Augmented Reality Application for Architects and interior designers: Interno A cost effective solution

SidraNasir[1], Mohammad Noman Zahid[1], Talha Ahmed Khan[2, 3*], Kushsairy Kadir[4], Sheroz Khan[5]

[1]*Faculty Of Science and Technology, Ilma University Formerly IBT, Karachi, Pakistan*
[2]*Universiti Kuala Lumpur, British Malaysian Institute (BMI), Jalan Sungai Pusu, 53100 Gombak, Malaysia*
[3]*Usman Institute of Technology (NED University), Karachi, Pakistan*
[4]*Universiti Kuala Lumpur, IPS, UniKL1016, Jalan Sultan Ismail, 50250 Kuala Lumpur, Malaysia*
[5]*Dept. of ECE, Faculty of Eng. International Islamic University (IIUM), Kuala Lumpur, Malaysia*
Talha.khan@s.unikl.edu.my
tahkhan@uit.edu

Abstract— **Now a days with excessive work load and busy life, many professional face problems that results in the loss of their clients or the certain overheads that spoil the process of satisfying the client. The proposed software will be used by interior designers or architects. This proposed research most likely acts as an effective tool which can decrease the gap between industrial company and customer in addition to other applicable business communities. It will help in visualizing architect plans and interior designs. A virtual model of real environment can be designed before its physical implementation, it will allow interior designers to implement their idea in the given workspace virtually and then view it in real environment, it will also allow architects to view their 3D visualizations on their 2D drawings. Application is based on my findings of user's expectations of an augmented reality interior design service, a service which is a combination of various functionality of social media, augmented reality (AR) and 3-D modeling that encloses the concept of home design. This study distinctively bridges all users of relevant businesses to the user-intensive design of an augmented reality. The paper provides you with the inner depth on how the augmented reality can be implemented to facilitate the architects and interior designers as well it discusses the algorithm used to achieve the functionalities. The proposed application exhibits two types of Augmented reality, Marker less and marker based. The novelty of the project is that it does not require any sort of expensive gadgets. It can easily be used via smartphones and tablets. It is also operable on any operating system. This is a cost-effective solution that primarily reduces the overheads that interior designer and architects confronts on daily basis. The software exhibits all the features that might be required by interior designers and architects respectively.**

Keywords—3D visualizer, workspace, interior designers, architects, augmented reality, Marker based AR, Marker less AR

I. INTRODUCTION

Envisioning how a specific object will look in a room before it is decorated is a difficult challenge for anyone. Augmented reality is a new technology that includes the placing of some of the virtual objects on the real environment. As an outcome, the end-user can see the real environment augmented with physical object where you can interact with them. In General-context, this reality was also termed as mixed reality which discusses multiple fields that covers Virtual Reality (VR), Augmented Reality (AR), tele-presence, and other related technology. This technology has been used in various fields like in repairing, medicine, tele-robotic, manufacturing, robotics, maintenance, engineering design, education and military application.

Fig. 1.   Paul Milgram's point of view about augmented reality [1]

Paul Milgram's reality-virtual continuum. Augmented reality systems integrate virtual world and the real world in a manner that the end user experiences them as one. An essential asset of AR is finding digital tools within the proper vicinity and position, which makes the monitoring tool one of the most crucial attributes of an AR system. Basically, an AR system should be able to comply with the user's point of view dynamically and maintain virtual items aligning it with the actual environment entity. The primary attributes of an AR system are a shown, camera for image capturing, and computer hooked up application software, plus diverse and specific forms of hardware can be used. [1].

II. RECENT TRENDS

Augmented reality remarkably facilitates, to resolve real lifestyles issues. Issues are in particular, primarily based on elements i.e., money and time. The hassle encountered turned into the overhead of interior designing and its growing demand these days. Hardware implementations are

required in Head-mounted displays and monitors and are in particular designed for expert users. [2]

Android application for augmented reality was the key to resolve these issues considering the fact that it is an android application, it was supported by means of android devices such as smart-phones that are easily available to the end-users. the provision of numerous tools for the implementation of Augmented Reality as an android app, research on applications of Augmented Reality within the discipline of architecture and its usefulness in promoting precision in decision making. Hence, saving money and time therefore it can be regarded as a reliable cost-effective solution. [3]

It is a troublesome to envision how any object will appear in a room or in an open area with lot of aspects left to end-user's imagination. The scale, color, and the way it integrates with the existing surroundings. Augmented reality, technology that places computer graphics on the real environment has several applications within the discipline of architecture and engineering and has been used to address some issues of the real environment. Earlier it was referred to as mediated reality wherein a view of reality is changed by means of a computer; the technology has changed one's notion about reality. Head-mounted display (HMD), contact lenses, eyeglasses, monitors are some of the gadgets wherein augmented reality has been integrated. Many advanced gadgets typically assist professional users. Common people or the non-professional people also can make the most out of the augmented reality functions for solving their real existence issues. [4]

Wearable display offers wonderful experience with non-invasive and large screen in regards of augmented reality. However, such wearable should be expensive and cannot be afford by everyone. Moreover, the device is built with lots of sensors to improve it user experience that is for gaming applications. For the designing app the system gets more complex and expensive. Thus, is not affordable by everyone. [5]

This Augmented reality system permits the end users estimate the length of the presented space captured by Kinetic-depth sensor. It also supplies the end-users with a user-friendly interface where you can select and manipulate the object. It applies a prioritized strategy to prioritize the scale of the furniture automatically according to the size of the room. [6]

A system was programmed to arrange furniture automatically. It used Spatial and functional Links and implemented it on existing computer vision. Its approach was to produce an innovative application to assist end-users in decorating their house. Therefore, this snatches the chance from the user to implement their own idea using this application. [7]

Android application has become a medium to introduce augmented reality for purchasing relevant furniture. Markers are placed at the required place (for instance floor or wall) with the purpose to define the scale and coordinates of the room. The end- user chooses the virtual object and drags it into the augmented area. here the idea is used to combine the selected virtual furniture within the surroundings

wherein the actual furniture is already existing. All of this is done in-order to purchase the furniture with convenience and thus this saves resources and efforts by avoiding the need to actually go to the store and select furniture. [8]

It is difficult to satisfy the client's contentment level while purchasing the furniture for their room without imaginary view. Thus, allowing the user to drag only one object with in the design space. And let the user view how it will look in their respective real environment. A marker-based application that is marker is found in the catalog containing the textual data thus allowing the layman; to experience Marker based augmented reality. Nowadays, everybody is busy with their work therefore proscribing their time to visit numerous shops to buy furniture for his or her regular use. Hence it led towards the decrease in end-user's expenses [9].

This research presents an application that helps the user by suggesting placements of furniture based on interior design guidelines. [10]

This article discusses the issues that are regarding the future of interior design education. These issues maybe concepts foundation, integration of technology, etc. [11]

This study discusses how the construction of distributed AR applications can facilitate interior design applications. [12]

This research observes virtual furniture and its alteration to create a new strategy for interior design education by using Augmented Reality technology. [13]

This paper addresses the complications encountered by users while tracking a virtual object on the table top. [14]

This survey discusses the needs of 21st century interior designers and also their perception as well as limitations that their attitude and discernment exhibits. [15]

Method	Merit	Challenges	Resource/ Capacity Required
Questionnaire and Surveys	Inexpensive to administer, Easy to analyze can be adapted into many forms (online, paper, verbal)	Might not get careful answers. Answers might be biased.	Low
Interviews	Can be flexible. Eliminates the gap of understanding between stakeholders.	Can be hard to analyze. Might take a lot of time	High
Focus Groups	Helps in having great depth of information in a short time.	Difficult to schedule 5 to 6 people together.	Moderate
Case Studies	Powerful mean of understanding information strategically.	Time Consuming	High
Document reviews	Will help in obtaining Comprehensive historical information.	Data is restricted to what already exists.	Moderate-High

Table 1: Data collection and comparative results

Table no. 1 demonstrates the mentioned approaches that were pursued and their pros and cons have also been discussed. Data collection is the second challenging thing because augmented reality is not largely known in many countries including Pakistan. People have no idea how it works and it tends to confuse them but we have obtained some responses and have saved the multiple responses of the Architectures and the interior designers. Desired features of an AR interior design service for different target groups, and discusses their technical and practical feasibility. User expectations for AR interior and architecture design services were studied with a scenario-based survey, co-design sessions and focused interviews. Altogether 100 consumers and pro-users responded to the ambient design service on the survey. Thereafter, special co-creation meetings with five consumers and two interior designers and three architects were held to have better understanding with the respective groups. In addition, we interviewed many different commercial users on the field to deepen insights on product expectations. The combination of different user-centered approaches proved valuable input in the primary stages of concept design. After the interview and group discussions among the domain specific personnel's it was concluded that this user-friendly design tool is the need of an hour for them. It will reduce their overheads and it will also them in making their clients to grasp the idea behind the design by providing them with the 3d visual aid at the primary stage as discussed above. It seems that there is a demand for user-friendly design tools both for consumers and professional users.

III. METHODOLOGY

The print media (images, panaflex, print outs) influence is not capable and sufficient to satisfy designers and architects to visualize their ideas and complicated stuff in their desired way in the real-world environment. The application should convert 2D maps into 3D by scanning (specifically for architects) and end users can maintain their schedules and set the reminder, share their work among the community (blog) and will also have accessibility of understanding other designers work which will provide them with new motivation. The users can maintain their profile. And can also upload their own customized models too. Only authorized users can access this application (as we have provided sign up and sign in functionality). The user can interact with virtual 3D models of the furniture using an Augmented Reality in real time, and altering the color of walls and furniture, style, or covering of furniture in a real environment. Therefore, this permits complex and innovative designs to be explored and envisioned, making AR technology for interior designer and Architects accessible to both pros and amateurs. The applications aim to integrate two types of augmented reality and associated it with a specific discipline. This application is a complete package for designers and architects, our intention was to reduce the overhead of paper work and expenses consumed by them while dealing with the ambiguity of their client. This will also help them in maintaining their work schedule at the same time promote their work to gain recognition.

This application will also act as an opportunity for beginners to learn new skills from qualified veterans. As it will help interior designer to learn some important things from architects that are often learned by trial and error. While previously, the applications were only focused on providing brand of home furnishing with retail business by promoting their products. There has been no other application that has introduced the two distinguished types of augmented reality on one common ground.

A. Module for Architecture

Marker based augmented reality is used to enable the functionality developed for architects. A marker is required to view the rendered 3D object. An image or a representation that can be perceived by an image tracking module using methods consisting of pattern recognition, image processing and computer vision techniques can be defines as a marker. It defines the correct size and position of the camera once detected. In the process of marker detection, after deciphering its identity and approved as a marker. Using this feedback, the application calculates the position of the 2D image. The tracking module comprises of two main phases. First, the application detects the marker and evaluates the co-ordinates of the marker. Hence, implements it on the available space. Then, the tool will provide an automatic arrangement of the building according to the 2D image. Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units. At last, a proposed display plan of the building will be rendered into the real scene. It is the heart of one part of an application. This module starts when the AR camera is launched. After the calibration of the camera and it gives feedback to the AR camera in real time. The camera evaluates every image in the scene and detects the markers. The marker coordinates are tracked and marker's position are calculated and sent to the AR camera. The coordinates are sent to the Image rendering module where an object is rendered on it.

B. Module for Interior Designing

Marker-less AR is another part in which location and mapping is simultaneously done that allows you to place your AR experience pretty much wherever you want. This technique is the heart of another part of an application, specifically designed for interior designing. In this Module, Camera calibrates and the co-ordinates of the area is calculated. An object appears when an end-user selects an object. When the end-user desires to change the objects pose and size. Their fingers gesture on the selected object is analyzed if the gestures are identified then the camera is calibrated and when the pose change is approved then it is displayed in real time. This application allows the users to interact with multiple virtual object in real-time. The user can also delete the object on its selection if it is not needed and later can capture its image for safe keeping.

C. Camera Tracking Module

If Calibration about the stationary details of a scene then the system has to deal with dynamic scene changes too. Therefore, it estimates the scene for instance, certain features especially in interior design module. As for the

Module dedicated to Architects on detection of tracking point on the 2D image it calibrates itself.

D. Algorithm

Image Tracking:
Create class (Image Tracking)
Create variables (Set the below variables = 0)
- Camera Position
- Camera Angle
- Camera Target position
- Camera Target Angle

Launch and calibrate Camera
If (Image = Marker)
  Start Rendering the 3D Object
  If (Image (Marker) Moves)
    Move the rendered model with it
    Send information to Camera tracking Module
  If (Marker is Lost)
    Disable Image Rendering
Else Do Nothing
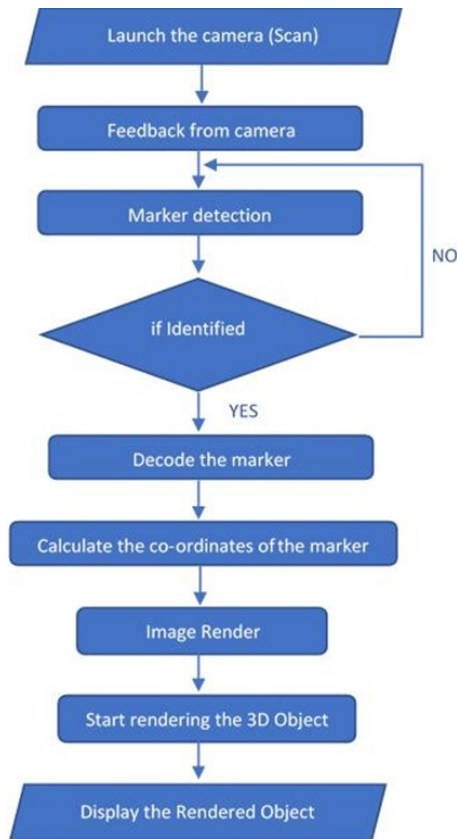
Fig. 2. Image Tracking/Rendering Module

Pose and Proximity Detection:
Create class (Pose and Proximity detection (Object Tracking))
Create variables (Set the below variables = 0)
- Camera Position
- Camera Angle
- Camera Target position
- Camera Target Angle

- Object default Position
- Object default Angle
- Object User-defined Position
- Object User-defined Angle

Launch and Calibrate Camera
Estimate the real environments (magnitude and co-ordinates)
If (On-Click Button (Object))
  Load the object in default pose
If (On- Click Object (Select))
  Enable Scale, Rotate, Move
    If (User Input (Motion) = Move)
      Move the object
      Send information to Camera tracking Module
    If (User Input (Motion) = Scale)
      Resize the object
      Send information to Camera tracking Module
    If (User Input (Motion) = Rotate)
      Rotate the object
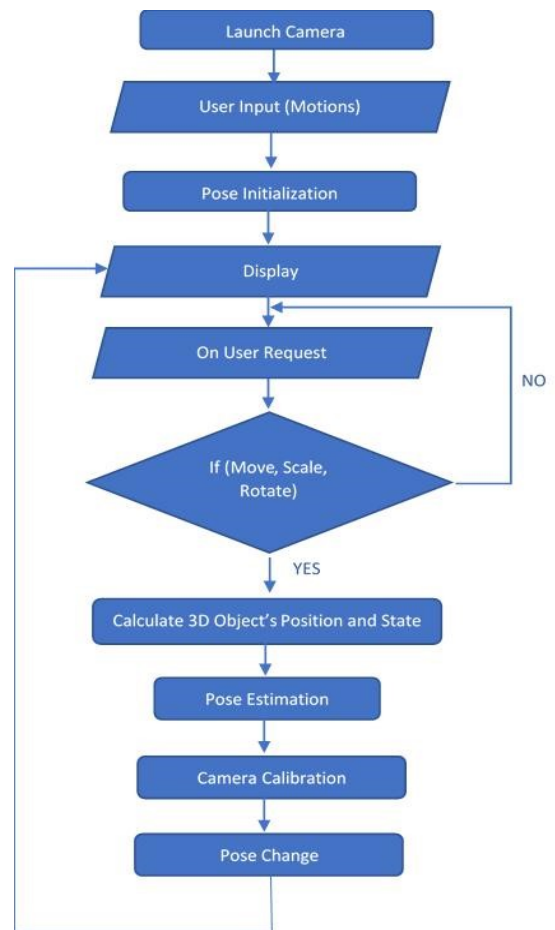   Send information to Camera tracking Module
Else make no Change

Fig. 3. Pose and Proximity Detection/ Object Rendering/ Tracking Module.

Camera Tracking:
Create class (Camera Tracking)
Create variables (Set the below variables =0)

- Camera
  Position
- Camera
  Angle
- Camera Target position
- Camera Target Angle

On start (Launch and Calibrate Camera)
Send Feedback to Image Tracking Module
Send Feedback to Object Tracking Module
If (Image = Marker)
    Estimate the Markers Position
    Start Rendering the 3D Object
    If (Feedback from image tracking module (verifies the marker) = true)
        Start Displaying the rendered Object
    If (Feedback from object tracking module (Motion) = true)
        Update the display of an Object
Else Do Nothing
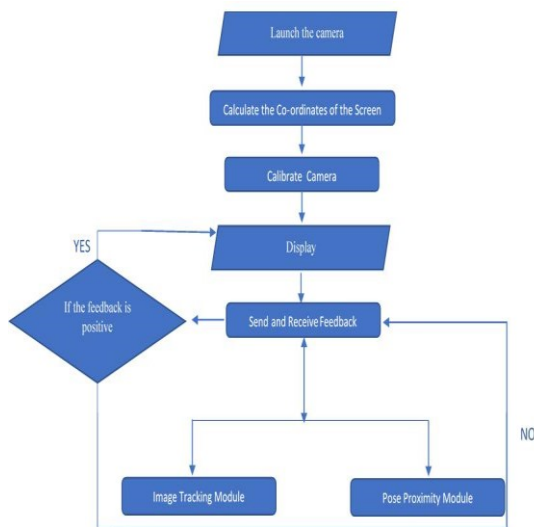
Fig. 4.   Camera Positioning and tracking Module

IV. RESULTS AND DISCUSSION

This application is relatively new, this application allows the user to add multiple object to the screen in real-time. The user can manipulate the object like, move, rotate, resize and change the color or texture of the object on selection. Thus, allowing the interior designer to implement their design and evaluate them in real- environment. In this application one module is endowed to Architectures where over their 2D image a 3d object is rendered to let them consider and assess their idea.
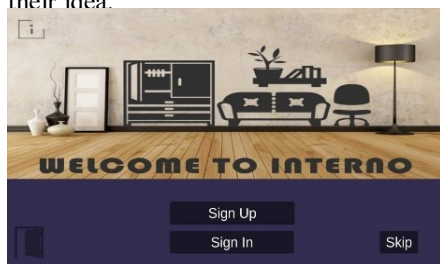

Fig. 5. Home screen of the proposed application

This is the Home Screen of the Application. Here user will sign up create his profile. In Case anyone who have no account on application can excess the restricted version using skip button.

Fig. 6. Help Panel

This is help panel, where the user is who is using the application for the first time can be guided.
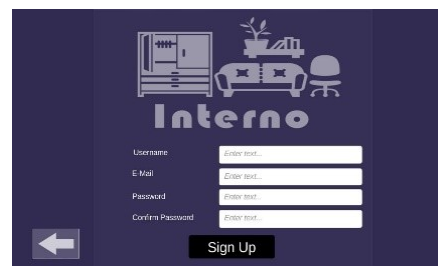

Fig. 7. Sign up panel

This is the Sign-Up Panel, where user will register and make his account.
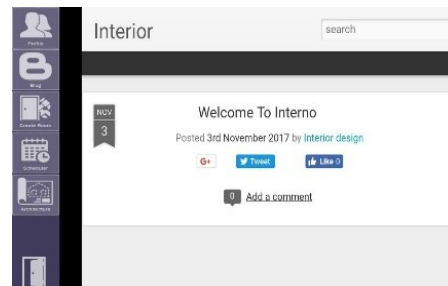

Fig. 8. Community Page

This is the Blog / Community Page. Here, user can share their work and converse with other users and learn new things.
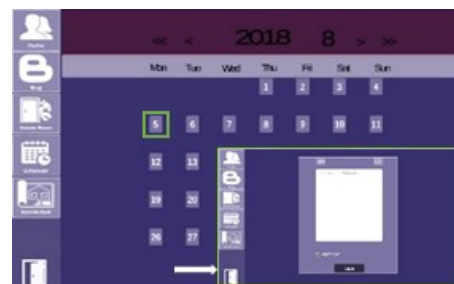

Fig. 9. Scheduler & Reminder Panel

This is the Calendar/ Scheduler Panel. Here, the user can schedule his meeting. After clicking any date in the calendar, user will be directed to the reminder panel. He can write his notes as well as set the reminder for meeting,

which he will later receive via notification on selected date.

Fig. 10. Create room panel

This is known as the Create Room Panel and one part of the application. This panel enables the user to implement their design by dragging the object on to the Screen. This Panel shows all the functionalities of Augmented reality (Marker-less). It also exhibits the Categories that is provided to the user to use.
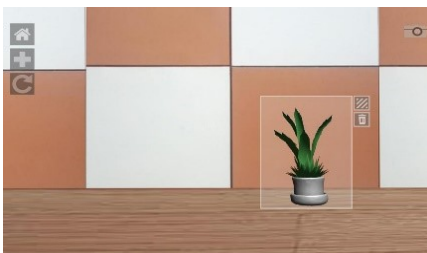

Fig. 11. Create room panel with object editing panel

This figure reveals that on selection of the object the texture and delete button will be visible.

Fig. 12. Architect Panel

This is the Panel dedicated to Architects. This is known as the Architecture Panel and another major part of the application. This panel scans Image containing the tracking points which is later on scanned and when authorized over the 2D image target, rendering of the 3D models commences.

V. CONCLUSION AND FUTURE ENHANCEMENT

The proposed solution is based on the research regarding to its subject so we have found no applications like ours introduced yet. It will be very useful especially where client's minds change within a blink of an eye. We want to conclude our report that our research is a step to the technology advancement in the field of architects and interior designers where there are many other problems and issues that might have to be faced by them. By implementing this research, we believed that their work flow pipeline will be benefited from it.

REFERENCES

[1] P. Milgram, H. Takemura, A. Utsumi, and F. Kishino, "," *Telemanipulator and Telepresence Technologies*,

[2] G. Klein and D. Murray, "Parallel Tracking and Mapping on a camera phone," *2009 8th IEEE International Symposium on Mixed and Augmented Reality*, pp. 83–86, 2009.

[3] A. Nee, S. Ong, G. Chryssolouris, and D. Mourtzis, "Augmented reality applications in design and manufacturing," *CIRP Annals*, vol. 61, no. 2, pp. 657–679, 2012.

[4] Prof. B.Y.Jani, Pratiksha Dahale, Ankita Nagane, Bhavika Sathe, and Nilam Wadghule, "Interior Design in Augmented Reality Environment," *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 4, no. 3, pp. 286–288, Mar. 2015.

[5] William A.S. Buxton, "Living in Augmented Reality: Ubiquitous Media and Reactive Environments.," *Video Mediated Communication. Hillsdale, N.J.: Erlbaum*, pp. 215–229, 1997.

[6] J. K. Tang, W.-M. Lau, K.-K. Chan, and K.-H. To, "AR interior designer: Automatic furniture arrangement using spatial and functional relationships," *2014 International Conference on Virtual Systems & Multimedia (VSMM)*, pp. 345–352, 2014.

[7] R. T. Azuma, "The Challenge of Making Augmented Reality Work Outdoors," *Mixed Reality*, pp. 379–390, 1999.

[8] H. Matsuoka, A. Onozawa, and E. Hosoya, "Environment mapping for objects in the real world: a trial using ARToolKit," *The First IEEE International Workshop Augmented Reality Toolkit,*2002.

[9] Khushal Khairnar, Kamleshwar Khairnar, Sanketkumar Mane, and Rahul Chaudhari, "Furniture Layout Application Based on Marker Detection and Using Augmented Reality," *International Research Journal of Engineering and Technology (IRJET),* vol. 2, no. 7, pp. 540–544, Oct. 2015.

[10] Paul Merrell, Eric Schkufza, Maneesh Agrawala, Vladlen Koltun, "Interactive furniture layout using interior design guidelines," *ACM Transactions on Graphics*, vol no. 30, article 87, pp. 87:1– 87:9, Jul. 2011.

[11] Denise A., Guerin Ph.D., "Issues Facing Interior Design Education in the Twenty‐First Century," *Journal of interior Design*, vol no. 17, Issue 2, pp. 9‐ 16, Sep. 1991.

[12] Klaus H. Ahlers, André Kramer, David E. Breen, Pierre‐Yves Chevalier, Chris Crampton, Eric Rose, Mihran Tuceryan , Ross T. Whitaker, Douglas Greer, "Distributed Augmented Reality for Collaborative Design Applications," *Computer Graphics Forum*, vol no. 14, Issue 3, pp. 3 – 14, Aug. 1995.

[13] Viet Toan Phan, Seung Yeon Choo, "Interior Design in Augmented Reality Environment," *International Journal of Computer Applications*, vol no. 5, pp. 16 – 21, Aug. 2010.

[14] H. Kato, M. Billinghurst, I. Poupyrev, K. Imamoto, K. Tachibana, "Virtual object manipulation on a table-top AR environment," *Proceedings IEEE and ACM International Symposium on Augmented Reality (ISAR 2000)*, pp. 5 – 6, Oct. 2000.

[15] Joan I. Dickinson Ph.D., John P. Marsden Ph.D., Marilyn A. Read Ph.D., "Empirical Design Research: Student Definitions, Perceptions, and Values," *Journal of interior Design*, vol no. 32, Issue 2, pp. 1–12, Jan. 2007.