Special Article

The Impact of Artificial Intelligence on Architectural Design, Identity, and Culture-Making in Kuwait and the Gulf

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Artificial intelligence (AI) is an up-and-coming technology that is creating a paradigm shift across virtually every sector of the tech industry, and that is rapidly affecting many other fields and industries, including medicine, architecture, science and engineering. It constitutes a wide-ranging branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence. This article reports on research on the application of AI in the characterization of the "traditional" in architectural design by exploring the challenges and opportunities for using its representational potential in terms of culture, identity, design, experience and regeneration. Specifically, the study employed interactive workshops to examine AI's ability to replicate images of major landmarks in Kuwait City, Riyadh, and Doha. Through verbal prompts, study participants used AI to generate hundreds of images that revealed the potential of this fascinating new tool of architectural visualization. But the images also suggested that AI's digital bias may produce inaccurate representations of certain building types. Tradition and culture may be seen as dynamic and fluid, evolving with technology to bridge between past and future. And in this sense the article argues that AI platforms may become a powerful tool to transform the design of buildings and cities. Yet even if AI technology presents a tremendous opportunity for change in architectural design and construction, it is still unclear how it will reshape culture in the built environment.

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There has not yet been significant research on how AI text-to-image-generation platforms perceive architectural culture in the Arabian Gulf. In Kuwait, however, the architect Abdul Ahad Duad became one of the first to use AI to visualize future traditional environments. With astonishing results, he applied AI to the task of imagining the renovation of the fire-damaged Al-Mubarikya, Kuwait's historic *souq*.[1] In this case, AI stripped the traditional marketplace of its vernacular elements and replaced them with contemporary, minimalistic abstractions, creating a new, morphed translation of reality.

This exploration has raised many questions. To what extent was this new vernacular imagined by the architect who described it? Or was it the AI that visualized such a new architectural identity for the space? By extension, given its capabilities, will AI be able to take over the role of the architect? Or will AI simply be used as an investigative design tool? Either way, the potential consequences for the architectural profession are enormous, and they open the door for profound new understandings of the evolution of culture in the built environment.

To examine AI's potential to shift the boundaries of cultural expression this study used identity-in-architecture workshops as a primary methodology. Participants were tasked with selecting ten landmarks in three Gulf cities (Kuwait City, Riyadh, and Doha). They were then told to use verbal descriptions to command the AI to generate new images and 3D reinterpretations of them.

The article will first outline and discuss the parameters for how AI operates and makes decisions with regard to architectural imagery. It will then analyze the content of the resultant images and compare them to photographs of the real buildings. The findings reveal many fascinating insights and provide a rich data set to inform and direct future design solutions.

The intent of this exploratory study is thus not only to see how architects may use AI as a design tool but also to better understand how AI outcomes may influence issues of architectural identity, form and style. This should suggest significant topics of concern both for the future of design and for conversations about architectural heritage and preservation.

THE EMERGENCE OF AI AND ITS POTENTIAL IMPACT ON IDENTITY AND CULTURE

The origins of the present field of artificial intelligence date to a paper by Warren McCulloch and Walter Pitts for designing "artificial neurons" in 1943.[2] The term artificial intelligence (AI) was later coined by John McCarthy in 1955 to encompass what he described as "the science and engineering of making intelligent machines."[3] Soon afterwards, in 1956, the field itself was founded at a workshop at Dartmouth College.[4] Today, artificial intelligence is an umbrella term for a lot of different kinds of computational techniques aimed at making machines behave and work more like humans. Some, however, see AI primarily as a tool for commercial surveillance, an outgrowth of surveillance capitalism, which has simply been repackaged as an innovation that is going to help humankind.[5]

Throughout the 1960s, governments around the world started funding AI projects, however the effort turned out to be more difficult than anticipated and funding stopped. Then, in the 1980s, some commercial projects with AI started but also did not gain traction. But in the 1990s interest in AI investment reemerged, exploiting formal mathematical methods to find specific solutions to specific problems.[6] At this time, however, commercial uses for AI were still largely focused in the fields of statistics, mathematics and economics.

In 2012, deep learning, a machine learning (ML) method, began to dominate and was adopted throughout these fields and in many related professions. Deep learning uses large, multilayer (artificial) neural networks that compute with continuous (real number) representation. The idea is to mimic the hierarchically organized neurons in human brains. Deep learning is currently the most successful ML approach, usable for all types of ML with better generalization from small data sets and better scaling to big data sets and computational budgets.[7] Its success has encouraged the recent growth of AI funding, leading to increases in research, performance, and the speed of systems.[8] The results of this advance now appear in various applications powered by AI, including Google search engines, language translation systems such as Google

Translate and Microsoft Translate, the AI recommendation systems used in YouTube and Netflix, and AI virtual assistants such as Siri by Apple and Alexa by Amazon. AI has also been used in many facial-recognition software applications such as Apple's Face ID for the iPhone and Microsoft's Deep Face.

In the last few years some researchers have started to examine how different manifestations of AI will affect the discipline and professions of architecture, interior design, and art.[9] For example, in a 2021 paper, Matias del Campo, Alexandra Carlson, and Sandra Manninger explored how generative adversarial networks (GANs) could be used to produce architectural designs for a project called Robot Garden developed at the University of Michigan.[10]

As recently as 2020, generative AI platforms have also become capable of producing messages using text, images and other media. Of particular importance for design, text-to-image artificial intelligence systems have also started to emerge, such as Stable Diffusion, MidJourney, and DALL-E.[11] These systems, called neural networks, are able to convert text inputs from users into AI-generated images. They allow designers to easily convert written descriptions of buildings and spaces into realistic 3D images, giving them the ability to visualize and experiment with different design options in a matter of seconds. The images created by these "bots," which are both real and imaginary, have become popular online, sparking many discussions about the future of AI technology in architecture.[12] Yet, as a result of the fast pace of AI development, they have also prompted many questions related to such concerns as appropriate regulations, copyright infringement, job losses, and a lack of technological transparency.

Other recent discussions have revealed a global North/South divide in terms of access to the benefits of AI. Thus, it has been pointed out that while AI developers mostly reside in locales such as Silicon Valley, the workers who make it happen reside largely in the global South. Some have even raised concern over how technology companies using AI may take the place of old colonial empires, driven by algorithms that reflect bias and discrimination. In addition, AI systems are only as good as the data they are trained with, and in the global South large segments of the populations of many countries are still not online. If they are thus digitally uncounted, the chances of their exclusion or of bias against them are very high. At the same time, according to one report:

> *AI systems and machine learning [embody] a status quo technology [that] reproduces the future . . . based on the past. What that means is even the data that does exist already reflects historical patterns of injustice and discrimination against certain people, race, religion, etc.*[13]

Such insights by industry experts highlight the need for regulation of AI systems. They also indicate that people should not blindly have faith in machines or see AI as a source of truth. Quite the reverse, AI's representation of identity and culture may be deeply flawed and embody inherent types of bias. It is precisely the intention for this study to shed light on these issues in the field of architecture—and, in so doing, examine the future role of AI in design and identity creation.

To date, there has been very little research on how AI platforms may affect issues of identity and culture in architecture. Identity is an abstract idea with many layers that "can be applied in different contexts and can have its own unique set of principles that characterize its meaning."[14] Identity can be rooted in an interpretation of a culture and its self-expression. It can also give a sense of meaning to places, using architecture as a language to assert state power, or even emerge through reinventing the vernacular.[15] As UNESCO'S declaration of cultural rights states,

> *Cultural identity applies to all cultural references through which individuals or groups define or express themselves and by which they wish to be recognised; cultural identity embraces the liberties inherent to human dignity and brings together, in a permanent process, cultural diversity, the particular and the universal, memory and aspiration."*[16]

Cultural identity is therefore an expression of who people are.

Architecture and design have long been identified as a source of cultural identity. For example, the architectural theorist Chris Abel has described architecture as a way of being and defined the deeper functions of architecture as "not . . . simply describing the production of a certain type of artefact, but explaining one of the original ways in which we know ourselves."[17] One may thus see identity as very much intertwined with culture, tradition, and the reflection of the self.

In his edited book *The End of Tradition*, Nezar AlSayyad, however, claimed that what is "ending" in terms of tradition in the contemporary era is the notion of tradition as authentic or unchanging, a quality or practice that may be owned by certain people and attached to certain places as genuine heritage representing a legacy of the past.[18] He thus argued that globalization has changed the connection between people, their culture, and where they live. In place of older understandings, this has led to the view of tradition as no longer confined by the boundaries of time and space; rather, it has evolved into a global phenomenon.[19]

Given such conditions, it is very possible that AI technologies will further this trend, allowing tradition to become even more fluid and changeable within the virtual realm.

METHODOLOGY: ARTIFICIAL INTELLIGENCE WORKSHOPS

The research for this article composed a series of exploratory workshops based on an interactive, participatory group exercise. According to University College London's Public Engagement Unit, such a methodology can "be used to gauge and compare opinions on a range of different aspects, criteria or qualities of a project or activity." The Public Engagement Unit further describes workshops as "a means of capturing more qualitative information . . . probing the meanings participants give to their behavior, ascertaining reasons, motives and intentions."[20]

Acting as a researcher in an academic setting, an instructor's role can thus move from lecturing to becoming a "facilitator of a conference." In this model, the instructor does not remain passive but rather helps "direct and mold discussions by posing strategic questions and helping students build on each other's ideas."[21] The workshop may therefore become an essential tool to develop innovative instructional approaches and incorporate active learning strategies as a means to encourage critical thinking. In the present case, this approach provided an interactive way to understand different people's experiences using AI and its impact on architectural culture and identity in the Gulf.

The workshops that provided the basis for this article were conducted within the span of three days at the Department of Architecture, Kuwait University. Thirteen architecture students participated, of whom twelve were female and one male. They were first directed to select one architectural landmark each from Kuwait City, Kuwait; Riyadh, Saudi Arabia; and Doha, Qatar. Each landmark selected was intended to express a contemporary, postmodern approach to architectural design and to embody clear cultural references, such as Islamic geometric patterns, *mashrabiyas*, courtyards, *liwans* [covered arcades], etc. Moreover, the students were asked to select a range of structures that represented a broad view of architectural production in each country, such as mosques, houses, palaces, museums, cultural centers, government buildings, stadiums, and even skyscrapers. They were then asked to select ten keywords that described each structure's architectural elements, form, materials and color. The words "culture," "identity" and "tradition," were then added to every list, as were the name of the city and country in which each was located and the name of the landmark itself. The last three elements were added to direct the Artificial Intelligence to come as close as possible to reproducing an image of the original structure and its distinguishing features and details.

Once these selections and descriptions were created, workshop participants were asked to use the AI platform known as MidJourney to produce images of the buildings. MidJourney is a text-to-art or text-to-architecture image generator, an interactive "bot" that uses machine learning to create pictures based on text. This AI product was specifically chosen due to its ability to produce more advanced and photo-realistic architectural reproductions than its existing counterparts.

The participants were shown how to use the program, and then instructed to write a paragraph of text describing each landmark, including all the keywords. This text prompt was in turn used by the AI program to generate its own photo-realistic renderings of the buildings described. Afterwards, each participant picked an image that most closely resembled the original structure and directed the program to produce new enhanced variants. The images could thus be improved by running the program multiple times. Each iteration of the process also allowed participants to refine the prompt description and try different variations. The final AI-generated images thus reflected a reiterative process.

In summary, keywords entered into the MidJourney channel were used by the AI to produce four variations of the landmark. The closest to reality was then selected by the participants, and the AI was directed to enhance that version. This process continued until the AI generated an image that was as close as possible to the real appearance of the landmark. If one iteration did not produce an accurate representation, the process was repeated until the AI image matched the appearance of the original landmark as closely as possible.

After their work with the AI program was complete, the participants were instructed to place a real image of the building or landmark and the constructed AI image side by side. The primary researcher (the course instructor) then facilitated a discussion between the participants intended to explore the extent to which the AI had replicated or changed the perceived culture and identity of each work of architecture.

This process was repeated for three days, one day each for the selected landmarks in the cities of Kuwait, Riyadh and Doha. A final group interview was then conducted to cross-analyze the findings from the three cities and determine if general patterns and consistencies could be discerned in the AI output. This contributed to the formulation of a series of emerging themes, discussed below.

WORKSHOP RESULTS

The tables on the following pages summarize the outcome of the research and some of the underlying trends in the application of AI to architectural design as identified by study participants.

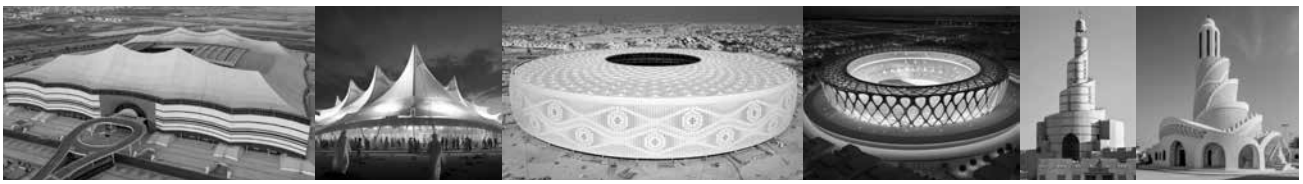

TABLE 1: *Kuwait City landmark photographs and AI generated images.*

#	LOCAL LANDMARK	KEYWORDS USED TO DIRECT THE AI	PHOTOGRAPH OF THE REAL BUILDING	ARTIFICIAL INTELLIGENCE (AI) REPLICATION
1	**Kuwait Towers**	Contemporary, highrise buildings, three towers, hierarchy, sphere, repetition, mosaic, Islamic geometry, glass horizontal, sharp point, culture, identity, tradition, Kuwait City, Kuwait, Kuwait Towers.		
	AI design process and image analysis: The Kuwait Towers went through three rounds of iteration, after which the landmark was replicated as a morphed, enlarged version of itself. Notice that the original landmark displays a hierarchy of spheres and sizes from larger to smaller towers, while in the AI image all the towers are almost equal in shape and form. Although the AI understood the overall significant elements of the Kuwait Towers, it failed to acquire an understanding of the details of its form and function.			
2	**National Assembly Building**	Arabian tent, tensile structure, repetition, curves, solid and void, rhythm, courtyard, Islamic *mashrabiyas*, semicircular shells, horizontal, culture, identity, tradition, Kuwait City, Kuwait, Kuwait National Assembly.		
	AI design process and image analysis: The Kuwait National Assembly Building went through three rounds of iteration. Designed by Jørn Utzon, this landmark uses traditional elements such as the courtyard, Islamic arch, and Arabian tent to inspire its concrete form. The AI regeneration took the Islamic arch and created a simplified abstract version, and by doing so lost connection to the original. As with the previous example, it is possible to notice how the AI struggled to express the details.			
3	**Kuwait Grand Mosque**	Dome, minaret, arch, square, arcade, Islamic pattern, repetition, high, courtyard, *mashrabiya*, culture, identity, tradition, Kuwait City, Kuwait, Kuwait Grand Mosque.		
	AI design process and image analysis: The Kuwait Grand Mosque went through three rounds of iteration, after which the AI did not manage to generate a convincing image of the actual mosque or even a close resemblance. Instead of one major dome it created one dome with two smaller domes, and instead of one minaret it created four. Finally, it seems the AI did not know how to comprehend the style of the actual mosque, and therefore its understanding of it as a work of Islamic architecture was inaccurate. This provided a further indication of AI's weakness when it comes to grasping local and regional traditional styles and elements.			
4	**JACC-Kuwait's Opera house**	Angular, sharp lines, Islamic pattern, *mashrabiyas*, solid and void, culture, identity, tradition, Kuwait City, Kuwait, Kuwait Opera House.		
	AI design process and image analysis: This image went through one round of iteration. The design was based on abstract Islamic geometric forms. It seems the AI was capable of providing a more accurate regeneration of the actual building in this case.			
5	**Fatma Mosque**	Stretched dome, conical circle, Islamic pattern, green, rhythm, geometry, *manara* [minaret], culture, identity, tradition, Kuwait City, Kuwait, Fatma Mosque.		
	AI design process and image analysis: The AI image of the Fatma Mosque went through three rounds of iterations, but it was very difficult for the AI to replicate its unusual dome. The intricate Islamic patterns in the facade were also poorly understood. Instead, the AI produced a simpler version of the structure, offering a poor replica of the architecture of the original landmark.			

#	LOCAL LANDMARK	KEYWORDS USED TO DIRECT THE AI	PHOTOGRAPH OF THE REAL BUILDING	ARTIFICIAL INTELLIGENCE (AI) REPLICATION
6	**Dahia Twin Villas**	Cubic axial symmetrical, sustainable, solar panels, wind catcher, modern *mashrabiya*, courtyard, *liwan* or shaded walkway, palm trees, culture, identity, tradition, Kuwait City, Kuwait, Dahia Twin Villas.		

AI design process and image analysis: In this case, the AI image went through five rounds of iteration. The design for the Dahia Twin Villas employs traditional Kuwaiti vernacular elements to promote sustainable design in a contemporary form. Because the AI was not familiar with these local elements, it highlighted the simpler notion of "twin villas." It thus generated the image of a pair of commercial-looking villas such as might be built by a real estate company in the region and which are largely devoid of traditional inspiration.

7	**Tent House**	Tent, pointed, repetition, arches, hierarchy, vertical lines, formed concrete, cone-like, ribbed fence, white, culture, identity, tradition, Kuwait City, Kuwait, tent house.		

AI design process and image analysis: This image went through two rounds of iteration. In contrast with the previous example, the AI was able to comprehend the tent concept more easily and produced decent versions of the original design. Perhaps the notion and form of the tent is more prevalent globally and online, and that made it easier for the AI to mimic.

8	**Al Shaya Diwaniya**	Islamic patterns, barrel-vault arches, courtyard, repetition, high ceiling, culture, identity, tradition, Kuwait City, Kuwait, Diwan Al Shaya.		

AI design process and image analysis: This image went through two rounds of iteration. It seems the AI was able here to reimagine the Kuwaiti *diwaniya* (a traditional male social space) in a mosque/palace-like setting. In doing so, however, it ignored the function of the traditional space, enlarging its scale and creating a less intimate social environment.

9	**Al Seif Palace**	Rectilinear, clay palace, hierarchy, arches, *mirzam*, traditional water gutter, Islamic patterns, clock tower, dome, courtyard, *mashrabiyas*, *liwan*, arcade, culture, identity, tradition, Kuwait City, Kuwait, Al Seif Palace.		

AI design process and image analysis: The reinterpretation of Al Seif palace went through four rounds of iteration and provided yet another example of how the AI struggled to understand local traditional architectural concepts. Here it replicated the palace in a more Indian/Mughal version that is out of context with the locale and derived from a different century than the original.

10	**Scientific Center**	Fabric tensile tents, repetition, pattern, traditional sails, ships, boom, *mashrabiya*, *mirzam*, open, sea, culture, identity, tradition, Kuwait City, Kuwait, Kuwait Scientific Center.		

AI design process and image analysis: The Kuwait Scientific Center went through two rounds of iteration. The design concept for this structure takes inspiration from Kuwait's maritime shipping heritage and uses fabric to boldly express its form. The AI easily understood this idea and provided a reasonably accurate rendition of the original landmark. It seems that it was easier for it to grasp a simple architectural vocabulary such as the fabric structures associated with many postmodern buildings.

TABLE 2: *Riyadh landmark photographs and AI generated images.*

#	LOCAL LANDMARK	KEYWORDS USED TO DIRECT THE AI	PHOTOGRAPH OF THE REAL BUILDING	ARTIFICIAL INTELLIGENCE (AI) REPLICATION
1	**KAPSARC Mosque**	Cubic form, long courtyard, glass, stone clad, concrete, Islamic patters, abstract, light, shadows, long rectilinear, modern minaret, culture, identity, tradition, Riyadh, Saudi Arabia, KAPSARC Mosque.		
	AI design process and image analysis: The imagery here went through two rounds of iteration, after which the AI clearly replicated the glass-cube structure but without the Islamic geometric pattern in the building's skin. A further major inaccuracy concerned the minaret, which the AI interpreted in a classical Fatimid style rather than in the more minimalistic, contemporary style of the actual structure.			
2	**King Abdulaziz National Library**	Square, shell, cladding, rhomboid textile awnings, revealing, concealing, Arabian tent, textile, triangles, opening, dissociation, semi-transparent skin, culture, identity, tradition, Riyadh, Saudi Arabia, King Abdulaziz National Library.		
	AI design process and image analysis: This image went through two rounds of iteration. The AI regeneration did remarkably well in terms of mimicking the complex abstract geometrical pattern wrapped around the library.			
3	**Kingdom Centre**	Simple solid, curtain glass wall, parabolic arch, steel bridge, void, inverted, culture, identity, tradition, Riyadh, Saudi Arabia, Kingdom Center.		
	AI design process and image analysis: This image went through two rounds of iteration. The AI provided a fairly accurate representation of the Kingdom Centre except that it exaggerated the upside arch opening at the top of the tower. It seems that the AI performs better with more recognizable buildings that are easily found online.			
4	**KAFD Riyadh Conference Centre**	Islamic geometric pattern, angular, sharp angles, triangular, steel, dynamic, green wall, culture, identity, tradition, Riyadh, Saudi Arabia, KAFD Riyadh Conference Centre.		
	AI design process and image analysis: This image went through two rounds of iteration. As with the Kuwait JACC building, the design of the Conference Centre is based on abstract Islamic geometrical forms, and the AI seemed to easily recognize this and generate a version that was close to the original. A pattern that starts to emerge is that AI does fairly well in configuring abstract and globally recognized forms, yet its abilities are more limited when it comes to local and detailed concepts.			
5	**Ministry of the Interior**	Inverted pyramid shape, sharp lines, symmetrical design, central core, steel framework, strong, central dome, strong, inter-connected beams, culture, identity, tradition, Riyadh, Saudi Arabia, Ministry of Interior.		
	AI design process and image analysis: This image went through two iterations. The AI here managed to replicate a simplified version of the form, but its output lacked most of details and specific qualities of the actual structure.			

#	LOCAL LANDMARK	KEYWORDS USED TO DIRECT THE AI	PHOTOGRAPH OF THE REAL BUILDING	ARTIFICIAL INTELLIGENCE (AI) REPLICATION
6	**Garir Villa**	Contemporary villa, rectangular, concrete, wood, modern courtyard, black *mashrabiya*, privacy, palm trees, Islamic patterns, cantilevered, culture, identity, tradition, Riyadh, Saudi Arabia, Garir Villa.		

AI design process and image analysis: This image went through two rounds of iteration. The AI has easily translated the villa here, yet in a way that made it seem larger and more luxurious. Another emerging pattern is that AI images tend to be more futuristic, posh, and attractive than the original structures. This outcome could reflect a bias toward capturing the attention of the viewer, perhaps as a reflection of a marketing strategy aimed at enticing users of the program to create more images.

7	**King Salman Palace**	Towers, rectangular watchtower, courtyard, arcade, wood, limestone, colonnades, triangular voids, culture, identity, tradition, Riyadh, Saudi Arabia, King Salman Place, Riyadh.		

AI design process and image analysis: This image went through four iterations. The design of the palace was inspired by local Najdi architecture, however the building itself is contemporary, making use of concrete and other modern materials. The AI could not produce a contemporary version of the traditional design, and instead generated an image of a purely mud-brick traditional building.

8	**Al Faisaliyah Tower**	Triangle, glass ball, truss system, hierarchy, pointed sharp, horizontal, organized, culture, identity, tradition, Riyadh, Saudi Arabia, Al Faisaliyah Tower.		

AI design process and image analysis: This image went through two rounds of iteration. As with the other landmark towers, the AI was able to produce an almost identical imitation of the form of the building with a few minor changes in the details.

9	**Al Muqarnas Tower**	Vaulting techniques, twisting, solar performance, skin, metal panel, shimmering mosaic, culture, identity, tradition, Riyadh, Saudi Arabia, Al Muqarnas Tower.		

AI design process and image analysis: This image went through two rounds of iteration. The AI image twisted and morphed the tower compared to the original. Perhaps because the building is relatively new and has a less well-established online presence, it was harder for the AI to replicate it accurately.

10	**Villa Ajmakan**	Modern courtyard, *mashrabiyas*, villa, light effect, white concrete walls, *majlis*, culture, identity, tradition, Riyadh, Saudi Arabia, Villa Ajmakan.		

AI design process and image analysis: This image went through two rounds of iteration. The villa is a simple *mashrabiya*-inspired block that was easy for the AI to regenerate. However, the AI-generated image was more exciting than the original, and its colors were more suited to the desert environment.

TABLE 3: *Doha landmark photographs and AI generated images.*

#	LOCAL LANDMARK	KEYWORDS USED TO DIRECT THE AI	PHOTOGRAPH OF THE REAL BUILDING	ARTIFICIAL INTELLIGENCE (AI) REPLICATION
1	**Qatar State Grand Mosque**	Arches, domes, large gate, Islamic pattern, courtyard, sandstone, horizontal, *mirzam*, repetition, minaret, culture, identity, tradition, Doha, Qatar State Grand Mosque.		
	AI design process and image analysis: This image went through five rounds of iteration. Even so, the AI version of the mosque was not able to accurately represent the original. The Qatar Grand Mosque features a series of small domes, whereas the AI image produced two large domes. The actual mosque also reflects a simple local form, while the AI replica contained more ornamentation in the parapet walls and patterns.			
2	**Islamic Art Museum**	White, cubes, geometrical shapes, artificial peninsula, volumes, courtyard, abstract, palm trees, cubes, dome, arched walls, culture, identity, tradition, Doha, Qatar, Islamic Art Museum.		
	AI design process and image analysis: This image of the Islamic Art Museum went through two rounds of iteration. The AI interpretation here was both different from and similar to the original. Despite a few differences in color and the addition of arches, the formal arrangements of the buildings were not far apart. Again, the AI seemed to do better with abstract forms.			
3	**Doha Tower**	Tall, geometry, *mashrabiya*, Islamic patterns, cylindrical, reflective glass, atrium, full-width dome, needle, Light and shadow, bird tower, culture, identity, tradition, Doha, Qatar, Doha Tower.		
	AI design process and image analysis: This image went through two rounds of iteration. Doha Tower is known for its *mashrabiya* skin, with a round dome pointing to the sky. The AI, however, slanted the core of the building and reduced the domelike appearance at its top.			
4	**Qatar Faculty of Islamic Studies**	Courtyard, geometric patterns, arches, solid/void, futuristic, curved, calligraphy, minarets, shadow and light, continuous, culture, identity, tradition, Doha, Qatar, Qatar Faculty of Islamic Studies.		
	AI design process and image analysis: This image went through three rounds of iteration. The AI regenerated the building lines and organic futuristic curves very nicely, but it was not able to add the calligraphy or cultural imprints that mark the original. The result reinforces the previously observed pattern according to which AI tends to generate abstract futuristic shapes more easily.			
5	**Al Bayt Stadium**	Old, *bayt al sha'ar* [Arabian tent], tensile structures, pointed, *sadu* patterns, red gate, rectangular, void, black and white stripes, symmetry, culture, identity, tradition, Doha, Qatar, Al Bayt Stadium.		
	AI design process and image analysis: The image went through two rounds of iteration. Because the stadiums of the 2022 FIFA World Cup are well known, with a vast online presence, the AI very easily replicated this structure to produce a highly accurate representation.			

#	LOCAL LANDMARK	KEYWORDS USED TO DIRECT THE AI	PHOTOGRAPH OF THE REAL BUILDING	ARTIFICIAL INTELLIGENCE (AI) REPLICATION
6	**Al Thumama Stadium**	Modern *mashrabiya*, circle, pattern, *gahfiya* [head cover], geometry, Islamic, white, lighting, flat, void, culture, identity, tradition, Doha, Qatar, Al Thumama Stadium.		
	AI design process and image analysis: The image went through two rounds of iteration. Because the stadiums of the 2022 FIFA World Cup are well known, with a vast online presence, the AI very easily replicated this structure to produce a highly accurate representation.			
7	**Fanar Qatar Islamic cultural center**	Spiral, arches, square, *mashrabiya*, traditional, rectangle, cubes, culture, identity, tradition, Doha, Qatar, Fanar Qatar Islamic Cultural Center.		
	AI design process and image analysis: This image went through three rounds of iteration. The landmark has a visible geometric swirl shape and is well known in Doha, which explains how the AI nicely regenerated the building.			
8	**Qatar University**	*Mashrabiya*, cubes, repetition, hierarchy, cladding, patterns, liwan (covered arcade), wind catcher, culture, identity, tradition, Doha, Qatar, Qatar University.		
	AI design process and image analysis: This image went through four rounds of iteration. Qatar University employs a modern version of the *bagdir* [wind catcher], a feature used in traditional vernacular architecture as a natural air-cooling system. The AI managed to maintain the form of the university building with a *Matrix*-inspired futuristic feeling. However, the AI did not show any sign of replicating the *bagdir*, which may again indicate how it fails to recognize local traditional concepts.			
9	**Lusail Naqsh house**	White, cubic, *mashrabiya*, patterns, glass, minimalist, courtyard, main entrance, solid and void, light and shadow, culture, identity, tradition, Doha, Qatar, Lusail Naqsh house.		
	AI design process and image analysis: This image went through two rounds of iteration. The house is a simple block with *mashrabiyas*, which the AI managed to regenerate in a more sophisticated and developed manner.			
10	**Al Janoub Stadium**	Sails, pearl, waves, oval, symmetry, white, void, futuristic, curve, rhythm, culture, identity, tradition, Doha, Qatar, Al Janoub Stadium.		
	AI design process and image analysis: The image went through two rounds of iteration. Because the stadiums of the 2022 FIFA World Cup are well known, with a vast online presence, the AI very easily replicated this structure to produce a highly accurate representation.			

DISCUSSION OF THE RESEARCH FINDINGS

The research produced fascinating insights into how AI was and was not able to replicate images that reflected the architectural culture, identity and character of significant landmarks in three major Gulf cities. In most cases, after a few iterations, the chosen AI software did manage to capture the form and essence of the buildings using specific inputted key words. However, the findings highlight significant divergent socio-cultural manifestations, which may suggest a fundamental issue related to AI's understandings and expression of architectural culture. The following themes emerged from the workshops as these bear on this concept.

Local vs. Global Interpretations. The frameworks used by AI to generate imagery rely primarily on the vast trove of information available on the Internet. Therefore, if major landmarks (such as the Kuwait Towers, Kingdom Center, and Doha Tower) are well known internationally and have a significant presence online, it is more likely that AI will be able to generate accurate images of them than less well-known works of regional architecture. In these reinterpretations, however, specific instances of cultural reference remain. Thus, Kuwait Towers still exhibited its iconic spheres, Kingdom Towers still displayed its unusual upside-down arch, and Doha Towers was still characterized by its modern *mashrabiyas*.

Similarly, when it comes to other important structures, such as the stadiums built in Doha for the 2022 FIFA World Cup, the AI reproductions were strikingly precise. This may suggest that the intense media coverage online of the World Cup as the biggest sports event in the world made it easier for the AI to iteratively generate ever-more-accurate images of the stadiums. This same outcome was also evident with regard to other notable buildings such as Kuwait's National Assembly, designed by the noted Danish modern architect Jørn Utzon, and Riyadh's Ministry of Interior. The AI imagery here was very similar to the actual buildings in terms of color, vibe, and (to a certain extent) shape.

By contrast, the AI reproductions of other buildings, such as residential villas, which are very local, was not very accurate. In these cases, the AI used the keywords to determine their overall essence with some detail but sometimes failed to imitate their likeness. This result was also apparent with regard to other types of residential architecture such as palaces. Instead of replicating modern imagery, AI presented most palaces as something from the past, reminiscent of ancient architectural landmarks. This was true of Kuwait's Al Seif Palace, which the AI interpreted as a gate-type structure with traditional Islamic ornamentation. It seems it did not know how to generate a traditional Kuwaiti-style palace, and instead defaulted to a generalized form of Islamic expression.

In general, then, the research findings from the participant workshops revealed that AI performed better when generating images of globally recognized architecture from the three Gulf cities than it did when dealing with local or regional landmarks.

Futuristic Renderings. A second interesting pattern that emerged from the research was that nine out of the thirty AI-generated images were photo-realistic interpretations that represented the landmarks in a futuristic way. This was evident either through how they were rendered, through the choice to present unusual, morphed forms, or (in some cases) through the chosen materials. It is not clear what produced this pattern. It may be that some of the keywords and textual references chosen by the participants triggered such a futuristic quality. Another explanation may be that the AI algorithm may have been trained to generate buildings that are deliberately attractive, eye-catching, and high-tech. This may suggest that existing architectural culture may have been reconfigured to represent a simpler, more ultra-modern identity.

This trend was clear in the before and after images of the Kuwait Towers. Here, the AI subtly removed key features and identity markers evident in the actual structure such as the hierarchy of its spheres, the materials used to build them, and the function of the structure itself. Instead, the landmark was replicated as a more refined, sci-fi version that mimicked the spherical shapes while losing its local cultural connection and architectural significance within Kuwait.

Digital Bias. According to present understanding, the fundamental frameworks used by AI for tasks such as examined here are dependent on the vast store of graphic information on the Internet. Artificial intelligence is also based on a "multi-language model." In other words, AI can be trained to learn any language — from spoken languages to mathematics to music. It does this by seeking out recurrent patterns and decoding them. In a graphic application, AI is then instructed to scrape billions of images from the Internet and use them to re-create new images.[22] The structure of the Internet thus presents a significant source of bias for AI, which may call into question its objectivity, especially as this relates to issues of culture, identity and tradition.

Machine learning applications will also be biased if they learn from biased data.[23] And if biased algorithms make decisions that affect or harm people, they may cause discrimination.[24] In fact, some AI researchers have already suggested that scientific publishers may perpetuate racist AI algorithms, which may indicate there is some level of bias or misrepresentation of reality.[25]

This effect was apparent in this study, and some images produced by the AI sparked lively group discussions. In particular, it was pointed out that AI had done poorly replicating the images of mosques. Out of the four mosques, only one was replicated with anything near verisimilitude, while the digital reproductions of the others did not appear anything like the actual structures. An evident issue that appeared in the AI images (and that became a major point of discussion) was how, when the keywords "Islamic patterns," "Islamic geometry," and "mosque" were used, the AI most often responded by generating a generic mosque structure that was far from the original reality. This weakness in translation could indicate a sort of digital bias, where the artificial intelligence applies a process of generalization and cultural misinterpretation to what is available online and so fails to account for local cultural specificity.

THE NEED FOR FURTHER DEVELOPMENT AND A NEW PARADIGM

The debate over the role of AI in the architecture profession is ongoing, with many topics that are still ill-defined. Among these are copyright for AI-generated art and architecture, the implications of AI on architectural practice, and the impact of AI on culture and identity (which this study has sought to better understanding).

It is clear from the research that AI is a powerful architectural visualization tool. However, the data suggests that when it comes to expressing culture, the MidJourney AI still needs more development. A digital bias due to limited knowledge of how to translate local traditional elements also seems to indicate how AI relies on generalizations, especially in terms of mosque architecture, palaces, and some residential types. That said, it is important to note that no one can anticipate what MidJourney will ultimately be able to re-create. Although the results were somewhat predictable, they were also characterized by a large element of randomness. Some participants thus stressed that they did not always get exactly what they had called for in their text prompts, even when they engaged in several iterations. On the other hand, they noted that they often got "a really cool image that you were not expecting."

It seems that AI itself is constantly adapting to people's feedback and changes, which in turn is the way it grows. However, a different paradigm is needed that is focused on addressing specific problems — one that is focused on building data sets to fix these problems rather than perpetuating the current model (which is to collect as much data as possible and hope for the best). Perhaps with more time and effort to refine the platform algorithms it will be possible to bring AI systems a step closer to replicating reality more accurately.

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