Approach to The Interior Design using Augmented Reality Technology

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Abstract—**This paper analyzes the use of Augmented Reality technology and Augmented Reality 3D interior model for interior design. According to the feature of interior design, the best way to share the concept of an interior design project to customer in the conceptual design stage is to perform it in a vivid 3D prototype. The traditional 3D interior space prototypes are created by designers and evaluated by customers, but we want to expand the affection of customers' requirements in the conceptual design. The designer and customer establish a 3D interior space model together in conceptual design stage by first creating 3D interior structure model, followed by choosing hard-soft decoration method and customized decoration requirements in an Augmented Reality Interior Design System. A hard decoration modeling framework is built for design project improvement and evaluation to guarantee that user can coordinate every aspect of the design project to achieve a balance between structure and function. The augmented content and sensory information of decorative material-furniture-appliance for soft decoration can be simulated with special stereoscopic equipments as an AR3D interior prototype in ARID system to enhance the understanding and participation of customers in the customized interior design project.**

Keywords- Interior Design;Augmented Reality; 3D interior models

I. INTRODUCTION

This paper discusses the possibility of Augmented Reality Technology applied to the interior design and construction process.

According to Ivan Sutherland's paper "The Ultimate Display"(1), he defines the term 'Virtual Reality' as a system used to display information to all senses of a person without this physical environment. The VR is usually used to define Simulation, Interaction, Artificiality, Immersion, Telepresence, Full-body Immersion, and network communication. In current scenario, the definition of VR has been changed and expanded, used to explain a notion which is between the virtual world and physical world so-called Augmented Reality (AR).The Augmented Reality is described in Fig.1.

The various category of space, material, furniture, and other related facilities in different kind of interior design and the consumer's high demand for participate in the designing process for achieve their individual style, increases the interior design and its designers require for information and interaction technologies. In recent interior design, the primary focus for interior designers and consumers is the ability to compositions of real and virtual information (include the objects, materials, and scenes) and flexible interactive in an augmented reality model. The augmented reality technology is fit for this purpose. AR can provide a vivid view (direct or indirect view) of the physical world where elements are enhanced by computer-generated files such as video, graphics, sound, images, or other kind of digital data. This technology is applied to allow a person (the designer, the manufacturer, and the consumer) to combine real and virtual information and objects in a physical, real-world environment. In contrast, VR technology still focuses on establish a simulated environment based on the real world by computer. Designer implemented VR techniques for the designing processes and the virtual prototyping, which can only provide the information and appearance of the virtual scenes for designer and consumer.

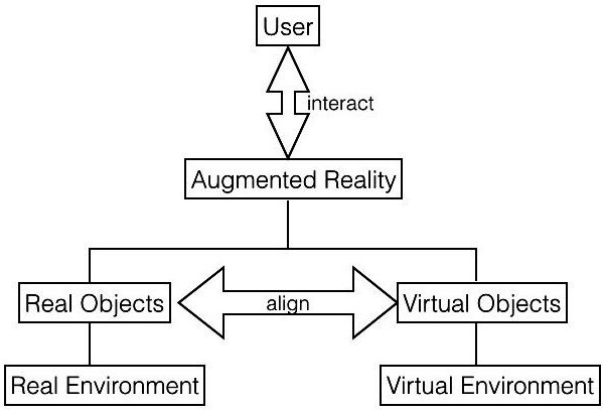

Fig.1 Augmented Reality

This paper's target is to analyze and evaluate the impact of Augmented Reality Technology in interior design. The research context is associated at the consumer's perception of the project in the management and execution of the interior design. Finally, we provide a design framework which shows that the augmented reality technology is the way of interior design future so that the cooperation of designers and consumer would be convenient and efficient.

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II. Interior Design with Augmented Reality Technology

Nowadays, conceptual development is the most important part in the early stage of interior design project which has greatly impacted the design effect and the customer reviews. Through the conceptual development, the designer's purpose and the customer demands are abstracted as interior design rendering and 3D digital modeling, which can be represented overall effect and all details of the design project. Usually, renderings and digital modeling can be used to reveal the general structure of space and the finial effect. However, the use of digital resources is commonly restricted, while it restricts the designer's creative and the design process flexibility. As a result, in actual design, these digital resources (including rendering and 3D models) for interior design are created while the final plan has been forming and they could not be better used for conceptual development.

For raise the function of these digital renderings and modeling in conceptual development, an augmented reality 3D model, which includes complete system and professional equipments, is recommended to allow the designers and the customers to interact and evaluate the project conveniently and provide them with full and accurate information of the design project. The AR3D model refers to the following features:

-AR3D model contains different sources of information which provide by real and augmented environment.

-AR3D model allows the user to interact with the visualized model and to get the update information in a real time.

- AR3D model shows the relationship between real and virtual objects and touches on how these objects can be used and influenced by each other in a same space.

An interior project AR3D model contains multiple sources information and details for all the elements of the spatial 3D models in an interactive augmented environment. According to the customer demands' feature and the requirements of interior design process, a customized interior design modeling should be developed based on an augmented reality environment system. When the conceptual development phase is finished, the functional partition, material chosen, and human-space relationship related to the interior design have been created, the project should be transferred to an AR3D model. The AR3D model will be played an essential role for project confirming and interact validation. In addition, design errors, such as inappropriate spatial partition, and management and construction problems, such as rational examination for illumination system, which directly influenced the final result, can be modified in the early stage. Using augmented reality technology can raise the efficiency execution of the interior design project so that the customers can easy understanding, cost-saving and satisfactory effect of the project.

III. Approach to Augmented Reality Interior Design System

Augmented Reality Design System has been reported. Generally, the proposed approach for using AR design system establishing AR3D models including hardware components, such as processor, display, sensors and input devices, and software and mathematical methods used for AR. Especially, this system combines the information from real and virtual objects to create a visualization mixed reality environment that allows the user can interact and modify the model immediately in an Augmented Reality Environment.

Based on the Augmented Reality Interior Design (ARID) system, the AR3D models involves augmenting reality modeling with all the information about the space structure, the spatial function and the relevant materials for the project. Visual effects for the project can be changed and modified by user through the Human-Computer Interaction interfaces to build 3D models for interior design in a simulated environment. The spatial structure can be exhibited for the designers and customers to distinguish the structural and functional division of the interior space, such as the different function requirements for the kitchen. Besides, users can easily interact with the digital model and take feedback from a series of sensors and device. Furthermore, the Augmented Reality Interior Design system is very helpful for design project evaluation. It can be saving the project cost and time, and reducing the changes at the finial stage when the physical construction has already been done. While this system is especially useful for conceptual development, many design concepts and customers' requirements can be tested and compared for evaluating the actual effect of the project.

Using Augmented Reality in conceptual development stage, the designer can practice every possible design concept which depends on digital interior 3D model and the responses from user-space interact. Figure 2 shows a framework of the conceptual development stage using ARID system to establish a customized AR3D model.

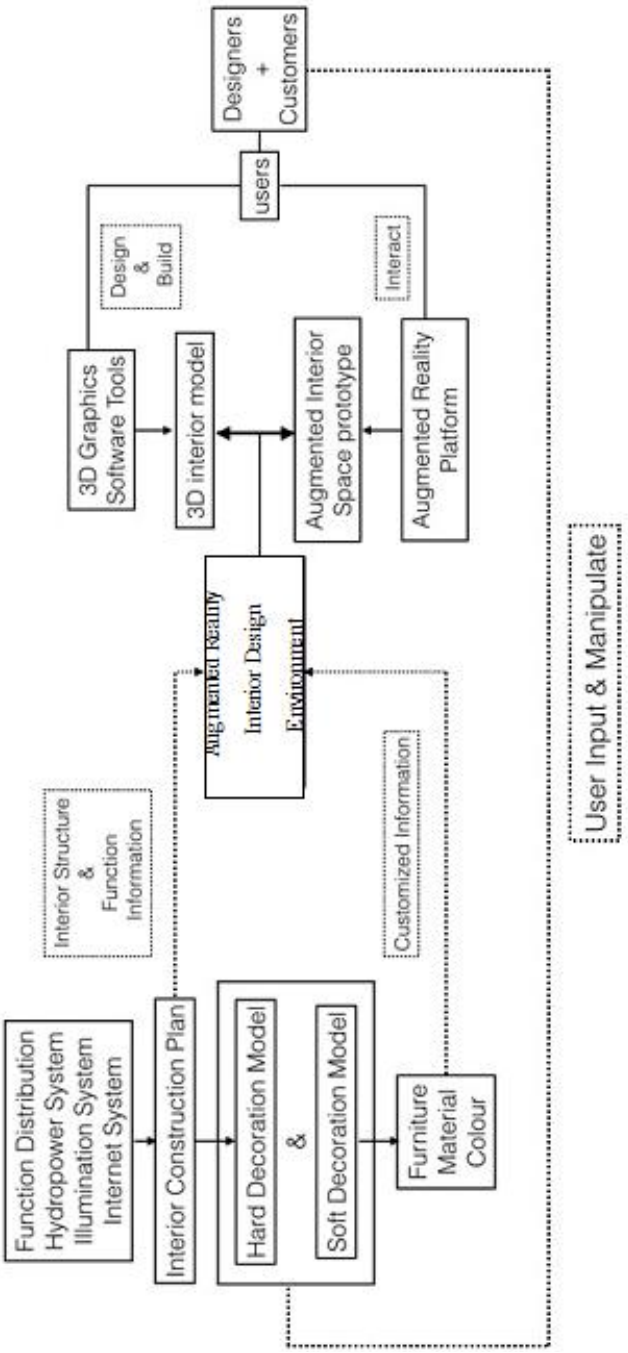

Fig.2 Conceptual Development Stage using ARID system to establish a customized AR3D model

Firstly, the Hard and Soft Decoration Models is used for the user - interior space interactions. User interaction includes the information input and the response output that the customized AR3D model will provide the response for user. The interior model response is the somatosensory system from the interior construction and soft decoration. At the conceptual development stage, the Hard and Soft Decoration Model will respond and the somatosensory from material, light, temperature and architectural structure which have been mainly from a compound database. Secondly, the users can build their desired interior space model, modify the model become the required structure and decorate them based on the original interior construction plan. The AR interior reality environment will provide a real-time rendering of the model for the user that they can get a vivid perception and experience of the design. Thirdly, using the ARID system, the designer and customer can achieve some special aims that would be impossible to reach using other design system.

-Emulation of the hard and soft decoration of the interior space when the user interacts with AR3D model in the AR environment. This can be evaluated the design project to allow the customer to understand and feel the decoration and communicate with the designer to improve the design project at the conceptual development stage.

- Design verification of the 3D Interior Construction models and hard -soft decoration models. Adjust between these two models is guaranteed not to be conflicted.

IV. Case Study

A case study has been proven the use of AR3D model and ARID system in the conceptual development stage of the interior design.

This case refers to the conceptual design of a customized interior decoration project (CIDP). The main requirement of the CIDP is to design the structure and function of the space, and to decorate the interior space based on the customers' demands. An AR3D model of the CIDP is established using ARID system so that the designer can work with a virtual interior prototype and show the design affection of a CIDP to the customer. There are existing interior decoration project which modified and set up the interior space structure, hydropower-illumination system, and customized decoration elements is to show the appearance of the concept of interior design project and the space use.

1、Establishing the 3D interior model

To understand the interior space structure, the designer has created a 3D interior model based on the interior construction plan. The necessarily parts of the interior decoration project are a basic space structure, hydropower system, illumination system, decorative material, furniture, and household appliances. Generally, a few parts of space structure and hydropower system can be modified, and the rest of the project has to be designed and shown through the 3d interior model. Augmented Reality 3D interior models are built for the main structure, hydropower-illumination system, decorative material and general furniture-appliance

arrangement and provided specific information about the project. (Fig. 3; Fig.4)

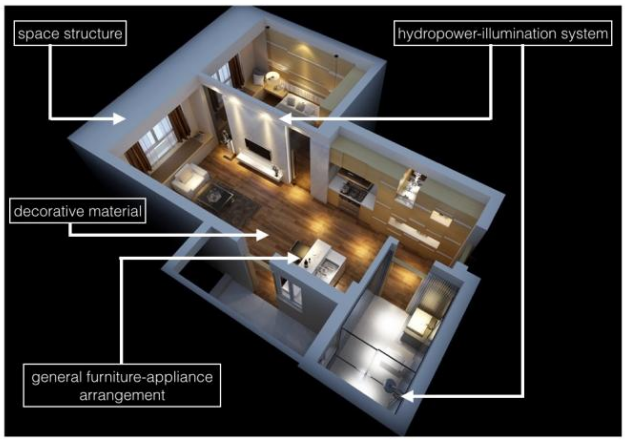

Fig.3 3D interior decoration model

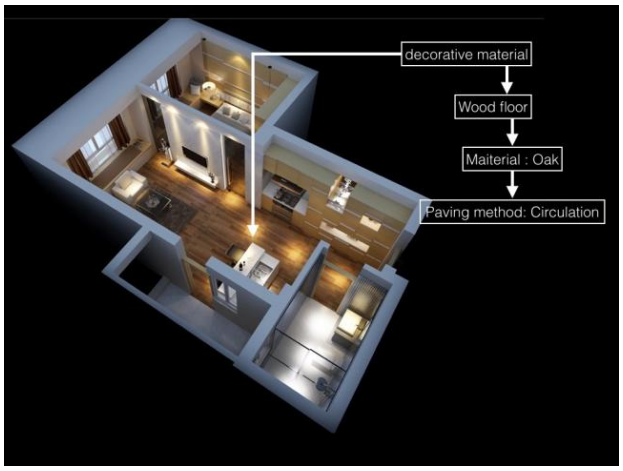

Fig.4 augmented information for the project

2、Evaluating and Modifying the Hard-Soft Decoration Model as an Augmented Reality Interior Design prototype

For the first interior decoration simulation, ARID prototype will allow the customers to change the space structure without damaging the structure of the space and the ARID system will represent the result on real time. For the second interior decoration simulation, ARID prototype will determine the kind, position and paving method of material, furniture and hydropower-illumination relative to the hard-soft decoration—for example, in simulation for testing the function of hydropower system or changing the style of furniture. Moreover, the ARID prototype can be simulated the real sense in order to create a lifelike experience. In that way, the customer will be modified and managed the AR3D interior model based on their real feel for the decoration project.

V. Discussion and Conclusion

The case study revealed the feasibility of using AR3D model and ARID system in the conceptual development design stage. AR3D models are automatically by the ARID system when the designer and customer have created the interior 3D model and the hard-soft decoration models. Space structure, space function, material, hydropower system, illumination system, and customized furniture are completed by the system to create the customized AR3D model, when the user interacts with it which can be provide the perception and the augmented information to users. The AR3D models include structure information, basic functional information, and customized hard-soft decoration requirements. This model allows that the structural, functional and customized aspects of the conceptual interior design stage are coordinating and helps the user to consider and balance all parts of the interior decoration project in real time.

The limitation and difficulty of the plan is that the 3D interior models can be created under ARID environment are limited by the size, number and quality of the hard-soft decoration primitive database. Therefore, the future effort is asked to expand and enrich the database which includes the material, hydropower, illumination, furniture, and appliance to the user.

To conclude, the implementation of AR3D interior model for the early stage of interior design in an AR interior design environment has been analyzed and presented in this paper. The main advantage of the AR interior design can be reduce the cost and provide the multimedia augmentation of high vivid simulations for user in real time. In addition, the customized AR3D model allows the customer to understand the concept of the project and thus enable them to achieve the customized requirements and better design affection.

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