Article

Analytical Experimentations with Midjourney Architectural Virtual Lab: Defining Some Major Current Limits in AI-generated Representations of Islamic Architectural Heritage

Ahmad Sukkar [*] , Mohamed W. Fareed , Moohammed Wasim Yahia , Salem Buhashima Abdalla , Iman Ibrahim , Khaldoun Abdul Karim Senjab

Article

Analytical Experimentations with Midjourney Architectural Virtual Lab: Defining Some Major Current Limits in AI-generated Representations of Islamic Architectural Heritage

Ahmad Sukkar [1,*], Mohamed W. Fareed [1], Moohammed Wasim Yahia [1],
Salem Buhashima Abdalla [1], Iman Ibrahim [2] and Khaldoun Senjab [3]

[1] Department of Architectural Engineering, College of Engineering, University of Sharjah, Sharjah P.O. Box 27272, United Arab Emirates

[2] Department of Applied Design, College of Fine Arts and Design, University of Sharjah, Sharjah P.O. Box 27272, United Arab Emirates

[3] Department of Computer Science, College of Computing and Informatics, University of Sharjah, Sharjah P.O. Box 27272, United Arab Emirates

[*] **Correspondence:** a.sukkar@sharjah.ac.ae

Abstract: In the realm of artificial intelligence (AI), generative systems, most notably Midjourney, have tremendous power to generate creative images of buildings and sites of Islamic architectural heritage through text-to-image generation based on the internet. The AI-generated representations have significant potential for architects, specialists, and common users. However, the system has considerable limitations when generating images for some buildings and sites where the representations appear too far from their original represented structures. This research article attempts to answer the question: What are the limitations of using the AI system of Midjourney in producing images similar to the original buildings and sites of the Islamic architectural heritage? The research employs prompt engineering techniques based on historical sources as inputs to examine the accuracy of the output of the AI-generated images of selected examples of structures of the Islamic tradition. It compares the output with the original look by employing direct observation and critical analysis of human intelligence (HI). It categorizes these limitations into four groups: (1) limits of the prompt, (2) limits of fame, (3) limits of regionality and historical styles, and (4) limits of architectural elements and details. It concludes that while Midjourney has great capability to represent high-end AI-generated images inspired by the Islamic tradition, it currently falls short of presenting the actual appearance of some of their original structures.

Keywords: Islamic architecture**;** architectural visualization**;** intangible heritage**;** text-to-image generation

1. Introduction

Many heritage buildings lack comprehensive documentation, such as accurate floor plans, elevations, and other architectural details. They often undergo modifications and renovations over time, making it difficult to determine their original state. The limited data poses a significant challenge for architects, historians, and preservationists who aim to accurately represent and restore these structures [1,2]. Innovative digital solutions, such as virtual and augmented reality and, more specifically, Heritage Building Information Modelling (H-BIM) [3–5], are often needed to help overcome this limitation by visualizing the known elements of architectural heritage to see the bigger picture digitally and thus open the opportunities to predict the missing elements by connecting the dots. In this process, it is crucial to evaluate the accuracy of the resultant models and the reliability of the data source [6]. However, accuracy is closely tied to the availability of reliable resources, such as archival documents and previous research, which can enhance the reliability of the outcome [7]. In this domain, AI image generation offers new opportunities to explore traditional architectural styles by blending them with modern elements or reinterpreting them in futuristic and fluid forms. The

advancement of AI has the potential to make substantial contributions to this aspect of heritage architecture.

Within this frame of reference, this article centers on the artificial intelligence tool, Midjourney, which leverages text-to-image technology. The AI-powered Midjourney system facilitates users' input of textual descriptions and subsequently generates corresponding visual representations. This tool boasts a user-friendly interface and operates through a prompt-driven procedure. It generates personalized visual representations based on the textual prompts provided by users. It accomplishes this task by employing an extensive repository of tagged images, taking into account object names, styles, and environmental conditions to construct the desired image [8–10]. Through experimentations with Midjourney, this article attempts to define some major current limits in its AI-generated representations of Islamic architectural heritage.

2. Literature Review

Recent academic literature has started to explore various aspects of the specific text-to-image systems of AI, albeit it is still very limited and in an early stage of formation. These studies cover a range of topics, such as computational thinking principles, evaluation of AI-generated images, prompt engineering for text-to-image generation, creativity in text-to-image art, and perception and communication in human-AI co-creation. Repenning and Grabowski [11] introduced the concept of prompting as computational thinking, providing a framework to help users navigate the complexity of AI tools while emphasizing the social aspect of sharing examples and suggestions within user communities. Göring et al. [12] focused on evaluating the appeal for realism of AI-generated images, finding variations among different generators and the need for specific models to assess these images. In the context of text-to-image generation, as demonstrated by Ruskov [13], prompt engineering is explored for producing illustrations for popular fairytales, with insights into the challenges faced by generation models. Oppenlaender [14] examined the nature of human creativity in text-to-image art and prompt engineering, highlighting the importance of online communities and discussing evaluation challenges. on the other hand, Lyu et al. [15] delved into how humans collaborate with AI and perceive the generated results, emphasizing emotional communication and the influence of the artistic background.

Given the relatively limited formal literature of academic articles on the particular, newly emerged topic of Midjourney, the following practical examples help clarify the case and set up the scene. In a design study conducted by the UK-based real estate group GetAgent, a series of fifteen visualizations was created using Midjourney, reimagining iconic buildings in various architectural styles and showing how they might have appeared if designed in different eras or by different architects. This application challenged conventional thinking about architecture, encouraging experimentation and inspiring a broader conversation about its role in shaping our environment [16]. Another notable example is the work of the architectural designer Kaveh Najafian who employed Midjourney to create a visually striking series entitled Flying Versailles. The project reimagined the iconic Versailles palace with maximalist and decorative elements such as feathers and gold facades. By continuously refining textual prompts, Najafian achieved intricate details showcasing the potential of AI technology to empower designers [17]. In a design workshop dedicated to envisioning the future of habitation on Capri Island of Italy, designers employed a combination of conventional techniques and Midjourney. They aimed to produce visually captivating postcards depicting a Mediterranean island that would not only allure viewers but also evoke small-scale urbanism, seamlessly blending public spaces and agriculture, all without the need for exhaustive research. The resulting proposals, varying from modest to surreal, effectively showcased an array of AI potentials in reimaging historic architecture and urban forms [18]. Another case conducted by the architect Rolando Cedeño de la Cruz employed AI to reimagine an ancient architectural typology by creating a modern art center inspired by Mesopotamian Ziggurats. The Midjourney-generated series presented a contemporary interpretation characterized by earth-toned exteriors and light-filled interiors [19].

In the field of Islamic Architecture, numerous attempts have been made to depict in a modern way the spiritual essence of mosque architecture and architectural elements such as arabesque and muqarnas. However, analyzing the representation of Islamic architectural heritage through AI has so far received relatively limited attention, especially concerning the limitation of the new tool of Midjourney in this field.

3. Materials and Methods

In order to address this gap in defining the current limits of utilizing an AI-driven text-to-image generation tool in the field of Islamic architectural heritage, this article leverages prompt engineering techniques through historical sources in this field as inputs in the Midjourney website, which requires a minimum monthly payment. In order to achieve this task, this article employs a range of diverse prompts encompassing various aspects of Islamic architectural heritage. The images generated by AI image generators are then analyzed through direct observation by critical analysis of HI, comparing them to real photos to explore the accuracy limits of the outcomes.

This article employs a mixed experimental and observational methodology defined by the mix of used AI and HI methods. It is experimental in that the Midjourney website acts like a virtual lab, where the variables are the prompts and the sample is defined by the specific buildings and sites referred to in the prompts. However, it is methodologically observational in that it does not affect the sample, the non-editable database on the internet that Midjourney used to create its dataset. Instead, it creates its samples through the prompts. It is worth mentioning that Midjourney does not refer to any particular original images used to generate its AI images but only gives the outcome of the prompt in the form of a set of four images. The user can pick one to make a second round of iterations. In the case of this research, the second iteration did not give dramatically different results but minor variations on the picked images. The validation of the results depends on human understanding and, thus, the consideration of the studied samples' characteristics. Therefore, it depends o n human subjectivity. This subjective validation poses natural limitations; however, it is indispensable in this kind of comparative study between artificial and human intelligence. Nevertheless, this methodology is innovative in terms of applying it in the field of Islamic architectural heritage, which has generally depended mainly on humanities methodologies of historical and theoretical studies for existing literature rather than practical studies on the methods of recreating them virtually through modern systems such as Midjourney.

While experimental and observational studies are usually considered quantitative, measuring the different quantities of the outcome, this article is better described as qualitative, judging the quality of the outcome. The pros and cons of these methods are embedded in it. Given the cons of the used methods, the results are indicative rather than deterministic as the results are subjected to the opinion evaluation of the authors of this paper instead of absolute measurements, which is impossible. The outcome was not exposed to external experts due to the length limitation; however, the prompts will be given to allow for reproducibility by other scholars. Only the short prompts are provided in the discussion, while the longer ones are referred to in the sources. However, prompting with Midjourney does not allow full reproduction of outcomes as the results are subject not only to the time in which they were inserted in the Midjourney platform but also to the sophisticated randomness embedded in its algorithm and generation process. Consequently, entering the same prompt, even at the same time, by two different users might not necessarily give similar, let alone identical, results. However, in its judgment, this article depended on a pattern of similar repetitive outcomes to generalize its conclusion (Figure 1).
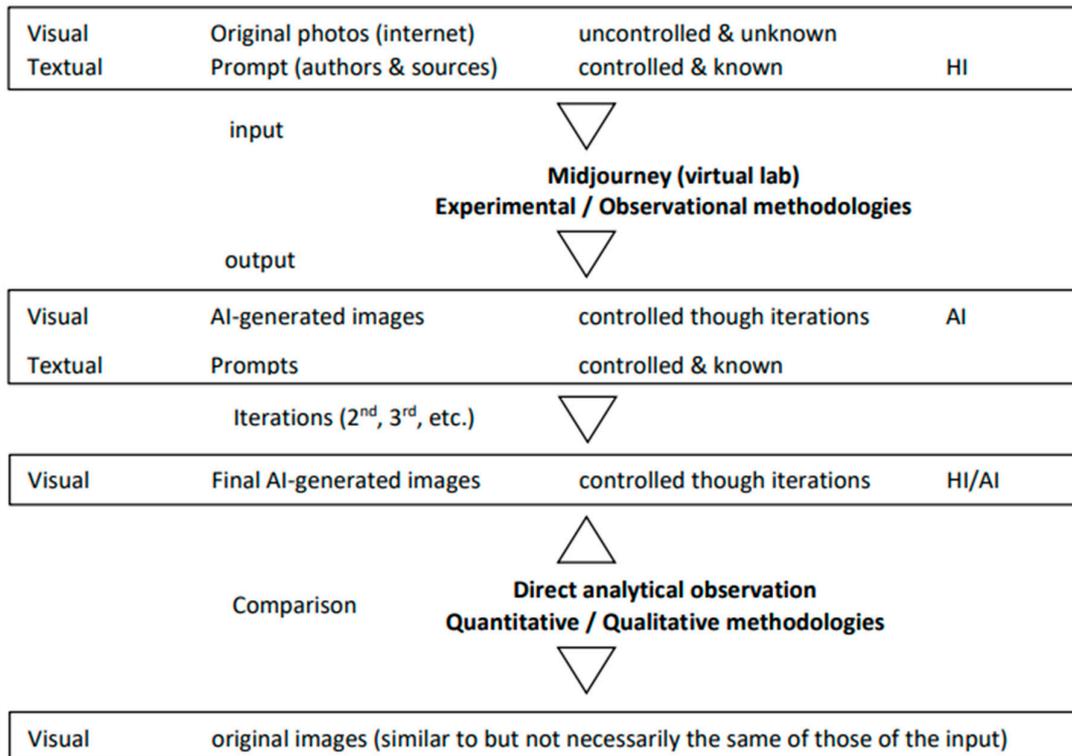
Figure 1. Diagrammatic representation of the methodological variables.

However, unlike design studies that methodologically seek to examine the opportunities and potential of AI in generating creative images for design purposes, this heritage study, in contrast, focuses on the limits and limitations of AI in generating realistic images loyal to their origins (Figure 2).

Figure 2. The difference in methodological approach between design studies and heritage studies in terms of AI-generated images.

The research materials tested in the prompts include titles of landmarks of Islamic architectural heritage and short texts taken from sources, such as Peterson's *Dictionary of Islamic Architecture* (1996) [20] and Bloom and Blair's *The Grove Encyclopedia of Islamic Art and Architecture* (2009) [21]. These sources provide a comprehensive collection of information on Islamic architectural styles, features, and historical significance. They were selected because they clearly convey details of various regions of the Islamic world in short excerpts. All prompts, seen in the captions of the figures below, were generated by ChatGPT and altered by the authors several times to reach the best possible results, except those of Figures 7, 8, and 9, which were inspired by the two sources mentioned above.

The significance of the visual approach of this article is that it allowed not only an exploration of the limits of the benefits of AI in generating images inspired by Islamic architectural heritage but also an indirect reinterpretation of various aspects of Islamic architectural heritage. However, its natural limitation lies in focusing on the visual aspect without delving into other important aspects of the study of Islamic architectural heritage, such as social and economic aspects.

4. Results

The analysis of the limitations in AI-generated Midjourney images of Islamic architectural heritage offered a structured framework to understand where Midjourney struggles and identify areas for further research and improvement. As a result of a structured examination, the article found that the identified limits can be categorized into the following four main thematic groups:

1. Limits of the prompt
   - Length
   - Language
   - Numeracy
   - Controllability
2. Limits of fame
3. Limits of regionality and historical styles
4. Limits of architectural and urban elements and details

5. Discussions

5.1. Limits of the prompt

5.1.1. Length

The restricted length of the prompt, limited in practice to approximately 1500 words (6000 characters), can hinder users from providing detailed descriptions of intricate architectural elements, such as ornaments and calligraphy, commonly found in Islamic architectural heritage. While this length might seem enough to describe a building or a site, it is, in practice, limiting for some intricate structures and areas. The shortness of the prompt may not allow for a comprehensive portrayal of these complex features. The results obtained from Midjourney improved by providing more comprehensive details. Consequently, longer prompts contribute to more accurate outcomes. Figure 3 demonstrates an example of two alternatives of architectural description for the main city gate, Bab al-Salah, of Al-Qata'i' based on the historical sources of al-Maqrizi, one generated with 67 characters (B) and the other with 1862 characters (A), where (A) is more realistic.

Figure 3. Two Midjourney AI-generated photos with prompts of architectural description for the same city gate: (B) generated with 67 characters and (A) with 1862 characters, where (A) is more realistic.

doi:10.20944/preprints202312.0093.v1

6

5.1.2. Language

The language used in the prompt also presents a categorical limitation. Figure 3 demonstrates AI-generated images with several English prompts and their Arabic counterparts. Those produced by the English language prompts consistently gave better results. This can be attributed to the fact that datasets and databases worldwide primarily comprise English content, while Arabic content constitutes a relatively smaller percentage. The linguistic bias can significantly affect the accuracy and quality of the generated outcomes for non-English prompts.

Figure 4. Midjourney AI-generated photos: using the prompt "examples of Ottoman architecture" and "examples of Mamluk architecture" in (A) Arabic and (B) English.

5.1.3. Numeracy

The quantitative limitations of the prompt word count extend to a qualitative limitation of the numeric information included in the text. Complex numerical calculations and precise quantitative specifications may be challenging to convey within the restricted character count. This limitation can impede the generation of accurate and contextually appropriate results for prompts requiring numerical input. Text-to-image generators often struggle with counting and accurately representing quantities in their generated images. This limitation stems from the nature of their training and their lack of understanding of physical objects and their referents. Unlike humans, who have a comprehension of various objects in the physical world, text-to-image generators rely solely on visual representations, which are patterns of pixels labeled with specific categories. They lack the rich sensory experiences and contextual understanding that humans possess [22]. The prompt used to produce the photos in Figure 5 included a detailed architectural description of the Umayyad Mosque, with given dimensions for the heights and widths of several architectural elements, but the results were far from reality. Strikingly, the number of minarets in the Midjourney AI-generated images where inaccurate (one or two), whereas they are, in reality, three.

Figure 5. Midjourney AI-generated photos using the prompt "The Umayyad Mosque has a total of three minarets.".

5.1.4. Controllability

While AI image generators can produce visually appealing images, they often pose challenges when users seek results close to the original forms. Even with lengthy prompts, the resulting image may fall short of expectations for accurate representation due to limited control over the creative process. The generated output may not align perfectly with the user's desired visual representation even after several iterations. Figure 6 shows how Midjourney could not visualize the minaret in the mosque of Ibn Tulun despite being given a clear architectural description of it. While adding the word spiral improved the result a bit, it did not help to capture the original form of the spiral minaret of the building.

Figure 6. Midjourney AI-generated photos: (A) using the prompt "Ibn Tulun Minaret," (B) using the prompt "Ibn Tulun Spiral Minaret.".

5.2. Limits of fame

Throughout multiple attempts to visualize various iconic buildings associated with Islamic architecture during a Midjourney visualization process, the outcomes proved successful and precise

when representing globally renowned structures like the Ka'ba and the Dome of the Rock (Figure 7). However, when attempting to visualize buildings with less fame, such as the Umayyad Mosque and Sultan Hassan Mosque, the AI visualization fell short of providing a clear and accurate depiction (Figure 8). Despite these mosques' significant artistic and architectural value, the AI algorithm encountered difficulties recognizing and accurately portraying their specific architectural elements and style, even when provided with a detailed description in the prompt. It was neither able to simulate the real building nor at least generate a similar style.

This limitation can be attributed to the restricted presence of these buildings in the database utilized by the Midjourney algorithms. It indicates a crucial requirement for a broader and more diverse range of architectural examples to enhance the AI's ability to visualize lesser known yet noteworthy monuments and sites of Islamic architecture. By incorporating a wider array of regional masterpieces into the training data, the AI model would gain a more comprehensive understanding of the diverse architectural styles and characteristics present within the realm of Islamic architecture, ultimately improving its capacity to generate accurate visual representations of such important structures.

Figure 7. Midjourney AI-generated photos: (A) using the prompt "Dome of the Rock" and (B) using the prompt "The Kaaba, also known as the Cube, is a stone building located at the center of the Masjid al-Haram in Mecca, Saudi Arabia. It is considered the most sacred site in Islam and is revered as the House of God by Muslims worldwide.".
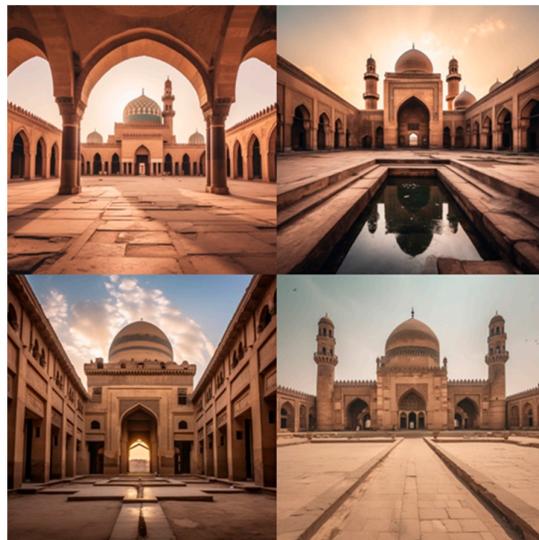
Figure 8. Midjourney AI-generated photos using the prompt "Mosque of Ibn Tulun.".

5.3. Limits of regionality and historical styles

Effectively representing the unique characteristics that differentiate various regions within the Islamic world remains a complex challenge. Islamic architecture encompasses a wide range of styles, motifs, and architectural elements that are shaped by historical, geographical, and cultural factors specific to each region. Unfortunately, existing AI image generators encounter difficulties when attempting to incorporate these distinctive regional traits into their generated images.

The minarets, recognized as an architecturally prominent feature within Islamic cities, were employed in this article as an illustrative model to explore the notion of regional variations in AI representation (Figure 9). The authors conducted a series of prompt-based experiments to trace the distinctive characteristics of minarets across eight sub-regions within the Islamic world: Egypt, Levantine, North Africa, West Africa, Arabia, Turkey, East Africa, and the Far East [20].

In the majority of the examined sub-regions, Midjourney effectively captured the distinctive characteristics of minarets in urban and rural contexts. For instance, the sand and mud tones were clearly identifiable in North, Eastern, and Western Africa (Figure 9 (A, C, G)), while the prevalence of forestry was notable in the Far East (Figure 9 (B)). Regarding architectural styles, the results demonstrated that Midjourney can identify various building materials, architectural forms, and outlines found in the Islamic world. Furthermore, it successfully depicted the hybrid architectural styles observed in the Far East (Figure 9 (B)), which combine Islamic, Asian, and local elements. However, in some cases, the scale is exaggerated (Figure 9 (E)). Based on historical sources, the minarets of large cities of Arabia, such as Hadramout and Sanaa, were known for their high minarets; however, they were not tall to the extent displayed in the above-mentioned image. In Figure 9 (H), the minarets generated share some common traits with the famous pencil-shaped minarets of Turkey, but the dimension of some parts are not very accurate compared to real-life examples.

Figure 9. Midjourney AI-generated photos using a combination of prompts describing the minarets within eight sub-regions within the Islamic world: (A) East Africa, (B) Far East, (C) West Africa, (D) Egypt, (E) Arabia, (F) Levant, (G) North Africa, and (H) Turkey.

5.4. Limits of architectural and urban elements and details

Midjourney successfully depicted the distinctive features of Islamic architecture through the effective utilization of straightforward and unambiguous geometric shapes, notably exemplified by the representation of the Ka'ba (a cube), the Dome of the Rock (a dome over octagonal extruded walls), and the Malwiya (a spiral geometry). However, the depiction of more complex examples from later periods of Islamic architecture, such as the Mosque of Ibn Tulun with its central dome building

within a courtyard setting, proved to be comparatively less accurate in its portrayal (Figure 7). Figure 10 demonstrates a clear drawback in AI regarding its limited ability to accurately incorporate precise details like ornaments, letters, words, calligraphy, and symbols within the generated images. This fact stands as an ironic contrast to AI proficiency in understanding and interpreting textual prompts for image generation. While the texts in these images appear very detailed and very close to the notion of Arabic calligraphy, it is not readable. Requesting specific text often leads to mismatching of letters or unintelligible combinations.
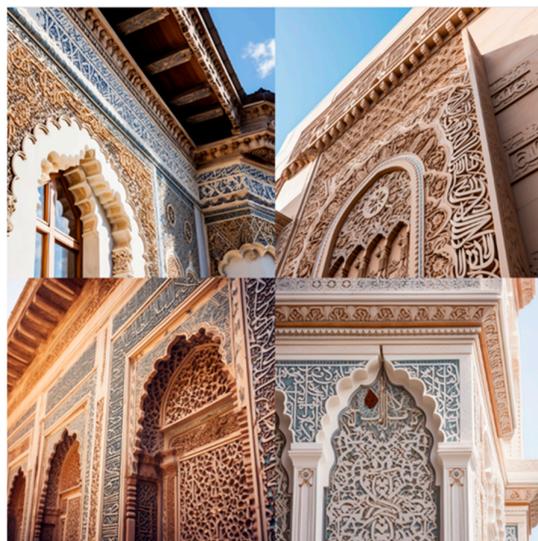

Figure 10. Midjourney AI-generated photos using the prompt: "Arabic calligraphy and ornaments on external facade of Islamic architecture.".

6. Conclusion

The widely known limitations of Midjourney, such as its inability to generate the accurate number of objects, suggest that the tool may struggle with generating images that require a high level of specificity. This article defined some major current intertwined limits in AI-generated representations of Islamic architectural heritage by deploying analytical experimentations with Midjourney. It concludes that while Midjourney has great capability to represent high-end AI-generated images inspired by the Islamic tradition, it currently falls short of presenting the actual appearance of some of its original structures. while the tool can be useful for generating creative images relate to this tradition, it sometimes struggle with more technical aspects, such as generating accurate representations of intricate architectural elements and producing detailed architectural drawings. Midjourney is primarily used by creatives for generating images for science-fiction journeys, games, and books. This suggests that the tool may not be designed or optimized for generating accurate representations of real-world architectural structures, which could explain some of the limitations identified in the paper. However, it can be, and it would be helpful to be, developed in this direction to serve representations of traditions such as that of the Islamic. Table 1 summarises and organises the limitations of Midjourney in generating images of Islamic architectural heritage and the factors/parameters of these limitations.

Table 1. A summary of the limitations of Midjourney in generating representations of Islamic architectural heritage and the factors/parameters of these limitations.

Limitations	Factors/Parameters
1. Limits of the prompt	
Length	Long … medium … short
Language	English, Arabic, etc.
Numeracy	One, two, three, etc.
Controllability	Controlable … less controlable … uncontrolable
2. Limits of fame	Famous … less famous … unfamous
3. Limits of regionality and historical styles	Arabia, Levant, North Africa, Far East, etc. Early Islamic, Ottoman, Mamluk, etc.
4. Limits of architectural and urban elements and details	Calligraphy, arabesque, ornaments, etc.

Some of the results can be applied accurately to sources beyond the Islamic architectural heritage, especially those of the AI prompt (length, language, numeracy, and controllability); however, the Islamic architectural and urban tradition is peculiar in terms of its regionality and historical styles and architectural elements and details that significantly affect the nature of the AI-generated images in program and service such as Midjourney.

The article contributes to future advancements in the field by directing attention to specific boundaries, constraints, and guiding efforts in order to enhance AI algorithms, training models, and datasets. The insights gained can also aid in the development of specialized AI-generative systems tailored for Islamic architectural heritage, allowing for more accurate representation and generation of images in this unique domain. Furthermore, the AI generation of images is a creative tool that can be used extensively in active teaching and learning in a field like Islamic architectural heritage, and hence, knowing its limitation is important to set the limit of interactivity and usefulness [23,24].

Future studies could define other major and even minor limits in this field and other fields, especially as AI technics and methods evolve and develop. They can polish the methodology used in this article by focusing on the application of iterative simulation of traditional design to participate in answering part of a question raised by Leach about the differentiation between how "artificial" Artificial Intelligence is and how misguided our own understanding of human intelligence has been [25]. They can compare AI-generated images to those created by natural human intelligence or produced through both AI and HI, which can contribute to what Cantrel and Zhang called "a third intelligence" [26].

Another area of study would involve conducting cross-cultural analyses to assess the effectiveness of AI-generated representations across diverse cultural and architectural contexts, including non-Islamic architectural styles. By comparing AI algorithm outputs from different regions, researchers can gain insights into how regional factors influence the generation of architectural images. A comparative analysis between the AI-generated images of Islamic architecture and Western architecture could provide valuable insights into the performance of Midjourney. This comparison could help to identify potential biases in the AI's training data and understand how well the AI can handle different architectural styles.

Last but not least, ethical and cultural considerations form another vital aspect of research in this field, necessitating an examination of potential issues such as cultural appropriation or misrepresentation that may arise from AI-generated representations.

References

1. Bevilacqua, M. G., Caroti, G., Piemonte, A., & Ulivieri, D. 2019. Reconstruction of Lost Architectural Volumes by Integration of Photogrammetry from Archive Imagery with 3-D Models of the Status Quo. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 42 (2/W9), 119-125. https://doi.org/10.5194/isprs-archives-XLII-2-W9-119-2019

2. Balletti, C., Dabrowski, M., Guerra, F., & Vernier, P. 2020. Digital Reconstruction of the Lost San Geminiano's Church in San Marco's Square, Venice. In *IMEKO TC-4 International Conference on Metrology for Archaeology and Cultural Heritage*, 1-5. Trento, Italy: October 22-24. Retrieved from https://www.imeko.org/publications/tc4-Archaeo-2020/IMEKO-TC4-MetroArchaeo2020-057.pdf

3. Sabri, R., Abdalla, S.B., & Rashid, M. 2021. Towards a Digital Architectural Heritage Knowledge Management Platform: Producing the HBIM Model of Bait al Naboodah in Sharjah, UAE. In P. Roca, L. Pelà and C. Molins (Eds.) *SAHC*, 12th International Conference on Structural Analysis of Historical Constructions. Retrieved from https://www.scipedia.com/wd/images/b/b5/Draft_Content_231632453p945.pdf

4. Aburamadan, R., Moustaka, A., Trillo, C., Makore, B. C. N., Udeaja, C., & Gyau Baffour Awuah, K. 2021. Heritage Building Information Modelling (HBIM) as a tool for heritage conservation: observations and reflections on data collection, management and use in research in a Middle Eastern context. In Rauterberg, M. (eds) *Culture and Computing: Interactive Cultural Heritage and Arts*, HCII 2021, Lecture Notes in Computer Science (vol. 12794). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-77411-0_1

5. Abdalla, S.B., Rashid, M., Yahia, M.W., Mushtaha, E., Opoku, A., Sukkar, A., Maksoud, A., and Hamad, R. 2023. Comparative Analysis of Building Information Modeling (BIM) Patterns and Trends in the United Arab Emirates (UAE) Compared to Developed Countries. *Buildings*, 13, 695. https://doi.org/10.3390/buildings13030695

6. Günay, S. 2022. Virtual reality for lost architectural heritage visualization utilizing limited data. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLVI-2/W1-2022, 253-257. https://doi.org/10.5194/isprs-archives-XLVI-2-W1-2022-253-2022

7. Pietroni, E. & D. Ferdani. 2021. Virtual restoration and virtual reconstruction in cultural heritage: terminology, methodologies, visual representation techniques and cognitive models. *Information*, 12 (4), 167. https://doi.org/10.3390/info12040167

8. Strobelt, H., Webson, A., Sanh, V., Hoover, B., Beyer, J., Pfister, H., & Rush, A. M. 2022. Interactive and Visual Prompt Engineering for Ad-hoc Task Adaptation with Large Language Models. *IEEE Transactions on Visualization and Computer Graphics*, 29 (1), 1146-1156. https://doi.org/10.48550/arXiv.2208.07852

9. Oppenlaender, J., Linder, R., & Silvennoinen, J. 2023. Prompting AI Art: An Investigation into the Creative Skill of Prompt Engineering. https://doi.org/10.48550/arXiv.2303.13534

10. White, J., Fu, Q., Hays, S. Sandborn, M., Olea, C., Gilbert, H., Elnashar, A., Spencer-Smith, J., & Schmidt, D.C. 2023. A Prompt Pattern Catalog to Enhance Prompt Engineering with ChatGPT. https://doi.org/10.48550/arXiv.2302.11382

11. Repenning, A., & Grabowski, S. 2023. Proompting is Computational Thinking. Proceedings for IS-EUD 2023: 9th International Symposium on End-User Development, 6-8 June 2023, Cagliari, Italy. Retrieved from https://ceur-ws.org/Vol-3408/short-s2-07.pdf

12. Göring, S., Rao, R. R. R., Merten, R., & Raake, A. 2023. Analysis of Appeal for realistic AI-generated Photos. IEEE Access 11, 38999-39012. https://doi.org/10.1109/ACCESS.2023.3267968

13. Ruskov, M. 2023. Grimm in Wonderland: Prompt Engineering with Midjourney to Illustrate Fairytales. https://doi.org/10.48550/arXiv.2302.08961

14. Oppenlaender, J. 2022. The creativity of text-to-image generation. In Proceedings of the 25th International Academic Mindtrek Conference, November, 2022, 192-202. https://doi.org/10.1145/3569219.3569352

15. Lyu, Y., Wang, X., Lin, R., & Wu, J. 2022. Communication in human–AI co-creation: Perceptual analysis of paintings generated by text-to-image system. *Applied Sciences*, 12 (22), 11312. https://doi.org/10.3390/app122211312

16. Barandy, K. 2023. Fictional Hybrid Structures (April 23). Retrieved June 23, 2023 from https://www.designboom.com/architecture/getagent-iconic-architecture-reimagined-ai-buildings-different-architectural-styles-ai-midjourney-04-03-2023/

17. Najafian, K. (edited by Z. Mango). 2022. Kaveh Najafian's AI Explorations of the Versailles Palace (September 15). Retrieved June 23, 2023 from https://www.designboom.com/architecture/maximalist-ai-explorations-versailles-palace-gold-facades-kaveh-najafian-09-15-2022/

18. Betsky, A. 2022. The Voyage Continues: Designers Use Midjourney to Reimagine Capri (October 05). Retrieved June 23, 2023 from https://www.architectmagazine.com/design/the-voyage-continues-designers-use-midjourney-to-reimagine-capri_o

19. Khan, R. 2023. Rolando Cedeño De La Cruz Rethinks Ancient Structures Using AI (April 27). Retrieved June 23, 2023 from https://www.designboom.com/architecture/midjourney-ancient-ziggurat-pyramid-temple-modern-arts-venue-rolando-cedeno-de-la-cruz-04-27-2023/

20. Peterson, A. 1996. *Dictionary of Islamic Architecture*. London: Routledge, 187-191.

21. Bloom, J., & Blair, S. eds. 2009. *Grove Encyclopedia of Islamic Art and Architecture*, 3 Volumes. Vol. 2. Oxford University Press.

22. Wasielewski, A. 2023. "Midjourney Can't Count": Questions of Representation and Meaning for Text-to-Image Generators. *The Interdisciplinary Journal of Image Sciences*, 37 (1), 71-82. https://doi.org/10.1453/1614-0885-1-2023-15454

23. Sukkar, A., Yahia, M.W., Mushtaha, E., Maksoud, A., Abdalla, S.B., Nasif, O., & Melahifci, O. 2023. Applying Active Learning Method to Enhance Teaching Outcomes in Architectural Engineering Courses. *Open House International*. https://doi.org/10.1108/OHI-10-2022-0259

24. Sukkar, A., M. W. Yahia, E. Mushtaha, A. Maksoud, O. Nassif, and O. Melahifci. 2022. The Effect of Active Teaching on Quality Learning: Students' Perspective in an Architectural Science Course at the University of Sharjah. *2022 Advances in Science and Engineering Technology International Conferences (ASET)*, 4th ASET (Innovations in Engineering Education), IEEE Xplore, 1-6. https://doi.org/10.1109/ASET53988.2022.9734977

25. Leach, N. 2018. Design in the Age of Artificial Intelligence. *Landscape Architecture Frontiers* 6 (2), 8-19. https://doi.org/10.15302/J-LAF-20180202

26. Cantrell, B. and Zhang, Zh. 2018. A Third Intelligence. *Landscape Architecture Frontiers* 6 (2), 42-51. https://doi.org/10.15302/J-LAF-20180205