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Accuracy of Sketch to Design Transformation in Artificial Intelligence (Case Study: Frank Gehry Sketch and Design)

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Abstract

The accuracy of architectural concepts from sketches to complete 3-dimensional forms gradually has a different way from decade to decade, especially architects of the deconstruction era and adherents of futuristic buildings with sketches that are complicated to understand and continue into advanced concepts. Initially, the architectural concept was transformed using manual methods through sketches developed through working drawings and models but at this time it continues to change until the 21st century, namely by utilizing digital technology, especially in the scope of the architectural profession and the world of architecture. The latest technology that is developing and used is artificial intelligence. The problems that arise and many questions are the ability of AI to translate complex sketches from architects such as Frank Gehry and the accuracy produced according to the work that has been built as a way to see how far AI translates concepts correctly. This study aims to see how accurate the use of AI is in terms of converting sketches into digital images based on the work that has been built. The method used is to use diffusion mode to manipulate the image into a realistic image. The results of this study are to produce a comparison with several modes of AI applications with a comparison of the accuracy of the resulting images. Therefore, this comparison and accuracy results can be used and tested further in the use of AI technology to facilitate the work of an architect in the future.

Keywords: Sketches; Concept; Frank gehry; Artificial intelligence
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INTRODUCTION

The accuracy of architectural concepts from sketches to complete 3-dimensional forms gradually has different ways from decade to decade, especially architects of the deconstruction era and adherents of futuristic buildings with sketches that are complicated to understand and continue into advanced concepts. Initially, the architectural concept was transformed using manual methods through sketches developed through working drawings and models but at this time it continues to change until the 21st century, namely by utilizing digital technology, especially in the scope of the architectural profession and the world of architecture. The latest technology that is developing and used is artificial intelligence. In its development, Artificial Intelligence (AI) has increased efficiency in building design and construction and created various solutions that will push the boundaries of architectural development and is an opportunity to find ways to improve the world through AI (Said et al, 2023). The application of AI in architectural creation is growing, with the most common being the creation of images directly from textual descriptions (Galanos et al, 2023.). The text-to-image creation method in AI offers an easily accessible approach that produces architectural design images based on text commands (Li et al, 2023). The AI test in this study was to try to use sketches and works from world-class architect Frank Gehry. Frank Gehry is a famous figure for his geometric complexity and in every conceptual design concept by drawing using hand sketches and making physical models while most architects have manipulated 2D surfaces on a computer screen (Samdanis & Lee, 2017). From the sketch, it will be transformed with AI prompts into 3-dimensional images so that its accuracy can be seen with the results of Frank Gehry's built work. The process of transforming sketches with AI into built works through the stable diffusion AI model. The stable diffusion model is an important milestone in the advancement of generative AI because of its high-performance architecture, which produces high-quality images (Rombach et al, 2022). This study will look at the extent of the similarities and differences between sketches and built works and the accuracy between the changes from sketches to 3-dimensional images through the AI process.

RESEARCH METHODOLOGY

The method used in this study is an experimental method. The first stage is collecting data on sketches and works from Architect Frank Gehry as material for simulation. Frank Gehry himself is a deconstruction expert with designs characterized by strange and irregular curves, and his sketches are

relatively abstract (Li et al, 2023). Deconstruction is an approach to building design by trying to see architecture in terms of fragmentation (cuts), manipulation of structural surfaces and facades, and processing of non-rectilinear forms (Dafrina, 2015). So it is considered suitable to conduct an experiment to see how far AI can translate abstract sketches into real buildings. The process of sketching is a fundamental human activity that is widely used to generate conceptual and creative ideas and overcome complex design constraints (Goldschmidt, 2017). Sketching is a powerful and frequently used design tool that provides a sense of freedom with its subjective interpretation capacity (Yıldızoğlu, 2024). Sketches are used to generate an idea. Idea sketches are an integral component of every part of the design process, there are certain phases where the use of sketches in such a context is essential (Jelínek, 2022).

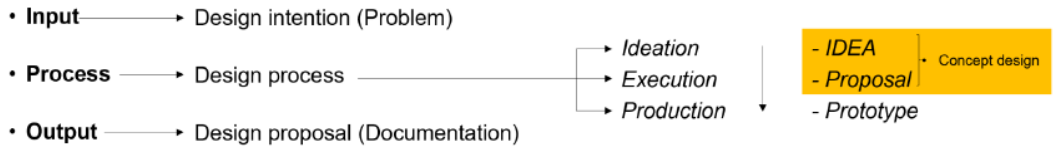


Figure 1. Phases in Idea Sketching

According to Bill Buxton (2007), he defines the following sketch attributes: (1) Fast, namely sketches are usually quick or give the impression of being made quickly (2) Timely, namely sketches can be made whenever needed (3) Cheap, namely the cost of sketches should not limit the possibility of experimenting and exploring (4) Disposable, namely if we are unable to throw away the sketch results, perhaps the sketch is not a sketch in the name of a visual idea (5) Abundant, namely sketches make sense in a series or collection (6) Clear vocabulary, namely style is the result of conventions that distinguish sketches from illustrations.

The second stage is to determine the type of project to be simulated. The selection of project types from Architect Frank Gehry is based on the type of material and building typology. Different types of materials to accurately detect AI identify sketches such as titanium, brick, glass and space frame materials. While typology looks at it from the perspective of midrise and higrise buildings and different building functions. The buildings studied are specifically public buildings that can be classified as medium or large-scale buildings and can be seen exploring more dynamic forms of the building mass. The next stage is a simulation using the mnml application (mnml.ai) with the ArchDiffusion V3 engine which is available and can be easily accessed by anyone. Researchers divide the simulation into 3 modes, namely sketch, modify and style modes. Where the mode is selected so that the original sketch is still used as the basic image used. The final result of the simulation will get which mode is closest to the original building and what kind of model is produced.

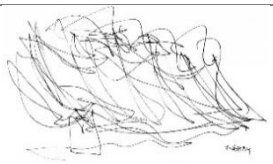
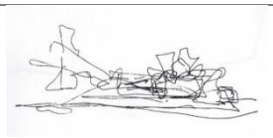
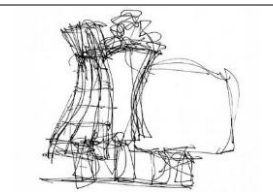
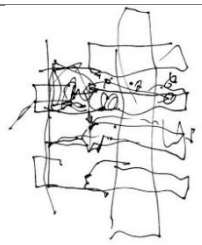
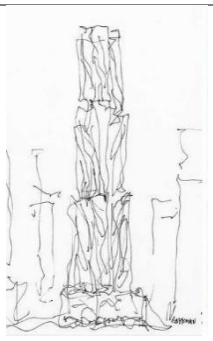
RESULT AND DISCUSSION

The transformation of changes studied is from the side of the building form, building facade elements, materials, textures and colors. There are 3 modes used, namely: sketch, modify and style. In this mode, researchers try one by one the AI simulations carried out by comparing them with the original building. It was found that some images have begun to approach similar results and others are far from the original building results. The selection of project types from Architect Frank Gehry is based on the type of material and building typology. Different types of materials to detect the accuracy of AI identify sketches such as titanium, brick, glass and space frame materials. While typology looks from the perspective of midrise and higrise buildings and different building functions. The buildings studied are specifically public buildings that are classified as medium and large-scale buildings and can be seen more dynamic exploration of forms towards the mass of the building.

1. Sketch Mode Method

In this sketch mode, some facade elements are missing and some are added such as windows and doors. While the materials read by AI mostly still resemble Frank Gehry's style such as the use of Titanium for facade materials but the color has changed slightly in some images (Table 1).

Table 1. Sketch Mode Simulation

No	Sketch	Prompt Text	Result	Original Building
1		Frank Gehry Style		
2		Frank Gehry Style		
3		Frank Gehry Style		
4		Frank Gehry Style		
5		Frank Gehry Style		
6		Frank Gehry Style		

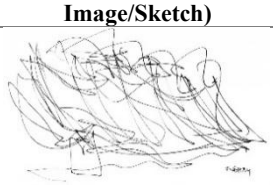
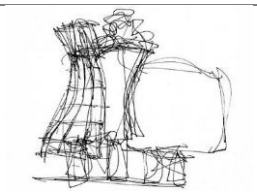
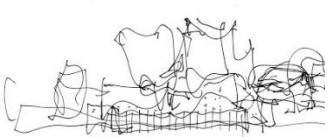
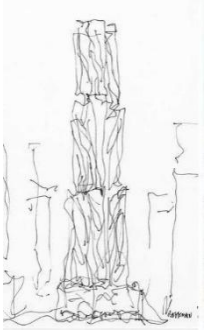
Source: Author, 2024

2. Modify Mode Method

The modify method is a method by replacing part of what we want to change. So the researcher did a brush section to replace the sketch image following the sketch pattern and then added a prompt typed by the researcher. The typed prompt is more detailed such as style, type of material and color. Some of

the image results are close to the original building in some facade elements and material details (Table 2).

Table 2. Modify Mode Simulation

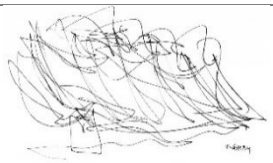
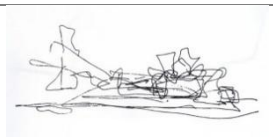
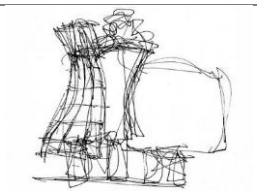
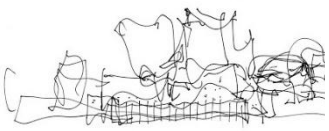
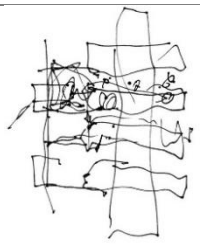
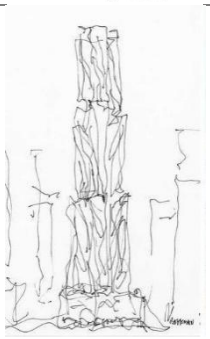
No	Image 1 (Original Image/Sketch)	Image 2 (Brush Area)	Prompt Text	Result
1			Louis Vuitton of Frank Gehry Design, Frank Gehry Style, More Glass, White Colour, Concrete White, Glossy	
			Guggenheim Museum Bilbao of Frank Gehry Design Style, Frank Gehry Style, White Colour, Titanium White, Glossy	
2			Dancing House of Frank Gehry, Frank Gehry Style, More Window, Concrete, Glass, White Colour	
3			Walt Disney Concert Hall of Frank Gehry Design Style, Frank Gehry Style, White Colour, Titanium White, Glossy- No Window (Negatif Prompt)	
4			Dr Chau Chak Wing Building of Frank Gehry Design, Frank Gehry Style, More Window, Concrete, Brick, Terracotta Colour	
5			Beekman Tower of Frank Gehry Design Style, Frank Gehry Style, More Window, White Colour, Concrete White, Glossy	

Source: Author, 2024

3. Style Mode Simulation

In this section, the researcher found a significant difference from the original. The possibility of combining two images resulted in a more distorted image than using the single sketch method with a short prompt (Table 3).

Table 3. Style Mode Result

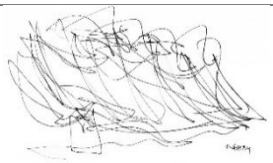
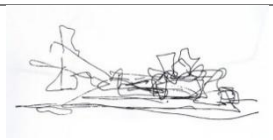
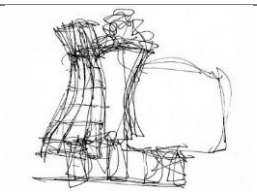
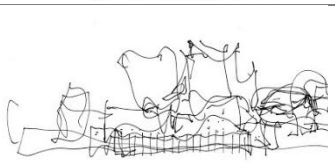
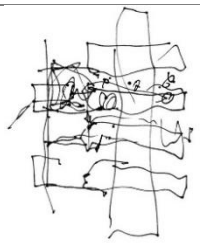
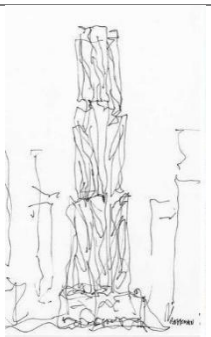
No	Image 1 (Original Image/Sketch)	Image 2 (Style Reference/Original Building)	Prompt Text	Result
1			Frank Gehry Style	
2			Frank Gehry Style	
3			Frank Gehry Style	
4			Frank Gehry Style	
5			Frank Gehry Style	
6			Frank Gehry Style	

Source: Author, 2024

4. Comparison Result of Mode Simulation

The final step is the researcher tries to compare the results that have been obtained. Seeing some similarities and differences (Table 4). But there are still elements, textures and colors that resemble the original in each simulation result from various modes (sketch, modify and style).

Table 4. Comparison of Each Mode Result

No	Image (Original Image/Sketch)	Result 1 (Combine of Sketch & Simple Prompt) Sketch Mode	Result 2 (Combine of Sketch & Prompt Detail) Modify Mode	Result 3 (Combine of Sketch & Original Building Image) Style Mode
1				
2				
3				
4				
5				
6				

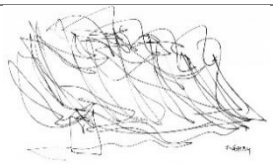
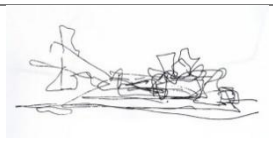
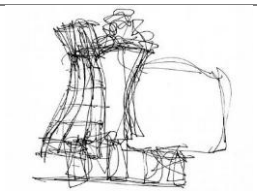
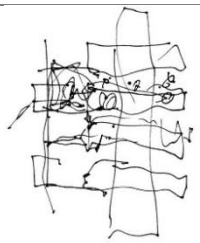
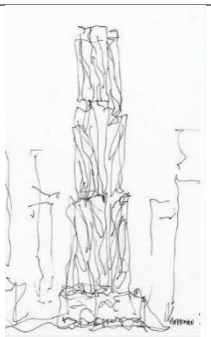
Source: Author, 2024

CONCLUSION

Researchers get a lot of design input based on the results of the transformed sketches to see the accuracy of the artificial intelligence technology working. It can be said that some results are accurate and some results are still not accurate. So from the various sketches in each project in each mode offered by AI get different results, so they cannot be classified based on the existing mode. So the results produced

need to be selected according to the results that are closest to the final result, which is similar to the original building.

Table 5. The Best Result of Simulation

No	Sketch	Result of AI	Mode of Simulation	Original Building
1			Sketch Mode	
2			Sketch Mode	
3			Modify Mode	
4			Modify Mode	
5			Sketch Mode	
6			Modify Mode	

Source: Author, 2024

The accuracy of the results of this study can certainly be used to see AI technology play a role in modifying design sketches from Frank Gehry or other architects more deeply. Other tests can also be used with different modes and even with different stable diffusion tools.

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