D basic models were constructed to generate the formation of three-dimensional objects of each historic building. At this stage, the number of a surface that must be built with detailed form can be detected. The process of generating 3D objects require a proper 3D modeling software.

Fourth, the 3D detailed model was the advancement phase from the 3D basic model stage. This stage focuses on improvement of 3D visualization by constructing each building surface with 3-dimensional detail and with image mapping.

Fifth, the application of color, image and texture on each building surface to construct the visualization of the historic building close to the actual reality. Selection of color, texture, or image should be considered thoroughly to prevent the file size of 3D buildings remains light.

#### E. The determination of 3D object entity

User involvement in 3D visual simulation in the Virtual Environment also requires interaction with 3D objects. The interaction of 3D objects in historic buildings has several levels of interaction. At the basic level, the interaction is limited to the act of viewing the building only with all its physical characteristics. At the intermediate level, user interaction is also capable of making changes to color, image, or building texture. While at the advanced level, user interaction is possible to adjust the building height or some stories, eliminating the buildings and adding new buildings. Therefore, the existence of the type and number of 3d object entities must have been determined during the 3D building modeling process.

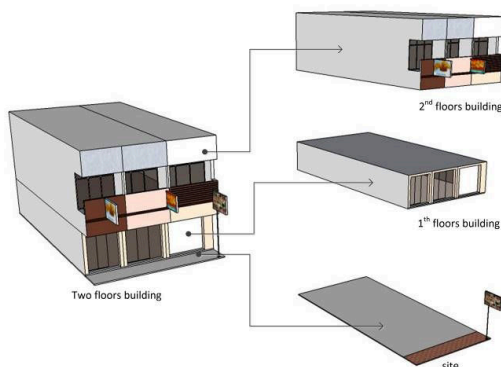


Figure 8. The constructing of 3D object entities

#### F. Image enhancement techniques

Image enhancement techniques is a photo retouching technique with the support of image or photo editing software. This technique aims to strengthen the picture quality as well as the texture that is attached to each geometry of the building plane. This image enhancement technique emphasizes the importance of accuracy of image retrieval process from the original building. Every building, especially a historic building, certainly has the elements of the visual appearance of buildings that are distinctive and valuable. Therefore, each element of the building's appearance should be photographed well and identified the character of the composition of the image. The result of image capturing becomes the basis of image retouching process in the picture editing software.

The application of image or texture mapping reinforced with image enhancement technique must be preceded by the determination and identification of geometry planes in each historic building. Identification of geometry planes aims to determine the type and number of image/texture to be created.

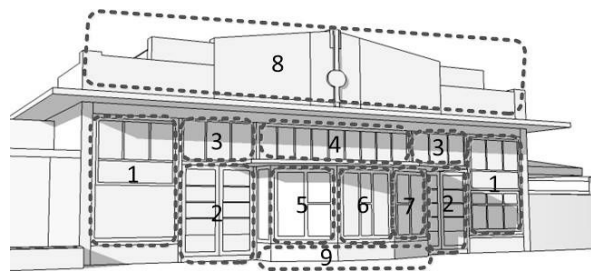


Figure 9. The identification of geometry planes

In this study, five principles of image editing techniques have been constructed in 11 historic buildings in Kayutangan streetscape. The five techniques include texture cloning techniques, image cloning techniques, image transforming techniques, image adjustment techniques, and image/texture making techniques.

Texture and image cloning technique is a technique of multiplying or multiplication of building texture or image elements with appropriate texture or image scale settings. The basis of texture or image cloning comes from the existing photo texture or image element of the historic building.

Image transforming technique is an image editing technique that includes scaling, rotating, skewing, distorting, and mirroring techniques. This technique focuses on the arrangement of texture or image composition which is adjusted to the shape and size of the building's geometry plane.

Image adjustment technique is an image editing technique that focuses on the aspects of light on the coloring and texture such as adjusting color brightness and color balance.

Technique image or texture making is the most difficult level in the process of retouching image. This technique is required when there are constraints in capturing the image or texture on the original building.



Figure 10. The process of image enhancement techniques

### G. Conclusion and Discussion

This study is an early development stage of Historic Urban Visual Planning System for the urban visual evaluation of Kayutangan streetscape through online participation (e-participant). A technical approach to computer simulation strategy was performed to develop a proper 3D visual simulation through Virtual Environment (VE) in the historic urban streetscape. This development scenario of 3D visual simulation is used as a guide steps in making a modeling simulation of the 3D historical buildings that will be inserted in Virtual Environment.

Notably, the application of image enhancement method in the picture or texture mapping is capable to brings up the vibrant visual of 3D historical building modeling. This approach also become a solution for any effort for constructing of 3D visual simulation in Virtual Environment (VE) that dealing with the complex modeling structures in real-time. Further, the overall development scenario of 3D visual simulation described in this study is an appropriate strategy to reduce the level of complexity of the 3D model structure without reducing the quality of model representation in real time.

The overall sample result of the historic building on Kayutangan Street constructed in the 3D visual simulation is 11 buildings. The entire 3D modeling of the building has a low number of polygons with small

or light file sizes. Strategies that have been attempted is to change the geometry of the building full of detail with the mapping image or texture that has been through the process of photo or image retouching. The process of retouching an image that has a high difficulty level and full of a challenge is to make a wall texture that is peeling and mossy and has the impression of old or ancient buildings. Another challenge is the taking of visual photo element of the building which is much disturbed by the shadow of the sun. The presence of the shadow will affect the image editing process, which must consider the presence of shadows on 3D visualization of building elements. The important thing to note is the result of photo or image retouching that will be used in the process of image or texture mapping on each geometry plane must have a relatively small file size because the number of geometry plane in one building will be more than one plane.

Furthermore, image enhancement technique depends on two critical stages. The first is the capturing process of the essential elements of the original building, which depends on the precision of taking each of the visual elements in the appearance of the historic building. The second is the process of photo or image retouching that associated with the level of accuracy in editing each element of the picture or texture.



	Photograph (photos capturing)	facade tracing (image of building facade)*	3D model development (the detailed form)**	the finished 3D model (textures and images based)**
ZONE 1	 E11		 File size = 655 kb	 File size = 823 kb
	 E12		 File size = 224 kb	 File size = 663 kb
	 W112		 File size = 290 kb	 File size = 792 kb
	 W121		 File size = 265 kb	 File size = 777 kb
	 W2		 File size = 238 kb	 File size = 665 kb
	 W9		 File size = 210 kb	 File size = 1000 kb
ZONE 2	 E10		 File size = 208 kb	 File size = 754 kb
	 E14		 File size = 200 kb	 File size = 1200 kb
	 W17		 File size = 426 kb	 File size = 996 kb
	 W9		 File size = 189 kb	 File size = 875 kb
ZONE 3	 W11		 File size = 225 kb	 File size = 1230 kb

\*) Facade tracing created using Autodesk AutoCad Architecture

\*\*) 3D models created using Google SketchUp Pro

Figure 11. The compilation sample result of 3D historical building modeling in Kayutangan Street



Figure 12. The example of 3D visual simulation results on building W11 in zone 3 in Kayutangan Street

Hence, this study concludes that the optimizing the geometry visualization using a combination of texture mapping and photo image capturing reinforced by image enhancement method is capable of enhancing the 3D visual simulation of the historic buildings in the Virtual Environment. Later, this study will be used as the basis for the development strategy of the Historic Urban Visual Planning System in Kayutangan Street.

**Herry Santosa** was born in Malang, Indonesia, in 1973. He received the Bachelor degree in architecture engineering from Brawijaya University, Malang, Indonesia, in 1997, and the Master degree in architecture professional design from Bandung Institut Teknologi (ITB), Bandung, Indonesia, in 2001, and Doctoral degree in architectural/ urban planning from Yamaguchi University, Ube, Japan, in 2014, respectively.



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Dr.Eng.Santosa was a member of Architecture Institute of Japan (AIJ) and also the professional member of Indonesian Institute of Architects (IAI). He was the recipients of AURG'14 Best Presentation in the 9th International Symposium on City Planning in Environmental Management in Asian Countries, Oita, Japan, in 2014.

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