

# Interior Design using Augmented Reality Environment

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**ABSTRACT:** This paper presents an interior design application using Augmented Reality technology. Along with the growth of digital technology, virtual information techniques are required in architectural field. Nowadays, people are busy with their work thus limiting their time to go to various stores to buy furniture for their everyday use. There is difficulty to fulfill the customers contentment of decorate their room without imaginary view of how the place would actually appear. A printed furniture catalogue is paper based containing textual information and images which does not provide any interaction for the user. We intend to use marker based AR for implementing a new design approach for interior design. This AR environment will allow the user to select from a range of furniture and then display the virtual furniture selected on the real environment. The user can also modify the virtual furniture in real-time on the screen allowing the user to have an interactive experience with the furniture in a real-world environment. This will provide a better view of the furniture placement and simplify the process of interior designing for users to save their time and effort.

## I. INTRODUCTION

It is a difficult challenge to visualize how any piece of furniture will look in a room with lot of factors left to human imagination. The size, the color, and how well it integrates with the existing environment. Augmented reality, a technology that overlays computer graphics on the real world has its applications in the field of engineering and architecture and has been used to tackle real world problems. Earlier known as mediated reality in which a view of reality is modified by a computer, the technology has evolved to enhance one's correct perception of the reality. Head-mounted display (HMD), contact lenses, eyeglasses, monitors are some of the devices in which augmented reality has been incorporated. All these devices are commonly serve professional users. Common people or the non-professional people can also exploit the augmented reality features for solving their real life problems.[4]

The interior designing system using augmented reality is an android application that overlays the virtual furniture in a physical environment. Markers are placed on the area (for example floor or wall) for tracking purpose to define the scale and coordinate system of the room. The user selects virtual furniture on the screen and places it into the design space. Here the concept of AR is used to integrate that selected virtual furniture with an environment where the actual furniture is present. The user can also manipulate the location of the selected furniture and view it in various angles. All the operations are performed in real time. It is implemented for android devices where the mobile camera is an important component. Smartphones are very popular and it is hoped that the proposed system will allow a large range of users. Also the most difficult challenge of decision making can be easily resolved when the user gets to choose the desired layout for a particular room. Thus this saves time and efforts by avoiding the need to physically go to the store and select furniture.

Some similar systems have already been presented but the system proposed includes additional functions for the user interface and an improved implementation. For instance, the user can interact with virtual furniture using Tangible Augmented Reality in real time allowing complex and varied designs to be explored and visualized, making AR technology for interior design accessible to both professionals and amateurs.[5]

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Augmented reality has an incredible ability to solve real life problems. Problems are mainly based on two factors, time and money. The problem encountered was the overhead of interior designing and its increasing demand in today's world. Head-mounted displays and monitors require hardware implementations and are mainly designed for professional users.[3] An augmented reality android application was one of the solutions. Since it is an android application, it is supported by all android devices or smartphones which are easily accessible to the users. The availability of various tools to implement AR as an android application, the papers on AR on the application of AR in the field of architecture and the ability to ease out the user's problem in decision making thus saving time and money was a motivation to implement an application for interior designing using augmented reality.

## II. RELATED WORK

A system for Automatic Furniture Arrangement using Spatial and Functional Relationships applied existing computer vision technique to produce a creative application, to help people in everyday life. This AR system not only allows the user to put virtual furniture together with a real scene but also able to estimate the lengths of the available space captured by KINECT depth sensor. This tool estimates the supporting planes for placing the virtual furniture models by a RANSAC-based approach. A user friendly user interface is provided for user to select and manipulate with the virtual furniture models. Also the tool can further suggest a reasonable arrangement for the selected furniture models according to their geometry and functions, and a prioritized scheme is applied to fill up the furniture models of extreme sizes/lengths. The mixed outcome of the virtual furniture and real scene is rendered and captured in a digital image for the user's future reference.[1]

Another system based on environment mapping for objects in the real world using AR Toolkit assumes that a virtual object is collection of multi viewpoint images of a real object with the background deleted. It has a *capture system* for generating multi-viewpoint images for real objects. The system takes photographs of an object from various angles and can automatically generate alpha masks and textures. Also, real-time image-based rendering techniques for the real environment using AR Toolkit are described. These techniques can consider objects' reflection, translucency, shadow, slide and color balance in real time. [2]

The existing systems in augmented reality were earlier implemented using heads up display wherein the user was able to see through wearable AR displays (Head Mounted Display or HMD) that didn't obstruct the user's line of sight allowing a non-intrusive, hands free, large screen experience and are desirable outcome to provide alternate use of the available computing power of smart devices.<sup>[1]</sup> Wearable displays are compelling because they offer the ability to display augmented reality applications on a large virtual screen hands free. However, any such device needs to be affordable and should have a form factor that is attractive enough so that users will easily adopt it. The users do not wear phones; the form factor challenges are different than with a wearable display device. Moreover, the device contains enough intelligence built into it in the form of sensors and video processing for making it useful for augmented reality and related applications. Basically, for interior designing applications using 3D objects, lot of hardware implementations were needed to be done making the system complex.

## III. PROPOSED SYSTEM

The proposed system is an augmented reality system for interior designing by overlaying virtual furniture in a physical environment based on a regular smartphone or any device with android operating system. Markers are placed on the floors or walls to track the object and define the scale and coordinate system of the room. Next, the user selects virtual furniture on the screen. The 3D virtual furniture is integrated into a real environment and can be arranged alongside real furniture.<sup>[2]</sup> The basic prerequisites is smartphones with android operating system and a printer. So it is expected that the proposed system will allow a broad range of users the system proposed in this paper includes many functions for the user interface and an improved and optimized implementation. The user can interact with virtual furniture using a technology called Tangible Augmented Reality in real time, and change the colour, style, or covering of furniture in a real environment. Because of this complex designs can be explored, making AR technology for interior design accessible to both professionals and amateurs.

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## A. MARKER DETECTION

The detection of furniture requires a marker. An image or a sign that can be detected by a video image using techniques such as image processing, pattern recognition and computer vision techniques is a marker. It is used to define both the correct scale and pose of the camera once detected. This approach is called marker-based tracking. In marker detection process, the first goal is to find whether there are outliers in the image, and then to deduce locations of marker's corners in the image. A decision system needs to decipher its identity to confirm that it is a marker. Finally, using the information from the detected marker location, the system calculates the pose.[4]

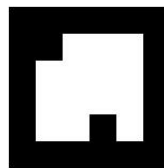


Figure 1: Marker

Figure 1 shows a marker which is a black and white image which provides coordinates for the object to render on it. The more the number of distinct edges, the more is the rating of the marker. Higher the rate, faster is the marker detection process.

## B. TRACKING MODULE

The tracking module consists of two major steps. [3] Firstly, the system detects the marker and estimates the co-ordinates of the markers in the room, and hence decides on the available space. The user can drag-and-drop his/her desired virtual furniture models in the scene via a user interface provided at this stage. Secondly, our tool could provide an automatic arrangement of the selected furniture models according to the position of the marker. Finally, a suggested display plan of the furniture will be overlaid on the real scene.

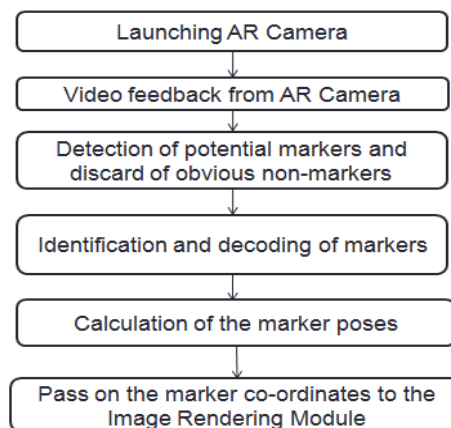


Figure 2: Tracking Module

The working of tracking module is shown in figure 2. Tracking module is the heart of our application. It starts with launching an AR camera. The video gives feedback to the AR camera in real time. The camera assesses every image in the scene and identifies the markers. The marker coordinates are decoded and marker poses are calculated and sent to the AR camera. The coordinates are passed to the Image rendering module where an object associated to the marker is rendered on it.

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### C. FLOW OF THE PROJECT

Application works as follows:

1. A video of the real world is captured by the camera and sent to the application.
2. Application searches through each video frame for any distinct features in the image or a marker.
3. If the features are detected, the position of camera is decided with respect to the marker.
4. The position of the camera is known and a computer model is drawn from the marker coordinates
5. This furniture model is overlaid on top of the video of the real world and it is linked to a particular marker.
6. The final arrangement is shown back in the camera feed. The user sees objects overlaid on the real scene.

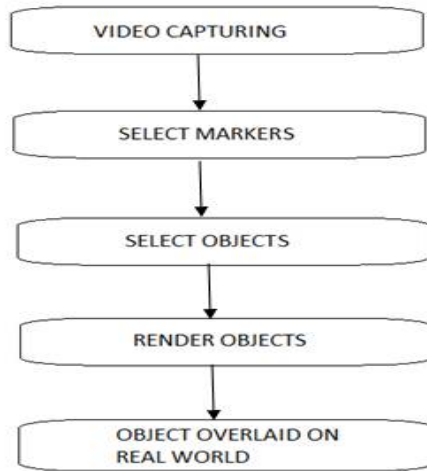


Figure 3: Flow Diagram

Figure 3 shows the flow diagram of the project. Real time video feed is captured and given to the camera. The markers are selected by the user and objects are linked to it. Upon detection of markers, objects are rendered on it. The objects can be moved, rotated and changed by the user in real time and finally placed at the appropriate position.

The Data module consists of the markers and the 3D objects required for the use of the application. The Position tracker and orientation tracker finds the coordinates of the marker. The tracker data routine contains coordinates for the 3D objects which the user selects from a furniture database. OpenGL renderer renders the 3D furniture and the users interact with the selected furniture using the interaction routine which is displayed to the user through the internal camera of the device in real time.

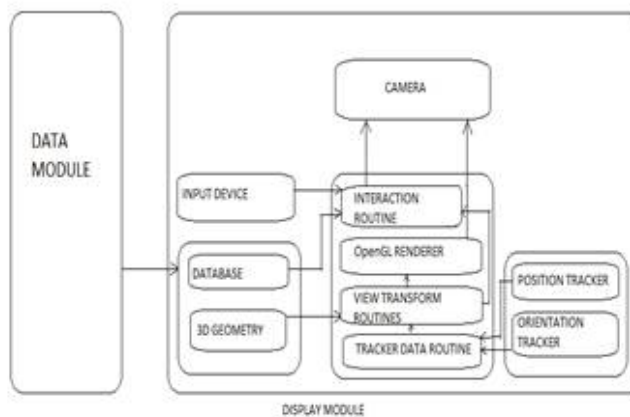


Figure 4: System Block diagram

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The system block diagram in figure 4 consists of two modules- the data module and display module. The data model contains markers and objects whereas the display module consists of camera and various sub modules which are useful for marker detection, object rendering, object tracking and object transformation.

## IV. IMPLEMENTATION

The operation of the system is described as follows.

1. First the user downloads and prints the markers from the interface. The size of the marker may vary depending on the area of the room and the nature of objects to be overlaid.
2. The user launches the application and places the marker in the appropriate position near the area which he wants the object to render. Every marker is associated with objects and stored in the application internally.
3. The next step is furniture arrangement. Objects render on the marker and are viewed by the user in real time.
4. The user is displayed with a furniture set. Furniture which the user does not want to appear in the scene can be removed by simply sliding the image out of the scene.
5. Initially, the objects render on the marker coordinates. The user can manually manipulate the objects. Dragging the object will change the position of the object.
6. The object can be rotated and the plane of rotation is easy for the users to understand as it can be viewed in real time.
7. Objects can be changed on the same marker. Every marker has number of objects of the same category- sofa, bed and so on. If the user wants to view a different sofa or different bed, three point touch is enabled and the user can view variations in sofa, bed and all other objects.

## V. RESULTS

The application was designed by using three markers and three types of objects- sofa, table and chair. Initially, when a single marker was placed, an object linked to it rendered on it.



Figure 5: Object rendering

In the above Figure 5, Object is rendered on the marker. Every object is associated with a marker. When AR camera is launched, it detects the features of the marker and the associated object is rendered. Here a sofa is rendered on detecting the marker.

When multiple markers were placed, multiple objects were rendered on it.

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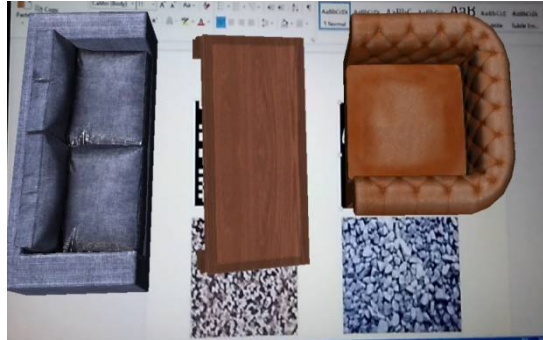


Figure 6: Multiple marker detection

Figure 6 shows multiple marker detection wherein 3 markers have 3 different objects associated with it. A long sofa, a chair and a single sofa are rendered on three different markers. The objects are independent of each other and are related only to their respective markers.

The objects could be manipulated- here rotated using two point touch and moved from the marker.

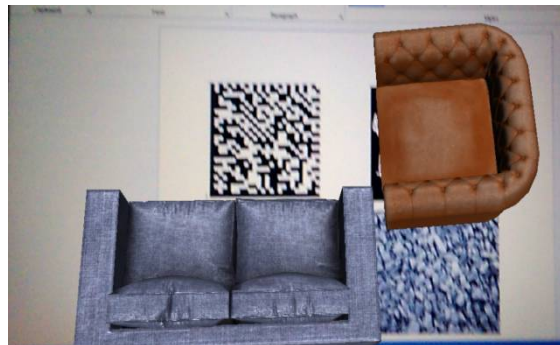


Figure 7: Object manipulation

Figure 7 shows how objects can be manipulated after they are rendered on the marker. The long sofa is moved by dragging it to the appropriate position. It is rotated using two point touch and placed at the appropriate position in the scene.

Finally, the objects were replaced using three point touch and positioned accordingly on the scene.

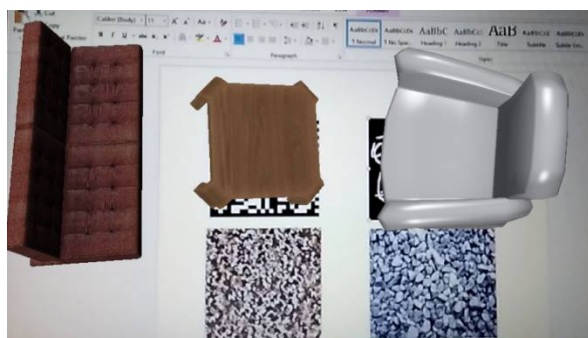


Figure 8: Object placement and changing

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In Figure 8, Objects are changed using a three point touch and placed at the appropriate position. The long sofa is replaced by a maroon sofa; the table and sofa are also replaced by different furniture of the same category. A marker with renders a sofa contains many sofas linked to it and can be changed by the user with three point touch. Every marker renders objects of one furniture category.

## VI. CONCLUSION AND FUTURE WORK

AR technology opens up many new research fields in engineering and architecture. For the interior design application created in an AR environment, design work can become more lively, convenient, and intelligent [4]. Plus, design work and manufacturing can be conducted at the same time and we close relationship with each other[4]. Modules can be developed and easily integrated using various AR tools. The results showed that furniture were rendered on the marker and scaled accordingly. The size of the object depended on the size of the marker and the distance from the camera. The users could manipulate the objects and place them according to the scene. Also, the user interface is simple allowing beginners as well as professional users to use the application.

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