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Interior Designing Mobile Application based on Markerless Augmented Reality (AR)

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Abstract - *Augmented Reality(AR) is a domain of research which deals with mixture of reality with computer associated data. It is an atmosphere that concerns between virtual reality and real circumstances. AR has been a broadly explored technology in various domains, it is also consistently utilized in civil engineering, architecture, and interior design experimentation. For interior designers and people who would like to decorate their rooms, being able to think in three dimensions and visualizing projects is of great importance. In an augmented reality ecosystem, digital furniture could be arranged and controlled in the real world in real time which permits the customer to have a synergetic experience. In huge pace being created in digital technology that virtual design hasn't keystoned productively. Our mobile application could resolve this by allowing customers to percieve at a 3D furnished prototype - a digital similarity of the real world appliances with no intrusion of the symbols. Our mobile application operates on three primary augmented reality features i.e Motion tracking, environmental understanding, light estimation. This implementation will assist the client to percieve and feel the appliance in the existing surrounding prior buying it from the producer.*

Key Words: **Augmented Reality, Interior Design, ARCore, Real world environment, Markerless AR.**

1. INTRODUCTION

Augmented reality (AR), is a technology that overlays computer graphics on the real world and has its applications in the field of engineering and architecture to tackle real life problems. The predominant task of augmented reality is that it connects elements of the virtual world into the existence of the physical world. The component does not just appear as simple display of data, but due to the augmentation it is perceived as natural parts of an environment. It is a creative idea to furnish real data and display it in an effective method so that digital components become members of the physical environment. Augmented Reality becomes feasible due to the intake of input data using on device sensors like the accelerometer, gyroscope, depth sensors. The input through sensors is handled by the computers to acknowledge the ecosystem on the basis of the usable volume of exposure which permits the client to arrange 3Dprototypes in actual time.It is a tedious task to percieve how any part of appliance will appear in a space with a plethora of factors left to human knowledge. Some of the devices in which augmented reality has been integrated are Head-mounted display (HMD), contact lenses, eyeglasses, monitors. All these devices are usually serve customers with ample experience [4].

Using this AR technology, an interior designing application is developed which will assist customer to have a digital sight of appliance in the actual world prior to buying it. Through this application the client can opt a digital appliance from the options provided and arrange it onto the photographed room by just heaving the digital appliance on the actual surrounding. The application will be adaptable with all the present android versions where the mobile camera is an essential element. The camera captures picture in actual environment for a broad perspective where the client can move the position of the opted appliance and percieve it in different perspectives. By availing this application, the customer will meet benefits like less time and effort consumption for opting the furniture by visiting the shop physically. The execution of the AR technology in the mobile application is done with the assistance of AR SDK tools.

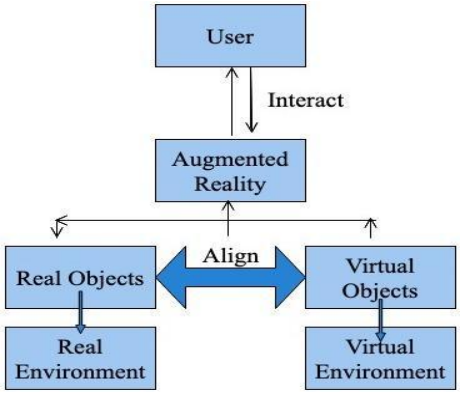

Fig -1: Augmented Reality

2. EXISTING SYSTEM

Recently, AR technology is very much in demand in the field of science and medical but it has also started evolving in the field of engineering and architecture as a result various research are undergoing. AR is a technology that overlays a digital world on a end user's actual environment. It is also known as **Mixed Reality** because it mixes both the real and the virtual world. Following are the various methods which are used to develop various existing system using AR technology:

2.1 Recognition based Augmented Reality

Recognition based augmented reality depends on acknowledging real world items such barcodes, images, texts, etc. to provide details. The most familiar type of Recognition Based AR App is a language translation app which uses camera to recognize the letters, translates it and overlays on top of a picture.

2.2 Projection based Augmented Reality

It depends upon projection onto object surface. Projection based augmented reality works by the projection of artificial light onto real world scenario. Projection of light on objects can be used to analyse the position, orientation, and depth of a virtual or real object. In such situation, an object is considered and its formation is explored thoroughly. Detection of the user's interaction is done by differentiating between an expected projection and the differentiated projection. One of the interesting applications of the projection-based augmented reality is laser plasma technology to project a three-dimensional (3D) interactive hologram into mid-air [5].

2.3 Superimposition based Augmented Reality

It allows users to merge real and virtual worlds. It permits the actor to achieve a replacement of the object by restoring either a part or the complete display with an augmented sight. In other words, it partially or fully replaces the original scene of an object with a newly augmented scene of that same object. In superimposition based AR, object recognition plays a crucial role because the application cannot replace the original view with an augmented one if it cannot determine what object it is. For example, whenever the driving person is parking your car in the dark, outlining AR recognizes the boundaries of the road and outlines them for the driver. This method can also be used in architecture and engineering to detect the buildings and their supporting pillars [6] [7].

2.4 Location based Augmented Reality

It relies on location of the device, orientation, sensor data to find out where the user is looking and provides meaningful information based on that. Popular instance of this type of augmented reality is *Pokémon Go.* As one of the most widely used applications of augmented reality, marker less (also called location-based) augmented reality, uses a GPS, digital compass, velocity meter, or accelerometer which is implanted in the tool to give information as per user's location. A strong force behind the location based augmented reality technology is the wide availability of smartphones and location detection features that the devices provide [4]. It is most commonly used for locating the directions, finding nearby places, and other location- centric mobile applications.

2.5 Common Types of AR Techniques

2.5.1 Marker-based Augmented Reality

Marker-based AR application usually involve image recognition, the images that are to be recognized are predefined in the application. During execution, the application examines the camera stream and try to locate a marker (target). Once it encounters the marker, the AR markers are used as the co-odrinates for delivering digital elements. AR markers can comprise a broad range of pictures but can be as clear as a barcode.

2.5.2 Marker-less Augmented Reality

Marker-less AR products detect elements that were not predeclared. Application recognizes different features, patterns, colors etc. As there is no predetermined picture goals on it. During execution, the application has to examine various variables in camera fixture to activate AR measures.

2.6 Disadvantages of existing system:

The primary disadvantages in the existing systems are: Static view of design(can't convey the exact idea of clients), time consuming for designers to understand and make drawing for every view of the customer. Hence, there is a need for a medium which is beneficial for both designers and users. Therefore, providing multi-angle view for a single design concept and changing the position of appliance as per user requirement are essential in the future systems.

3. RESEARCH MOTIVATION

Augmented Reality (AR) technology is full grown and broadly utilized as a replacement to digital reality on mobile phones. Design domains are enormously naturalizing AR to produce significant client adventure because AR permits ventures to develop applications that assist clients to percieve real products. With the progression in computer vision procedures and inexpensive hardwares, AR has finally become a primary domain. Furniture consumers always had difficulties related to material returns because whenever they would purchase furniture through online mode, they were unsure if the particular furniture will suit a specific room. The degree of freedom for clients to decorate their residing place as per their own knowledge is what encourages us the most to construct an application which can improvise client's interaction. With an AR android mobile application, customers can arrange a real table in their living room to figure out if the table suits the space and looks fit. This ideology dramatically reduces the difficulties of product return and management cost. Assisting clients to redesign their internal circumstances, arrange 3D appliances through the application is our aim. Various professionals like architects, interior designers and usual end-users can visualize

various internal design sequences, execute their knowledge in home decoration activities. Complexities that may encounter in interior design is that the user is not able to visualize and feel how actually an object may look in reality, which also restricts designers and architects to convey their design to their customers on an idea of full- fledged interior design.

4. PROPOSED SOLUTION

With the sudden demand of good quality cameras and more precise sensors in soon-to-be mainstream devices, Augmented Reality is evolving from picture or QR code relied activations to Marker-less Augmented Reality encounters. In our current implementations of marker less AR we use sensors in devices to accurately detect the real-world environment, such as the locations of walls and points of intersection, allowing users to place virtual objects into a real context without needing to read an image.

5. IMPLEMENTATION

The proposed system uses Marker-less Augmented Reality as a basis for enhancing user experience and for a better perception of objects. Marker less tracing is a technique of location tracking - the confirmation of location and direction of an element within its surrounding. This is a crucial characteristic in virtual reality (VR) and augmented reality (AR), making it feasible to notice the line-of-sight and perception of the client - permitting for the digital atmosphere to respond appropriately or the installation of augmented reality content in agreement with real[1]. While marker-based techniques of motion tracking utilize certain optical markers, marker-less positional tracking does not demand them, making it a more feasible technique. It also refuses the demand for a processed environment in which fiducial markers are placed beforehand, for example. However, a marker-less viewpoint permits the client to roam in a room or a new ecosystem and still receive positional feedback, extending the pertinency range[5]. The fundamental assumption of the initiated system is to laminate virtual 3D prototypes on top of actual elemens using a mobile phone camera. Initially, the development was started with Marker- based approach because of the lack of support for Marker-less augmented reality. Recently, Google notified its ArCore platform that would permit programmers to code Marker-less AR products so we developed our mobile application around android operating system mainly because of its accessibility, noticability, dependence rate, and quickness. The devel-opment environment included **Unity Game Engine, Java Programming Language, Android Studio IDE** and we currently only support android devices.

Augmented Reality for interior design demands conventional networking between hardware and software elements. Environment plays a crucial part in the system formation. Precise performance of camera, sensors, types of software API's working altogether makes the system efficient of augmenting virtual 3D elements on the display screen.

Implementation involves following steps:

Step 1: Initially, the prototypes are opted for which the suggested system is to be developed for.

Step 2: The proposed system focuses on Interior Designing which includes furniture's, appliances, etc. Hence the models for the same will be created.

Step 3: 3D Modelling

Step 4: Motion Tracking (Google's ARCore Utility)

Step5: Environmental understanding and Light estimation (Google's ARCore Utility)

Step 6: Next, the models are scanned with precision and the selected model is rendered and processed to be loaded. The android application is then run.

Step 7: Mapping of grid information onto the smartphone screen takes place which decides the dimensions of the model which is then rendered and displayed onto the screen.

To begin with, 3D furniture models(such as Chair, Table) need to be designed using 3D modelling process in any of tools like Unity 3D or Autodesk Maya.

3D modeling is a method in computer graphics for generating a 3D virtual display of any element or space.An artist utilizes specific software to move points in digital workspace(called vertices) to shape a lattice: a group of co-ordinates that devise an element.These 3D components can be produced spontaneously or developed manually by disfiguring the lattice, or else moving or changing co-ordinates.3D prototypes are utilized for different platforms such as games, films, construction, etching, engineering, and merchandise advertising. This task generates a virtual element that can be completely animated, making it a crucial stage for character animation and special effects. The essential component of a prototype is the lattice which is best depicted as a pack of points in space. These points are mapped into a 3D grid and connected together as polygonal shapes, commonly triangles or quads. Each point or vertex has its own location on the framework and by coonnecting these points into shapes, the surface of an element is generated. Prototypes are often exported to other application for use in games or movies. But some 3D prototyping programs allow the generation of 2D images using a phase called 3D rendering. This technique is effective for developing mind-blowing visuals using complex lighting procedures.

All relative terminologies for augmented reality are supported by Google's ARCore utility. ARCore is Google's

framework for developing augmented reality products. By availing various APIs, ARCore authorize your mobile phone to observe its ecosystem, acknowledge the surrounding and communicate with information.

Fundamentally, **Google's ARCore** is doing two things: tracking the position of the mobile device as it moves**(motion tracking)**, and building its own **understanding of the real world.** ARCore's motion tracking feature utilizes the phone's camera to figure out fascinating markers, called **features**, and traces how those markers migrate over time. With a mixture of the locomotion of these markers and values from the phone's inertial sensors, ARCore estimate both the placement and direction of the phone as it migrates through the room. Besides this, ARCore can figure out plane areas and can also calculate the **average lighting** in the area around it. These potential abilities blend to permit ARCore to develop its own knowledge of the surrounding around it. ARCore's knowledge of the actual world permits you to locate models, observations, or other data in a way that amalgamates faultlessly with the actual world. ARCore boost our progress through its impeccable potentials. [1].

A clear functionality for execution is accompanied such that an AR utility accessible smartphone camera will discern the ecosystem, operate the space photographed, organize the empty space so that elements can be positioned in it. Opting models from a simple menu bar is the second stage. Regularizing the model as per user needs, revolving the model across three axes of a plane is a feature. ARCore package com.google.ar.core.* provides a way to stack objects on device screen that use classes like ModelLoader,CameraConfig, CreateAnchor, Session, Pose classes.

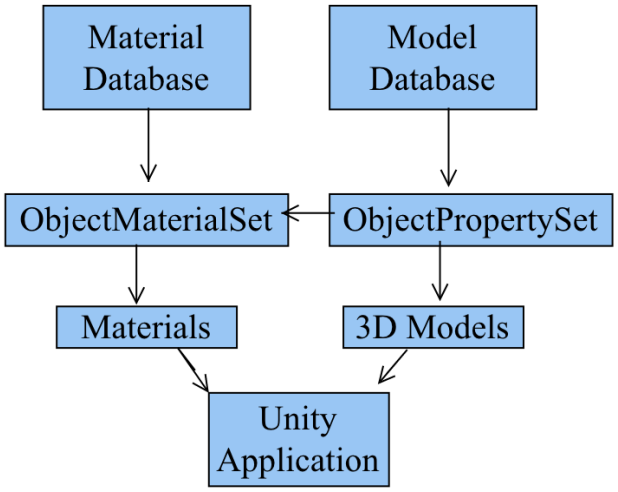

Fig-2: Data Flow in the Application

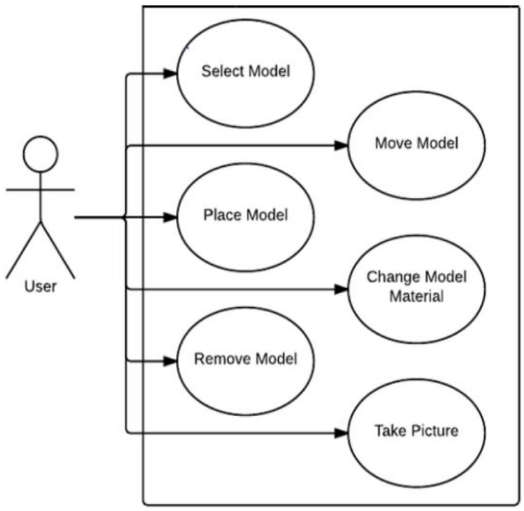

Fig-3: Use case Diagram

6. ARCHITECTURE

The whole application is constructed by utilizing **Model View Controller** architecture because whenever user call on a functionality, UI **Controller** earn requests for the application and then works with the **Model** to process any data demanded by the **View**. The **View** uses returned data to generate the final depictable output message and upgrades the user interface. For instance, when the user selects a 3D Furniture from the UI, It is mapped to the **Controller** which grabs the 3D Furniture from the **Model** and updates the **View** component which is UI.

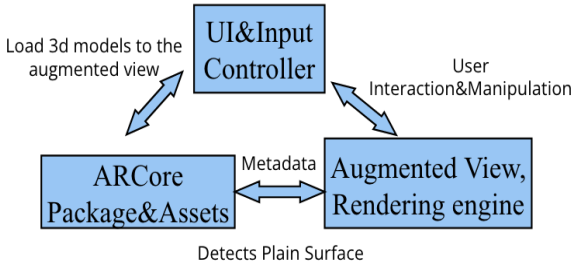

Fig-4: Model View Architecture Diagram

7. DESIGN AND DEVELOPEMENT

7.1 Front End Development:

A minimal User Interface for the app is created. A primary rule was that at any time the user should be able to view the camera stream and the rendered model. Transparent menus and sliders that would only come up when the user needs it were designed. Instead of having buttons, touch gestures were used to manipulate and select rendered 3d models.Simple, easy-to-use gear to pull up the menu was created . When the user selects the gear menu it renders a slider with available furniture like shown in the following picture.

With the menu toggle, the user can opt for various furniture. Once the user chooses the furniture one can just click on the colored plain grid. A 2-d vector is then pop from the tap action which we convert into vector3 that provides the real position where the furniture is going to be located. Once the furniture has been processed, the user can sight the furniture from various angles. Besides this, the user can move the furniture by using touch gestures. The furniture can be slided to move it around the frame. The user can use pinch gestures to rotate the furniture. The app provides variations of tap actions to remove or select the rendered furniture.

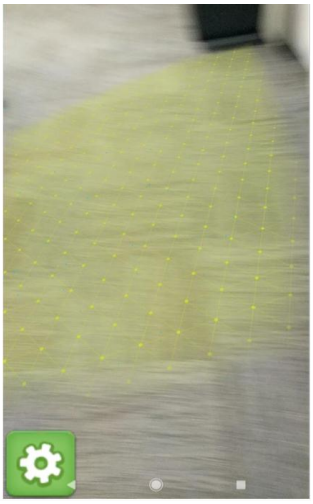

Fig-5: Menu Invoking Gear

7.2 Backend Development

As we are using MVC architecture, there is separation of concern. Frontend and Backend are loosely coupled which allows us to make improvements to either stack without affecting the other. As of now, backend logic primarily consists following components:

7.3 Interface to Local Storage

This stage predominantly concerned with 3D models and it's storage. It gets data request from the controller concerning 3D models. It helps exporting the 3D model from local storage to augmented reality environment. Besides this, it is used to store the snapshots of the augmented reality environment.

7.4 Input Controller

It can be seen as the mediator between the UI and the backend logic. Its main task is to control the UI steps and trigger results in the backend. This phase is responsible for finding gestures for rotating, moving the 3D models in the environment. It also contains logic for address conversion.

7.5 Demonstration results of the Application

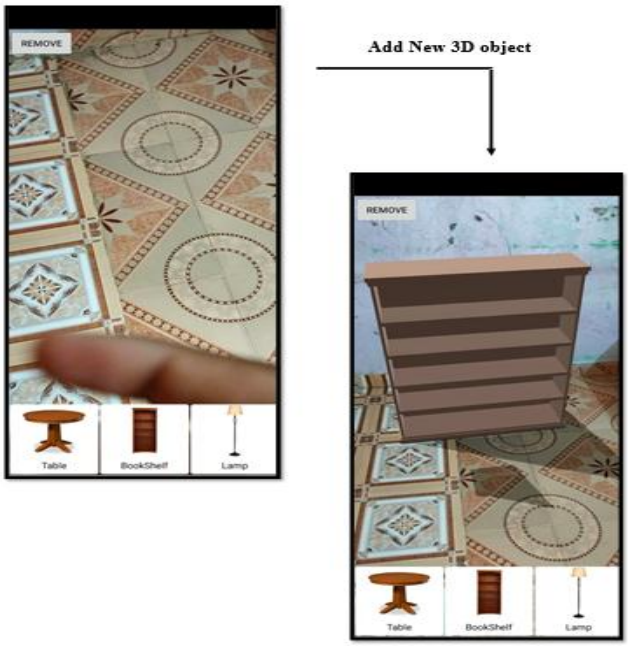

Fig-6: List of Available Furniture

Fig-7: Application rendering multiple furniture

Fig-8: Manipulation of augmented furniture

8. CHALLENGES

Vertical Plane recognition along with horizontal Plane recognition is a challenge. Implementing both of the aspects alter- natively in the system as separate features will allow user to specifically perform visualization of various features of interior design separately and depict a clean implementation. Features like placing furniture, visualization various interior design plans, patterns, ceiling designs, light lamps and so on will help user enhance their understanding and design of their home structure.

Operation system versions being an addition to that . Hardware support like minimal required RAM and processor are a must to obtain augmented reality support . Difference is operating systems like Android and iOS is also a major concern. Other limiting factor is the availability of 3D assets on a large scale along with good quality and small size of the assests. Performance constraints due to the lack of quality of assets can lead to the failure of the whole application. Scaling the application to variety of customers and their adaption to the new ways of visualization can cause some other limitations. Rendering an AR experience utilizes too much power. We've have achieved a lot when it comes to miniaturized processors and graphics cards, but we're still not able to match the level we require to make high-end everyday AR and reality Computing generates a lot of heat. Basically, the more power used, the more heat that gets generated, and the smaller the device, the slower it gets rid of that heat. Rendering an AR scene is complex process.

That heat generated in turn can slow down processors. In AR, all things exist primarily in three dimensions , but its an misconception to sat that Augmented reality has to 3D but the majority of data assets , application and experiences will need at least a little 3D designing knowledge somewhere in our project. Currently the base of people with graphic development skill is still limited. Giving computers the ability to recognize the full catalog of earthly objects at any time of day and segment them into useful groups, just isn't something we've completely pulled off yet. Successful registration needs an accurate tracking system which mainly depends on various sensors integrated in AR system [6]. Camera is the most functional and flexible one. Combining with vision-based computational technologies, such as graphic recognition algorithms, camera- based registration is potentially competent for any AR application. Another difficulty is that marker-less registration has a high requirement of computational resources performance which mainly indicates hardware performance.

9. SOCIAL IMPACTS AND FUTURE DIRECTIONS

In the upcoming trends, we hope the furniture firms will make the 3D models of their appliances (in actual lengths) and make them easily accessible to their customers . Our tool may serve as a part of the app, which automatically suggests the suitable furniture (types and styles) and render the outcome in combination with the real scene. We believe that it eases people's lives a lot. As future work, we will also allow user to import self-designed furniture or collaborate with furniture sellers such as IKEA to enrich the furniture model database. We intend to merge photogrammetry to our present application which will permit us to reform a 3D prototype of furniture from images. We plan to network the product to a cloud repository from which a client could download furniture models and implant it during execution.

10. CONCLUSION

In an AR environment, visualizing 3D objects could be convenient and easy while saving costs by completely lowering the risk of product returns. In this study, we examined how a marker-less AR could be used for interior design. We proposed a mobile application that enables users to visualize home decoration objects in reality.

In this AR environment, the user is able to adjust the properties of virtual furniture and create its own arrangements in the real world. Through the mobile camera the user can detect the plan surface and select the furniture through the application and place it on the screen. Further this mobile application can be integrated with Artificial intelligence to enhance the user's imagination and give an animated experience in real-time environment. As a design solution, this application can help cut the prototyping costs and help simulate a better experience for the customer. It also enables the customer to be

the designer themselves and make their home as they want it to be. It also helps them to set a theme in the house and get a feel of it before placing an order. This application will also prove beneficial to the companies for advertisement purpose.

Thus, this system can overcome the following shortcomings:

a) Difficult to fulfil the customer's content to design their room without actual image of the finished room.

b) Catalogues don't provide all the possible views of the furniture.

c) Difficulty in visualizing the furnished space.

d) Constraint in the number of furniture that can be displayed in shop.

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