

Virtual Reality Environment for Presenting Al-Qatt Al-Asiri Saudi Art

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Abstract—Virtual museums digitally exhibit art and heritage using virtual reality technology. Such projects are unique in including the past, present, and future. They are teaching the past heritage using modern-day technology to communicate with the future generations. Al-Qatt Al-Asiri is the traditional art of interior wall decoration done by women in the Southern Region of the Kingdom of Saudi Arabia (KSA). In 2017, this art has been inscribed on the UNESCO Representative List of the Intangible Cultural Heritage of Humanity. This paper presents the work conducted towards the development of a virtual museum of Al-Qatt Al-Asiri art, within the framework of the user-centered design and evaluation methodology for virtual environments. The proposed virtual museum simulates the real-world museums found in the Assir region in the South of KSA. Moreover, it adds gaming elements by providing rooms for colouring and storytelling.

Index Terms—Al-Qatt Al-Asiri, virtual reality, virtual museum, Saudi heritage, culture heritage

I. INTRODUCTION

Saudi Arabian arts and heritage are increasingly being recognized in local and global context. The 2030 vision of Saudi Arabia proposed establishing more museums to promote Saudi Arabian arts and heritage [1].

Museums play a key role in promoting the cultural heritage of a country and exhibiting it globally. However, physical museums are restricted by their geographical places, and burden with their enormous budgets. Therefore, the solution of virtual museums was proposed to resolve these issues. Virtual museums are inexpensive and are not geographically restricted. This kind of museum uses the technology of virtual reality to simulate physical objects into a nonphysical computer-based environment [2]. Visitors of these museums use virtual reality devices to interact with their computer-based environment.

In line with the 2030 vision of Saudi Arabia and using the virtual reality technology, we propose in this paper a virtual museum for Al-Qatt Al-Asiri art (which shall be shortened to VMQA for the remainder of this paper). Al-Qatt Al-Asiri is a traditional art of interior wall decoration done by women

in the Southern Province of the Kingdom of Saudi Arabia (KSA). In 2017, this art was the first Saudi art to be inscribed on the UNESCO Representative List of the Intangible Cultural Heritage of Humanity [3].

Using virtual environments as exhibition halls for national culture is not new. It was used to explore the Ancient Egyptian heritage [4], to simulate the Italian Drama Theatre from the 19th century [5], and to conduct virtual tours to the famous Louvre Museum in Paris [6]. However, few such museums have been implemented for Saudi heritage like the work proposed in [7] and [8]. To the best of our knowledge, the VMQA project is the first to exhibit Al-Qatt Al-Asiri art in a virtual environment.

VMQA gives a chance for Saudi Arabian art and culture to be exposed to a whole new audience of people to observe, and with the continuation of such products Saudi Arabian art can be taken to a new, international standard, which may give encouragement to the development of new Saudi Arabian artists in the next generation, and will further encourage a surge of tourism to the country to see the historic sights it has to offer, further enhancing and growing Saudi economy.

This paper presents the work conducted to develop a virtual museum of Al-Qatt Al-Asiri art, within the framework of the user-centered design and evaluation methodology for virtual environments. The proposed virtual museum simulates the real-world museums at Assir region at the southern region of KSA. In addition to the exhibition hall for Al-Qatt Al-Asiri art, and for the purpose of enhancing visitors' experience, VMQA provides two rooms for colouring and storytelling. In the colouring room, visitors will be able to colour some of Al-Qatt Al-Asiri's most famous patterns, and in the storytelling room, visitors will engage in a three-dimensional experience which tells the story behind Al-Qatt Al-Asiri art.

Currently, the proposed virtual museum will be a standalone virtual reality software that can be downloaded on PCs which imply with the proposed virtual reality software and hardware specifications. In future work, we will provide a lighter web-



Fig. 1: Al-Qatt Al-Asiri art [9]

based version of the museum to reach even more visitors around the world.

The remainder of this paper is organised as follows: section II introduces Al-Qatt Al-Asiri art, section III explores the related work, section IV explains the design development process and the validation process of VMQA, and section V concludes the paper and suggests future directions for VMQA.

II. BACKGROUND

The focus of this paper is on the development aspects of VMQA. However, in this section, we introduce Al-Qatt Al-Asiri art to justify the importance of dedicating a virtual museum for it. Al-Qatt Al-Asiri is the traditional art of interior wall decoration conducted by local housewives in the Southern region of KSA, see Fig. 1.

It is unknown exactly when Al-Qatt art started. However, field trips to Assir region discover the art at houses aged three years all the way to four hundred years [10]. Moreover, travellers to the Assir region like Cornwallis [11], Tamizier [12], and Philby [13], have documented the existence of this art since 19th century. In 2017, this art was the first Saudi art to be inscribed on the UNESCO Representative List of the Intangible Cultural Heritage of Humanity [3].

To decorate walls of houses in the Assir region, a group of women gather and work under the supervision of an expert female artist [14]. Women express their passion and feelings using patterns and colours. They use brushes made from the hair of goats' tails tied with a wooden stick [14]. Colours are extracted from natural elements - for example, the white colour (called *Gypsum*) is made from many layers of lime taken from surrounding mountains. The green colour is extracted from grass, while blue colour is taken from the *Indigofera Tinctoria* plant (called *Nela*) and colours are restricted to: white, black,

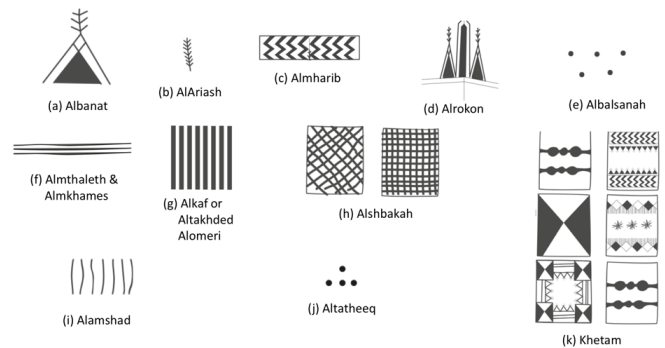


Fig. 2: The symbols of Al-Qatt Al-Asiri art [15]

blue, green, yellow and red. These traditional colours were used until 1970's, and after that, women of Assir started using modern colours [14].

The painting process starts by sketching the pattern outlines with black, then filling them with other colours. The patterns could have many shapes such as *Al-Banat*, *Al-Ariash*, *Al-Mharib*, and *Al-Rokon* - see Fig. 2. Each shape has a specific position in Alqatt patterns. Some of them have meanings - for instance, it is believed that *Al-Banat* symbolizes a female and *Al-Ariash* represents plants.

Al-Qatt art structure is characterized by straight shapes instead of curves. The local citizens of Assir explain that this is inherited from the texture of Arab-Islamic art [14].

III. RELATED WORK

The concept of virtual museums was first introduced by André Malraux [16], and it includes all type of virtual museums. Virtual museums can be a collection of simple two-dimensional images in a website or a complex three-dimensional experience in a virtual environment using sophisticated devices [17].

In the literature, there is a considerable number of virtual museums research. The aspects of designing a virtual museum varies depending on the nature of the virtual museum. Virtual museums could be proposed to allow visitors to live a past experience like the virtual Italian Drama Theatre Museum [5] which reconstructs the Italian drama theatre from the 19th century. Visitors are welcomed by *Meneghino* the virtual guider who accompanies visitors and tells them the story of the theatre. The same concept was used in a more recent project, called *Viking VR* [18]. In this project, the visitors live the virtual experience of being in one of the four Viking encampments designed for this project and are told the story of how the Vikings changed life for people in Britain.

Another type of virtual museums is the one that allows visitors to conduct virtual online tours to real-world museums via internet like the Louvre Museum tour [6]. Recently, Google Arts & Culture has teamed up with the most famous museums around the world to provide virtual tours to them [19].

Virtual tours could be provided inside museum to interact with historical artefacts and learn more about them, as has

been implemented at the Archaeological Museum in Milan, to educate visitors about Egyptian funeral objects [4]. In both projects, visitors can interact with the exhibited objects by zooming and rotating, and they can read a full description about any chosen object. In these projects, the design process concentrates on building the historical artefacts database.

The other type of museums is a mixture of the two previous types, like the *Soviet History* museum [20]. In this museum, they simulate the *Ruijin* city red culture heritage and implant, and also provide the option to search the historical objects of this period of time.

As aforementioned, few virtual museums have been proposed for Saudi heritage and art. The most know endeavours are the virtual tours to Saudi historical places [7] and *Basmoca* [8]. Basmoca is the name of the Saudi artist Basma Alsulaiman's virtual museum for contemporary art [8]. In this museum the artist, Basma, virtually exhibits her collection and allows visitors to interact with the paintings and the art objects. Basmoca also provides a platform for multiple visitors to simultaneously present at the museum to communicate and to discuss art issues.

The other project is the endeavour of the *Saudi Commission for Tourism and National Heritage* (SCTH) to allow the visitors of its website to conduct virtual tours to the most known tourism spots and historical places in KSA [7]. Visitors can see the places in the map and read a short description about them.

In our project (VMQA), we exhibit Al-Qatt Al-Asiri art in a virtual environment. VMQA will be a mixture type museum, where visitors can live the virtual experience by moving around the virtual halls and explore the exhibited artworks of Al-Qatt Al-Asiri. Visitors can also interact with these works of art to learn more about them by clicking the museum guider who will companion visitors during their tours. Additionally, for the sake of enhancing visitors' experience, VMQA provides two rooms for colouring and storytelling. In the colouring room, visitors will be able to colour some of Al-Qatt's most famous patterns and in the storytelling room, visitors will engage in a three-dimensional experience which tells the story behind Al-Qatt art. The designing and validation process for this project will be presented in the next section.

It is essential to present the local artefacts via virtual museums to promote the country local heritage and make it easy access via the internet. VMQA contributes in boosting tourism in Saudi Arabia by providing a virtual environment which allows visitors to explore Al-Qatt Al-Asiri art.

IV. USER-CENTRED DESIGN AND EVALUATION PROCESS

In this section we present the design and validation processes of VMQA based on the user-centered software development methodology [21] and with insights from the structured development process of virtual environments [22].

We develop the VMQA following the user-centered software development methodology. The framework of this methodology consists of several rounds of systematic user and software requirements (elicitation, documentation, and

validation). Each round clarifies the software requirements and refines the prototype functionalities based on the feedbacks of the previous rounds and the input from the software stakeholders who usually include the product owners, and representative end-users.

The framework of the user-centered software development methodology as suggested by Tromp *et al.* [21] consists of five stages: domain analysis, requirements elicitation, requirements analysis, requirements specification and software building. With insights from the structured development process of virtual environments [22], we adopt these stages and structure them following top-down approach to be: problem definition, requirements elicitation, requirements specification, software building, deployment and verification. We further divide the software building stage into five iterations (prototype, reception, tour, storytelling and coloring), each iteration consist of three stages: detailed design, implementation and testing. Therefore, in our project the design and validation process starts by defining the project's problem. Then, the requirements are collected and analyzed before defining the software specification. This is followed by five rounds of detailed design, implementation, and testing. At the end, the final product is deployed and verified.

The details of these stages are presented in the next subsections.

A. Problem Definition and Requirements Elicitation

The problem was clearly defined in previous sections. Requirements for this project were collected by conducting several interviews with artists, specialists, and representative end-users and one co-design workshop (details is at Section IV-D). In addition, a field trip was conducted to *Al-Raqdi Museum* for Al-Qatt Al-Asiri art [9] in the Assir region.

Relying on the collected set of requirements and taking in consideration the virtual museum standards by the *Institute for Cultural and Natural Artistic Heritage- LEM* projects [23], the software context and scope were shaped. In addition, a draft of the museum floorplan was proposed - see Fig. 3.

The proposed museum floorplan consists of five areas:

- 1) The lobby hall which represents the entrance to the museum - see region 1 in Fig. 3.
- 2) The garden pathway, which contains a garden that contains the famous plants in the region, in particular the one used for extracting colours - see region 2 in Fig. 3.
- 3) The main exhibition hall (which represents the hall of the museum that exhibits the collection of Al-Qatt Al-Asiri artworks) - see regions 3 and 4 in Fig. 3. In this hall, visitors will accompany by a 'guide' character, sketched in Fig. 4. This character is responsible for providing help to visitors during their stay at the main exhibition hall.
- 4) The storytelling room, where the museum narrative (Ms. Fatima) tells story of Al-Qatt art using animation and three-dimensional models - see region 5 in Fig. 3.

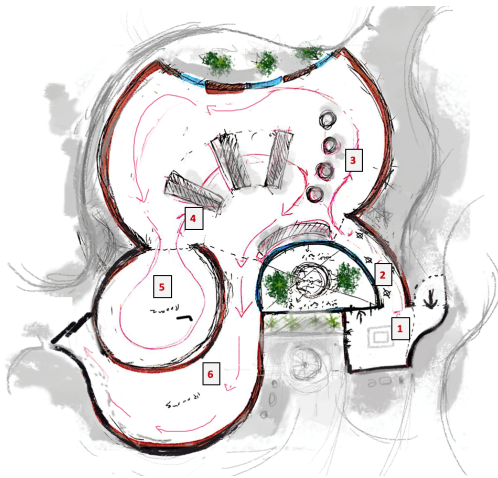


Fig. 3: Floorplan of the VMQA

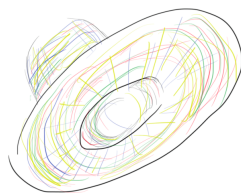


Fig. 4: The design of the museum guide

- 5) The colouring room, where visitors will be able to colour some of Al-Qatt's most famous patterns - see region 6 in Fig. 3.

Based on the suggested floorplan we also propose five user scenarios for each area as follows:

- 1) **Scenario 1:** The user (visitor) launches VMQA by clicking on the software icon on the PC desktop. The user wears the virtual reality glass, holds the right controller in their right hand, and holds the left controller in their left hand. They read the pop-up museum instructions message and press any button on the controllers to start their tour at VMQA. The user looks around the lobby hall. If they start moving, the museum sitemap appears on the hall's ground. The user moves to the front, to the right and to the left to explore the lobby hall. The user reaches the garden pathway. The user can stay at the lobby hall or enter the garden pathway where **Scenario 2** starts.
- 2) **Scenario 2:** The user crosses the lobby hall using the right and left controllers, and stands at the front of the pathway. They see the pathway to the main hall. Using the right and the left controllers, the user can move through the pathway. The pathway has an indoor garden which has famous plants in the region on one side, in particular the ones used for extracting colours. The wall on the other side has descriptions of each of the garden plants. The user looks around the pathway. The user moves to the front, to the right and to the left to

explore the garden pathway. The user reaches the main exhibition hall. The user can stay at the garden pathway, return to the lobby hall, or enter the main exhibition hall where **Scenario 3** starts.

- 3) **Scenario 3:** The user crosses the pathway using the right and left controllers, and stands at the front of the main hall. At this point, the user meets the museum guide. The guide accompanies the user during their stay at the main exhibition hall in order to provide help to them. The user looks around the main hall. The user moves to the front, to the right and to the left to explore the main hall and observes the Al-Qatt artwork. If the user steps near a piece of artwork, the guide will offer to describe it to them. The user also can ask the guide for other types of help, like the museum's instructions. The user can stay at the main exhibition hall, return to the garden pathway, enter the storytelling room where **Scenario 4** starts, or enter the colouring room where **Scenario 5** starts.
- 4) **Scenario 4:** The user crosses the main exhibition hall using the right and left controllers, and stands in the front of the storytelling room. At this point, the user meets the museum's narrator Ms. Fatima. Ms. Fatima tells the story of Al-Qatt art using animation and three-dimensional models for the user. The user can stay at the storytelling room, or return to the main hall.
- 5) **Scenario 5:** The user crosses the main exhibition hall using the right and left controllers, and stands in the front of the colouring room. At this point, three different patterns of Al-Qatt art appear and the user can choose one of them to colour. The user can change colours using the colour palette. The user can stay at the storytelling room, or return to the main hall.

During any of these scenarios, the user can immediately exit the museum by clicking on the EXIT button on controllers. A confirmation message appears and the user can press OK using the controller buttons.

B. Requirements Analysis and Specification

In requirements analysis phase we organize, analyze, and validate the collected requirements following the scenario-based approach explained in [22].

First, we designed the form in Fig. 5 which is a scenario-based requirement gathering form inspired by Table 15.2 in [22]. We use this form to group the requirements based on the defined scenarios in Section IV-A, and to ensure that they are complete, clear, linked, and verifiable. To illustrate how this is achieved please see Fig. 6 which presents the requirement form for **Scenario 2**. The requirements in these forms are used to document the final set of the software functional and non-functional requirements. Based on the requirements document, VMQA specification can be defined in terms of software goals, and user tasks. In our project, different techniques such as storyboards, requirements decision tables and interaction models are used to define VMQA software specification.

Scenario x

1. Place: area x (hall\room).	
2. Function: What is carried out in this area?	
3. Goals: What are the goals of the current function?	
3.1 Position: Where is the museum visitor standing at the beginning of this scenario?	3.2 Operational: What are the requirements of this scenario?
4. Evaluation: How should we evaluate that the goals are achieved?	

Fig. 5: Requirement gathering form

Scenario 2

1. Place: area 2, the garden pathway of VMQA.	
2. Function: Learn about the famous plants in the Assir region.	
3. Goals: The visitor shall be able to identify 10-15 plants from Assir region, in particular the ones used for extracting colours for Al-Qatt Al-Asiri art.	
3.1 Position: The visitor stands at the front of the pathway, and see through.	
3.2 Operational:	
<ul style="list-style-type: none"> • The visitor shall be able to step into the pathway area using controllers. • The visitor shall be able to move to the front in the pathway area using both controllers. • The visitor shall be able to move to the left in the pathway area using the left controller. • The visitor shall be able to move to the right in the pathway area using the right controller. • The visitor shall be able to move to the back in the pathway area using the left controller twice or the right controller twice. • The visitor shall be able to look around the pathway with a 360-degree view from where they stand. • The visitor shall be able to recognize the shape and the colour of the plants in the indoor garden. • The visitor shall be able to see a picture of each plant in the indoor garden and read a description about it on the wall opposite to the indoor garden. • The visitor shall be able to exit the pathway area to the lobby hall if they reach the border between the two areas. • The visitor shall be able to exit the pathway area to the main exhibition hall if they reach the border between the two areas. 	
4. Evaluation:	
<ul style="list-style-type: none"> • The visitor shall be able to link between the plants in the indoor garden and their descriptions on the opposite wall. • The visitor shall be able to identify the name, shape, and purpose of each of the 10-15 plants in the indoor garden. • The visitor shall be able to identify the plants which are used for extracting colours for Al-Qatt Al-Asiri art. • The visitor shall be able to know which controller to use to move. • The visitor shall be able to identify the area that they are standing on and all adjacent areas. 	

Fig. 6: Garden pathway scenario requirements

C. Software Building

As mentioned in Section IV, the software building stage is planned to be carried out in 5 iterations. In this section, we show how we build on the output of the previous sections and define the detailed design, implementation, and testing of each iteration of the project as follows:

a) *Iteration 1: prototype:* To implement the preliminary prototype, we first project the 2D floorplan, presented in Fig. 3, into a 3D floorplan - see Fig. 7a. Secondly, we use the Autodesk AutoCAD software [24] to digitize it - see Fig. 7b. After that, we use the SketchUp Pro software [25] to generate a 3D coloured model of this floorplan - see Fig. 7c. Finally, we use the same software to produce a 3D animated prototype of the museum, and we use the VR plugin within the SketchUp Pro software to enable the VR glass and controllers.

We test the design prototype by conducting a co-design workshop. A number of experts were invited to the workshop to validate the prototype and submit their feedbacks using surveys; the detailed of the workshop well be explained in the next section.

b) *Iteration 2: reception:* Iteration 2 covers the implementation of scenarios 1 and 2. In these scenarios, it has been mentioned that if visitors start moving at the lobby hall, the museum sitemap appears on the hall’s ground. Moreover, it has been mentioned that the pathway has an indoor garden which contains the most famous plants from the region on one side and their picture and descriptions on the other side. Therefore, to implement these scenarios we need to design the sitemap, the plants, and the plants pictures. In addition, the old floorplan design presented in Fig. 3 should be altered to reflect the collected comments during the testing phase of iteration 1.

This is accomplished by using Photoshop software and Wacom painting toolkit [26] to design the museum sitemap and the plants pictures - see Fig. 8, and by using Sketchup to design the plants. To design the plants, we first imported the pants as a block then we modified it to the proposed shape. Fig. 9 shows an example of the designing process of the *Adenium obesum* (desert rose) plant [27].

Fig.10 demonstrates the modification process of the old floorplan design presented in Fig. 3. Fig. 10a presents the new design of the floorplan , Fig. 10b shows the new measurements of the museums internal walls. Fig. 10c shows the 3D coloured model of the new floorplan.

All the designed objects are converted to interactive objects and imported into the Unity software [28] to make them alive objects at the virtual museum environment.

c) *Iteration 3: tour:* Iteration 3 covers the implementation of scenario 3. In this Scenario, it has been mentioned that visitors first greeted by the museum guide. Visitors move around to explore Al-Qatt artworks on the walls and observe Al-Qatt art pieces at the main hall. If the visitors step near a piece of artwork, a description of this artwork will appears. Therefore, we need to design Al-Qatt artworks and Al-Qatt art pieces. The museum guide was sketched before in Fig. 4

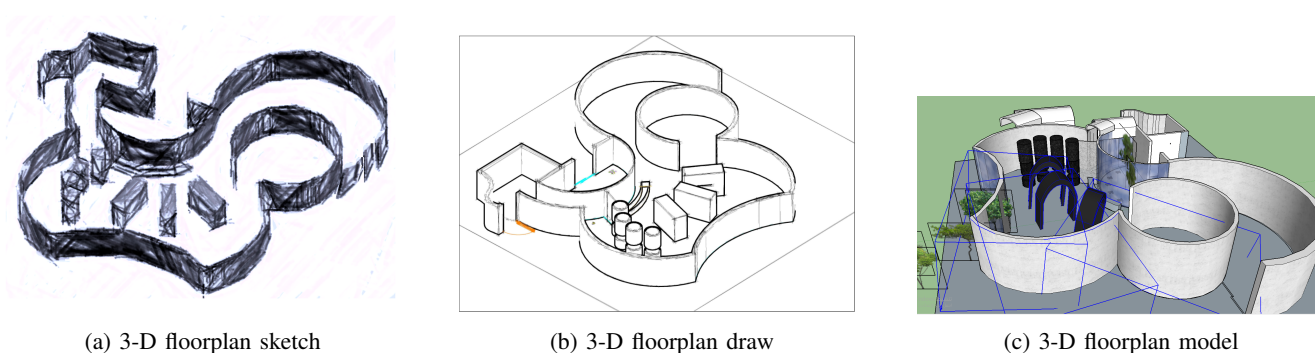


Fig. 7: Iteration 1: Prototype implementation

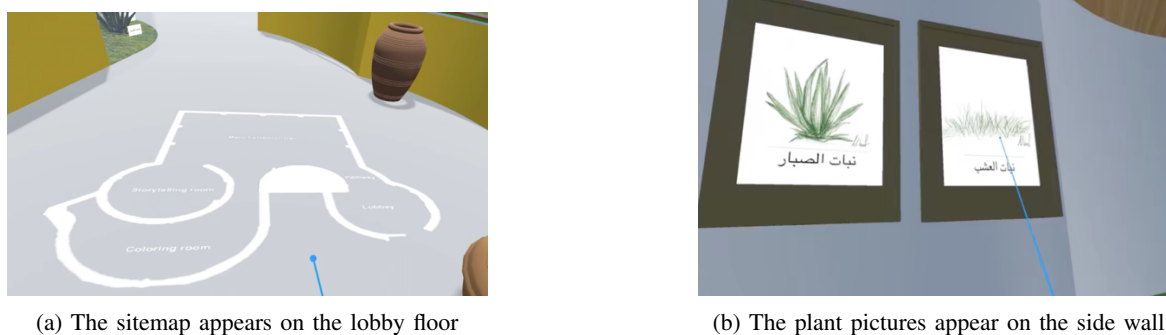


Fig. 8: sitemap and plant pictures design

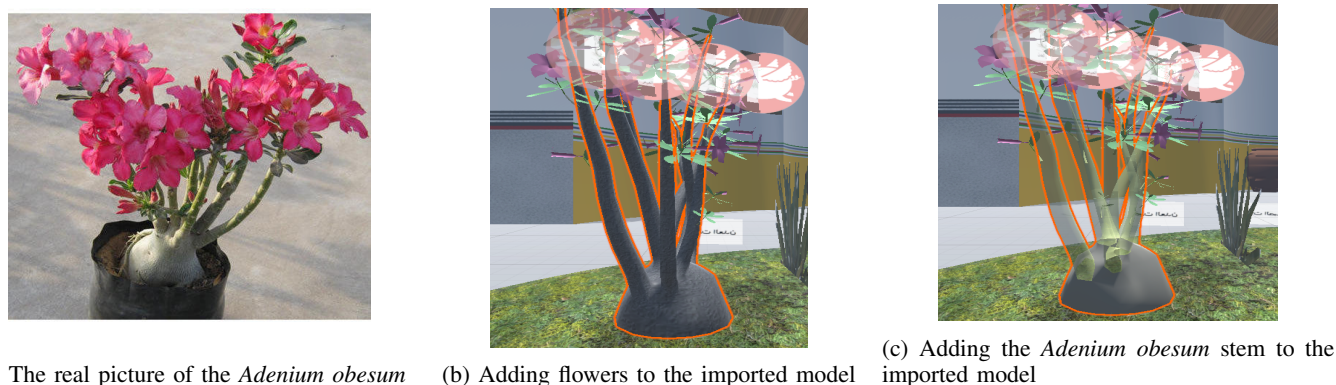


Fig. 9: The design of the *Adenium obesum*

To draw AL-Qatt artworks on the walls of the main exhibition hall we use Photoshop software and Wacom painting toolkit [26] - see Fig. 11. Each wall represents a house or tribe in Assir [14] region.

Moreover, the main exhibition hall exhibits four pieces from Alraqadi museum [9] -see Figure 12. SketchUp was used to design these pieces.

At the end of the implementation phase of iteration 3, all the designed objects are converted to interactive objects and imported into the Unity software [28] to make them alive objects at the virtual museum environment.

d) Iteration 4: Storytelling: Iteration 4 covers Scenario 4. In this scenario, it has been mentioned that visitors first meets the museum’s narrator Ms. Fatima and then Ms. Fatima tells the story of Al-Qatt art using animated pictures.

Ms. Fatima is designed using sketchUp. A sketchUp block was used as a start, then this block was modified to the proposed shape. Fig. 13 shows the steps of designing Ms. Fatima.

The designed items are imported to Unity software [28] to make them interactive objects and add them to the virtual museum environment.

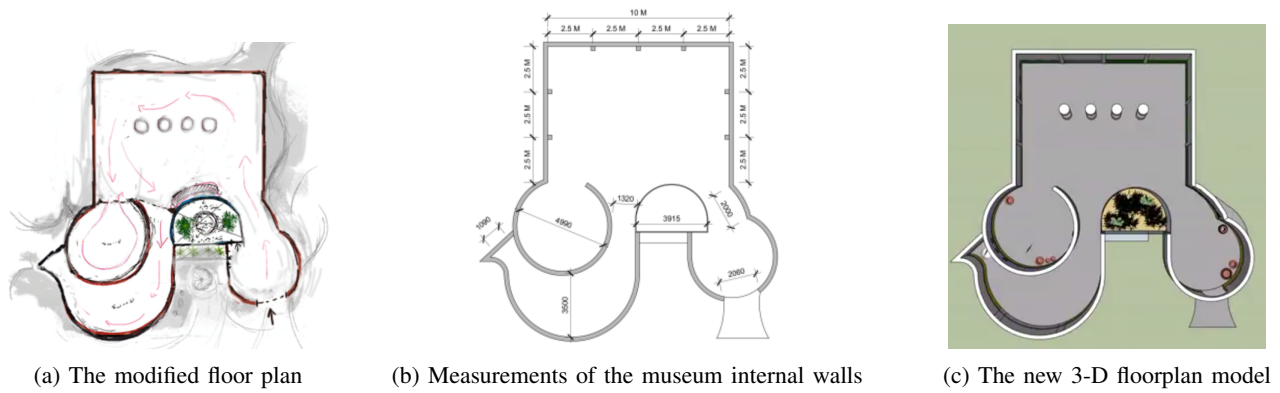


Fig. 10: The new floorplan

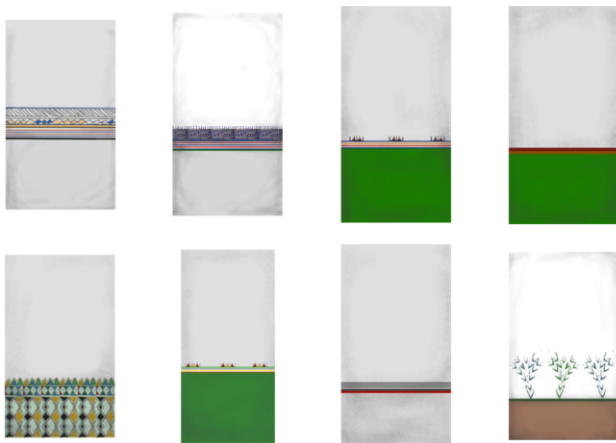


Fig. 11: AL-Qatt artworks



Fig. 12: AL-Qatt art pieces

e) Iteration 5: Colouring: Iteration 5 implements Scenario 5. In this scenario, it has been mentioned that a pattern of Al-Qatt art appears and the visitor can start colouring it. The user can change colours using the colour palette.

The pattern of Al-Qatt art was drawn using Photoshop then it was imported to Unity software to implement the colouring process. Fig. 14 demonstrate the colouring process. First the

user chooses the colour - see Fig. 14a, then s/he shouts the colour on the pattern to colour the targeted area - see Fig 14b.

This finishes the implementation phase of iteration 5 which was the last iteration in the project. The next section explains the testing process which was conducted to ensure the correctness of the project implementation.

D. Testing

In this section we present the testing techniques used to verify the correctness of the virtual museum.

To test the design prototype, we conducted a co-design workshop. A number of experts with diverse backgrounds were invited to validate the prototype. We presented our work and collected their feedbacks using surveys, and the discussion during the workshop was also very useful.

The co-design workshop involved subject-matter experts from various domains, including Dr. Salma Al-Zaid, Vice-Dean of Humanities Departments and Assistant Professor in the Department of Art Education, Dr. Abeer Monadher, Vice Chair of Curriculum & Instruction Department at KSU, who is interested in and is a researcher in Al-Qatt Al-Asiri art, Dr. Dafra Al-Shahri, Vice Chair of Archaeology Department at KSU and Princess Rukaya Al Saud, an artist interested in Al-Qatt Al Asiri art.

After studying the notes in the surveys and organizing the reflections from the workshop, two modifications were suggested:

- 1) To make the lobby hall wider, because the tight design of the lobby hall will restrict the movement of virtual visitors.
- 2) To change the walls of the main exhibition hall from carved walls to straight walls, because straight walls are more suitable to exhibit Al-Qatt Al-Asiri art patterns.
- 3) To remove the displaying edges in the main exhibition hall to give a space for visitors to more around in the hall.

The new floorplan after applying these changes was previously shown in Fig. 10.

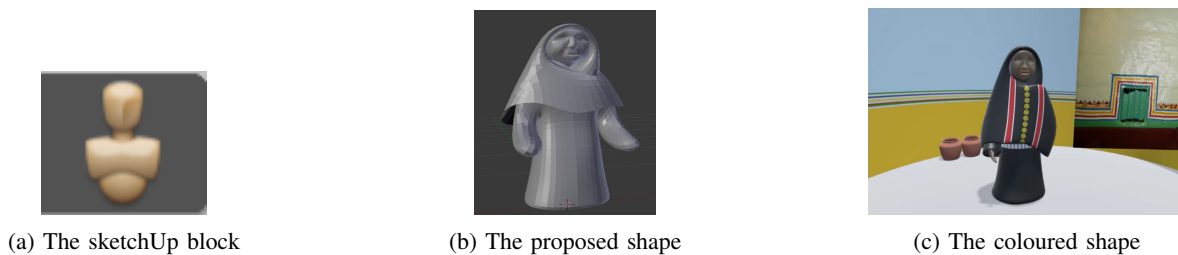


Fig. 13: The design of Ms. Fatima

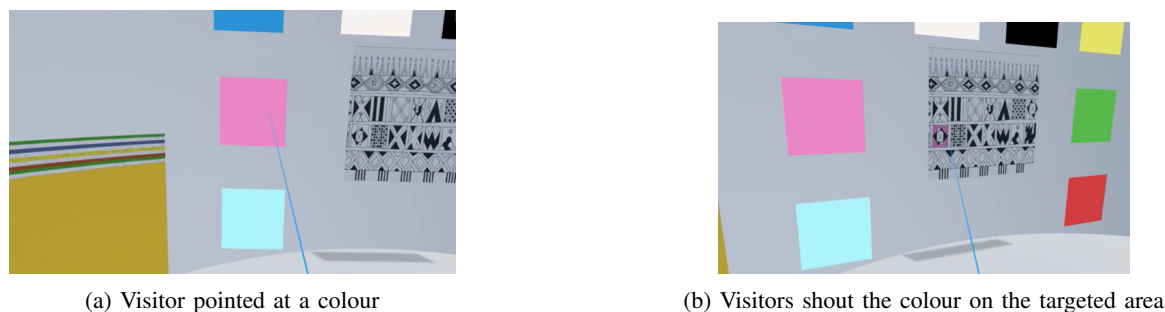


Fig. 14: Colouring room

As aforementioned, VMQA was developed in five iterations. After each iteration the outcomes are tested firstly by conducting unit testing to ensure that the implementation is correct, and secondly by conducting usability testing to ensure the practicality and the validity of the design.

After the completion of each iteration we integrate its outcomes with the outcomes of its predecessor and then apply down-top integration testing to ensure that the integrated version is correct.

At the end, we first conduct a system testing to prove that the final software performs as designed, and secondly we carried out a comprehensive usability testing to ensure that the final product meets the user expectation.

In the following we explain briefly each of these testing techniques. Interested reader can refer to [29] for more details.

- *Unit testing* is defined as a type of testing where each main function in the software is tested separately. The result of the unit testing usually presented in table contains the name of the function, the inputs, the expected output, actual output. If the expected output is the same as the actual output then the unit testing is passed successfully.
- *Integration testing* is defined as a type of testing where software modules are integrated logically and tested as a group. This testing is carried out by testing the functions that only work if the two modules are integrated.
- *System testing* is defined as a type of testing where a complete, integrated system is tested. The purpose of this test is to evaluate the system's compliance with the specified requirements.
- *Usability testing* is defined as a type of testing which conducted to evaluating a product by testing it with representative users. Typically, during a test, participants

are given realistic scenarios to complete while observed by researchers. This helps to highlight any gaps in the market that can be taken advantage of and illustrate where to focus design effort.

Due to the interactive and entertainment nature of the virtual museum this lies an importance on the results of the comprehensive usability testing. Therefore, we devoted the rest of this section to present the process and the result of the usability testing.

The usability testing was conducted on participants who can use virtual reality toolkits and interested in the art of Al-Qatt and in the range of 7 – 55 years. 10 participants are observed in every iteration and 40 are observed during the comprehensive usability testing. In each iteration the usability tests were monitored by recording the desktop screen using an outside camera. The visitors feedbacks were collected via paper-based surveys and tasks sheets.

The average time taken by visitors to complete the reception areas (lobby and pathway) is 40 seconds with no system errors observed. The average time taken to complete the reception areas, tour area and storytelling area is around 3 minutes, with also no system errors observed. The average time taken to complete the reception areas, tour area and storytelling area is around 3.5 minutes. The average time inside colouring room is vary depending on visitors preferences of colouring speed and amount.

Finally, validate all functions of the project we held a usability testing at King Saud University campus. The number of participates was 40 and they were faculty, students and staff with different ages and experiences. Participates were monitored by recording the desktop screen using an outside camera. The average time taken by participates to finish the

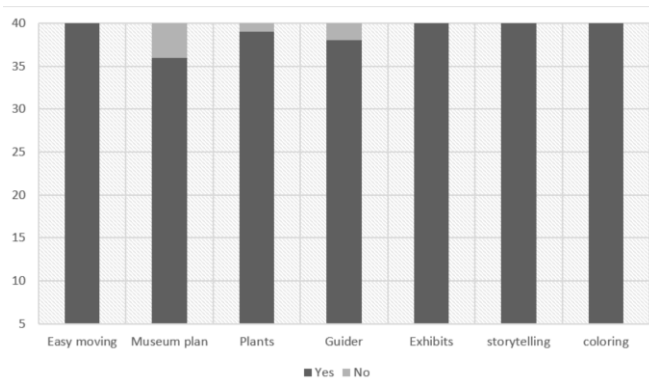


Fig. 15: Participants responses chart

whole museum is 3 minutes, with no system errors observed. The visitors feedbacks were collected via paper-based surveys and tasks sheets. In these surveys, the visitors were been asked questions which cover all the main functions of the museum, and they should answer by YES or NO. Fig. 15 shows the percentage of visitors answers.

Its worth to mention that the comments on the virtual museum tours conducted by the different visitors were in general very positive. However, visitors provided us with some recommendations such as adding background music and drawing arrows on the floor to show museum flow paths.

V. NEXT STEPS AND CONCLUSIONS

Al-Qatt Al-Asiri is the traditional art of interior wall decoration conducted by women in the Southern region of the Saudi Arabia. This paper presented the work conducted towards the development of a virtual museum of Al-Qatt Al-Asiri art, within the framework of the user-centered design and evaluation methodology for virtual environments. This framework consists of a number of iterations which involve end-users in the software design and evaluation processes. At this stage of the project, we completed the virtual museum of Al-Qatt Al-Asiri art with all its details. The software requirements were collected and the system design was built then the museum was implemented and tested on reasonable number of users.

VMQA is still an ongoing project. The next phase will be to add a second virtual museum for the art of the middle province of Saudi Arabia (Najd) houses. The final aim of the project is to end up with a collection of virtual museums for each province in the Kingdom of Saudi Arabia.

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