

Using Augmented Reality Development of 3D Model from 2D Architectural Plan

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Abstract

Augmented Reality (AR) turns the environment around you into a digital interface by placing virtual objects in the real world, in real-time. AR can be seen through a wide variety of experiences such as gaming applications, AR browsers, etc. AR adds computerized components to a live view by utilizing the camera on a cell phone. In contrast to Virtual Reality (VR), AR doesn't make the entire artificial situations to supplant genuine with a virtual one. AR shows up in direct perspective on an existing condition and includes sounds, recordings, and illustrations to it. A view of the physical certifiable condition with superimposed computer created pictures, therefore changing the impression of the truth, is the AR. AR is currently used to help visualize objects that aren't in the room and to create immersive brand experiences that engage consumers on another level. In this survey we propose a system for conversion of 2D architectural floor plans to 3D models using Augmented Reality. This will give the user an interactive and enhanced virtual experience to understand the floor plan.

Keywords— Augmented Reality (AR), Floor Plan, Indoor, 3D Interaction, Navigation, Mobile Device, Unity.

I. INTRODUCTION

AR is one of the most popular technology that has been currently used in real estate. The field of AR has existed for just over one decade, but the growth and progress in the past few years has been remarkable. In 1997, the principal creator distributed a survey[3] (based on a 1995 SIGGRAPH course address) that characterized the field, depicted numerous issues, and summed up the improvements up to that point. Since then, the field has grown rapidly. In the late 1990's, several conferences specializing in this area were started, including the International Workshop and Symposium on AR [29], the International Symposium on Mixed Reality [30], and the Designing AR Environments workshop. Some all-around supported interdisciplinary consortia were framed that centred around AR, outstandingly the Mixed Reality Systems Laboratory[50] in Japan and Project ARVIKIT [61] in Germany. A freely available software toolkit (AR TOOLKIT/UNITY) for rapidly Building AR applications is now available [2]. Because of this wealth of new developments, an updated survey is needed to guide and encourage further research in this exciting area.

The review won't endeavor to reference each new paper that has showed up since the first study; there are excessively numerous new papers. Rather, we reference agent instances of the new advances.

What is AR? The essential objective of an AR framework is to upgrade the client's view of and connection with this present reality through enhancing this present reality with 3D virtual articles that seem to coincide in a similar space as this present reality. Numerous ongoing papers widen the meaning of AR past this vision, however in the soul of the first study, we characterize.

AR systems to share the following properties:

- 1) Blends genuine and virtual, in a genuine situation
- 2) Real-time intuitive
- 3) Registered in 3D

Registration alludes to the exact arrangement of genuine and virtual articles. Without precise enrollment, the fantasy that the virtual articles exist in the genuine condition is seriously undermined. Enrollment is a troublesome issue and a subject of proceeding with inquire about. Making such an Augmented domain model requires a few pros and exceptionally asset devouring programming, for example, SketchUp, 3ds Max, Blender, and so on.

AR is the innovation that extends our physical world, including layers of advanced data onto it. Not at all like Virtual Reality(VR), AR doesn't make the entire fake conditions to supplant genuine with a virtual one. AR shows up in direct perspective on a current domain and includes sounds, recordings, and illustrations to it. A perspective on the physical certifiable condition with superimposed PC created pictures, along these lines changing the view of the truth, is the AR.

The term itself was instituted in 1990, and one of the principal business utilizes were in TV and military. With the ascent of the Internet and cell phones, AR revealed its subsequent wave and these days is for the most part identified with the intuitive idea. 3D models are legitimately anticipated onto physical things or utilized together progressively, different increased reality applications sway our propensities, public activity, and media outlets.

AR technologies enhance our perception and help us to see, hear, and feel our environments in new and enriched ways. AR technologies are capable of applying various AR services. Many AR applications are developed by the visual markers which are some pictures of patterns in place of AR Tool Kit markers.

To achieve this, few software and frameworks are required which are developed dedicatedly for AR development. These software are explained in brief-

Unity is a cross-platform game engine. It was developed by Unity Technologies. This project will use Unity as an important development platform. With the help of Unity 3D engine, users can develop their own games. They can also create a virtual world for various applications, or remake a real world entity in the virtual one. This project emphasizes on the remaking of real world objects such as 3D remake of an apartment.

Vuforia AR SDK is an augmented reality software development kit for mobile devices that enables the creation of augmented reality applications. Vuforia AR SDK provides a framework to create markers that will help identifying each marker that this project is going to implement.

Autodesk Maya, commonly shortened to simply Maya, is a 3D PC illustrations application. Using Maya users can create 3D models. This project will use Maya to create the required 3D models of the architectural plans. All the present entities are going to be rendered in this software such as walls, chairs, tables, beds, etc. All of these components will be incorporated into one android application that makes

use of all the components mentioned above. A definitive objective of enlarged the truth is to make a helpful and characteristic inundation, so a sense telephones and tablets will get supplanted, however it isn't clear what those substitutions will be.

In this paper we have proposed a system to create a real world application by rendering 2D plan to 3D that provides a realistic interior architecture of the property by using free and lightweight software: 3D Model and Unity. The end result will be mainly based on image processing and augmented reality technologies. This Application will enable users to easily review 3D model in real-time through their smartphones. For any architectural developer, it is crucial to have a demo flat or building ready. This demo flat gives an idea to the customer as to what they would be purchasing & how their flat would feel like in appearance & the arrangement of furniture is harder to imagine. Hence, we aim to develop an AR system which would enable the architects or building developer to provide a much richer experience. This saves the cost of preparing a demo flat to please the customer. The mobility and convenience of mobile AR system make a good first impression on the customer.

To achieve this, we have taken precise measurements of an institutional floor which will be transferred onto the 3D modelling system. The idea behind this, is to provide an accurate model of the architectural plan. The user does not need any expertise of architecture or civil engineering domain to use the application. Our motivation here is to increase the time efficiency and additionally improve the accessibility of different models of architectural plans and improve the resolution of 3D models. This will enhance the perceptual experience of the user making it easier to understand the floor plan.

This paper emphasizes on the application of AR for conversion of 2D architectural floor plans to 3D models. This paper is paper organized as: Section I introduces the domain of AR and also the framework and software's required for its implementation. In Section II the existing work has been summarized. Moreover the background of AR has been discussed. Section III contains the proposed architecture of the AR application with its specified objectives. Also the system architecture with the flow of process has been mentioned. Section IV concludes this survey.

II. RELATED WORK

There have been many studies, which each has its own strength and weakness, regarding interior architectural design in AR and VR environment. Deaky and Parv [1] made a virtual interior architecture model of a real estate-purposed house in Unity 3D game engine in order to save property sellers' and buyers' time and money. Their interactive 360° VR application works on various HMD (Head-Mounted Display) devices such as Google Cardboard and Oculus Rift. . Despite the fact that, they have accomplished a reasonable intelligent condition, there is no data with respect to whether the product they used is free or lightweight. In the following paper [2] surveyor has created an Augmented Reality (AR) and VR applications to present interior and exterior architectural projects. The user can interactively observe 360° spherical panoramic images of the model by using AR and VR devices. The users can only navigate on a set of predefined paths in the indoor environment. It aims to demonstrate contemporary approach in traditional architectural project presentation using mobile devices and methods of Virtual and Augmented Reality. This approach enables the spatial presentation of the 3D model within the real environment. Authors Siltanen and Oksman [3] developed an AR interior home planner for different target user groups. User can insert, move and remove virtual furniture in a physical room through a mobile device with camera. They aimed to provide a design concept of an interior house to these target groups. In this paper Mudliyar et.al [4] created a simple virtual reality system using

OpenGL to visualize indoor environment for design in VR. This paper tries to develop a platform for designers to explore the tremendous world of virtual reality and provide the clients with realistic view of the real world. This paper describes a system that aims at bringing the home tactics in life in a stunning 3-D. It will place you in unlimited oversight of how the 3D object of 2D that focuses on bringing the home strategies in life in a shocking 3-D. It will place you in full oversight of how the 3D object of 2D object is made. It transforms your cell phone into a computer generated simulation condition as it pushes the constraints of the 3D motor.

Xiao Yu et.al [5] in the following survey presents an interactive VR indoor environment for real-estate by using 3DS MAX for modelling and Virtools for interaction. Even if the users can modify the walls and probes, and turn on/off the lights in a room, the application was made in paid and highly resource consuming software. In paper [6] Vosinakis et.al presented web-based interactive application in which non-expert users select furniture and decorate elements, and try various arrangements in a room. To reduce the loading duration since it is a web-based application, their system only allows users to manipulate low-poly objects in one single room. In this research project the author has used Web-based interior design concepts with the help of concept sketches and scenarios of fictitious future service. The imaginary, portrayed help empowers normal individuals to design easily the outfitting and enrichment of their properties utilizing novel innovations, for example, enlarged reality. The proposed methodology emphasizes in the usability of the environment especially for inexperienced users and aims to increase user performance in the process of modelling an interior environment, selecting furniture and decoration elements, and trying out various arrangements. The paper also presented a prototype implementation of the proposed methodology. Shaoliang Qi et.al [7] created a semi-interactive virtual interior design of a house by using 3ds MAX and VRML to allow users observing indoor environment. In this paper VRML and Java have been used to discuss the virtual interior design. EAI (External Authoring Interface) and JASI are used to realize the interaction between user and virtual interior scene. His application is not completely interactive since passing from one room to another one is done by selecting the room name from a list displayed on the screen. In addition, the application was developed in commercial and heavyweight software.

In this paper, Kai-Yi Chin et. al. [14] explored a new and improved method of tourist place guidance system. This system introduced the AR technology for replication of historic building. Along with replication, they also provided an informative representation of the 3D models of the historic buildings. The representation included the information of a particular site with the help of AR and the real world. Dwi Ely Kurniawan et.al[15] have applied the AR innovation as a visit control on Batam Island utilizing 3D objects. They have accomplished this by utilizing the strategy “Marker Based Tracking” objects are put in the scene using Unity and Vuforia. The marker-based following technique utilizes a picture as a marker that has an exceptional example with the goal that the marker can be identified. They have likewise done some related investigation on the examination cum premise of various portable increased reality applications. In paper [9] the author has investigated an as good as ever strategy for visitor place direction framework. This framework presented the AR innovation for replication of memorable structure. Alongside replication, they additionally gave an enlightening portrayal of the 3D models of the notable structures. The portrayal incorporated the data of a specific site with the assistance of AR and this present reality.

Author Kosin Kalarat et.al [16] explains on the formation of reality in reality. Vuforia SDK is utilized for formation of mapping the 3D models in genuine world. Relief Mapping is utilized to defeat the confinements of hand held gadgets. The marker based following technique is utilized to speak to the 3D model of working in compelling manner. This is utilized to speak to 3D models in manufactured

way and it overlays the virtual models on the real 2D framework of floor plans. R.G. N. Ruwanthika et.al [17] acquaints an all-out path with manage amazing 3D model advancement from 2D house plans. This gadget stores up 3D models and overlays virtual model on the authentic 2D diagram of a house (basic or hand-drawn). Key substance of this assessment covers three estimations which are; Wall recognizable proof and Wall illustrating, Roof revelation and Roof showing and Template Coordinating of Doors/Windows. The last item will be generally subject to Image Processing and Augmented Reality advancements. This paper [8] surveys the field of augmented reality (AR), in which 3D virtual objects are integrated into a 3D real environment in real time. It describes the manufacturing, medical, visualization, path planning, entertainment, and military applications that have been explored. Two of the biggest problems in building effective AR systems are registration and sensing errors, so this paper briefs about the current efforts to overcome these problems. Areas requiring further research are also discussed. This survey provides an initiating point for those interested in researching or using AR technology. In this paper Ralph Schoenfelder et.al [18] underscores on the utilization of AR for mechanical structure acknowledgment. It additionally presents the gadget AR PLANAR and other AR frameworks. The application and execution of ARBA are appeared. Utilizing the AR planar we can look at this present reality and virtual models and confirm whether the structure satisfy its ideal utilitarian necessities. It can likewise pass judgment on the distinctions and state them precisely.

There have been many literature studies about VR applications that visualize the indoor environment of a construction. However, they either lack the interaction sufficiently, or are designed in commercial and heavy weight software, or do not present realistic 3D view. Our application was developed in completely free, user-friendly and lightweight software as fully 3D interactive real-time AR application.

Table No. 1

PAPER	TOOLS			OBSERVATION
	UNITY 3D	VUFORIA	AUTODESK MAYA	
[1]	YES	NO	NO	VR application has been developed to serve the purpose.
2	YES	YES	NO	VR and AR tools have been mentioned.
3	NO	NO	NO	Both VR and AR devices and the applications, no executed systems have been studied.
4	NO	NO	NO	Interior Designing application has been developed using VR.
5	NO	NO	NO	VR indoor environment for real-estate by using 3DS MAX for modelling and Virtools for interaction.
6	NO	NO	NO	A semi-interactive application has been created for interior designing using 3Ds MAX and VRML.
7	NO	NO	NO	Application that can be used for manipulation of objects. Java 3d API and VRML has been used for development of this application.
8	NO	NO	NO	Tools used for the implementation of the system have not been discussed.

9	YES	YES	NO	Marker based detection technique has been studied which are essential for the development of the proposed system.
10	NO	YES	NO	The marker based tracking method is used to represent the 3D model of building in effective way.
11	NO	NO	NO	The techniques of roof detection, wall detection, etc. required for development of the proposed system.
12	NO	NO	NO	It emphasizes on the application of AR for industrial building development.

III. PROPOSED SYSTEM

System Architecture

This figure (1.1) explains the architecture of our system. The system architecture provides an insight of how the flow of process will be. Entire process of how the system will move forward that will generate the end-result is depicted.

The figure below shows the architecture of the proposed system. As per the User's perspective, the User will open the developed application on mobile. Users will have to open a camera through developed application and the model list will be popped up. From the Model list, Users can select any model to superimpose.

Using the marker scanner in the developed system, it can detect the markers placed in the image to show the 3D model. It represents the 3D model, on the detected markers. Superimposing virtual objects in real rooms. We can view the model from various angles through a camera. After scanning the image, the Superimposing of 3D architectural plan is shown to the user.

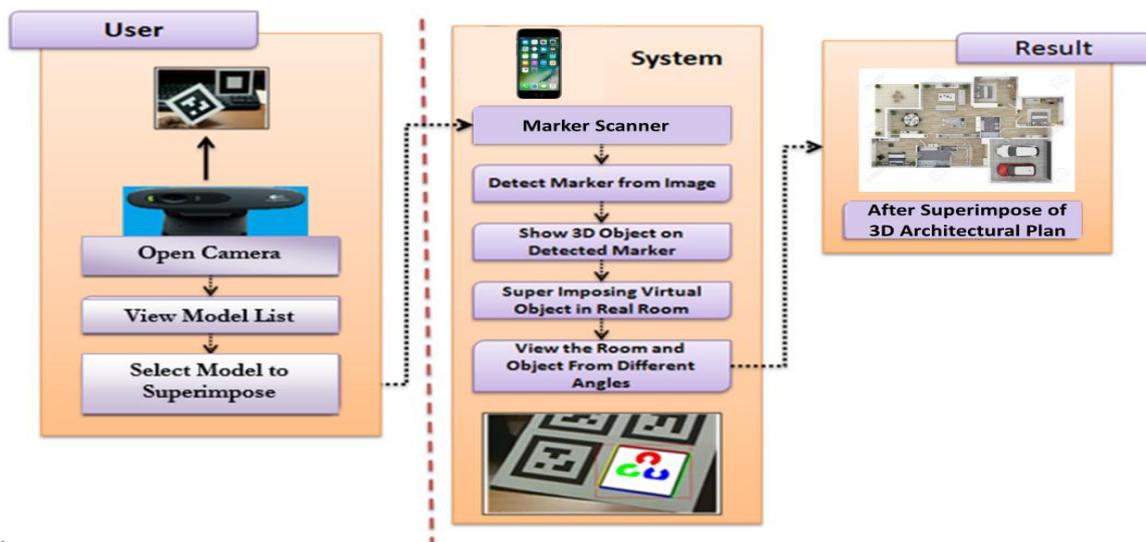


Fig. 1. System Architecture

To create 3D AR Model (Floor Plan), we have used free and light- weight software.

Creating 3D models using 2D interface

We have used Google SketchUp design software. This free software with its simple split screen 2D/3D views one can draw walls and room in 2D window, and simultaneously visualize them in 3D view (Figure 1). It also lets unexperienced first-time users tap on the 3D object to easily change the texture, color or material so it matches user's design. In addition, the user can pick and drop objects onto the 2D design. And not only that, they can drag the objects to desired place in the design.

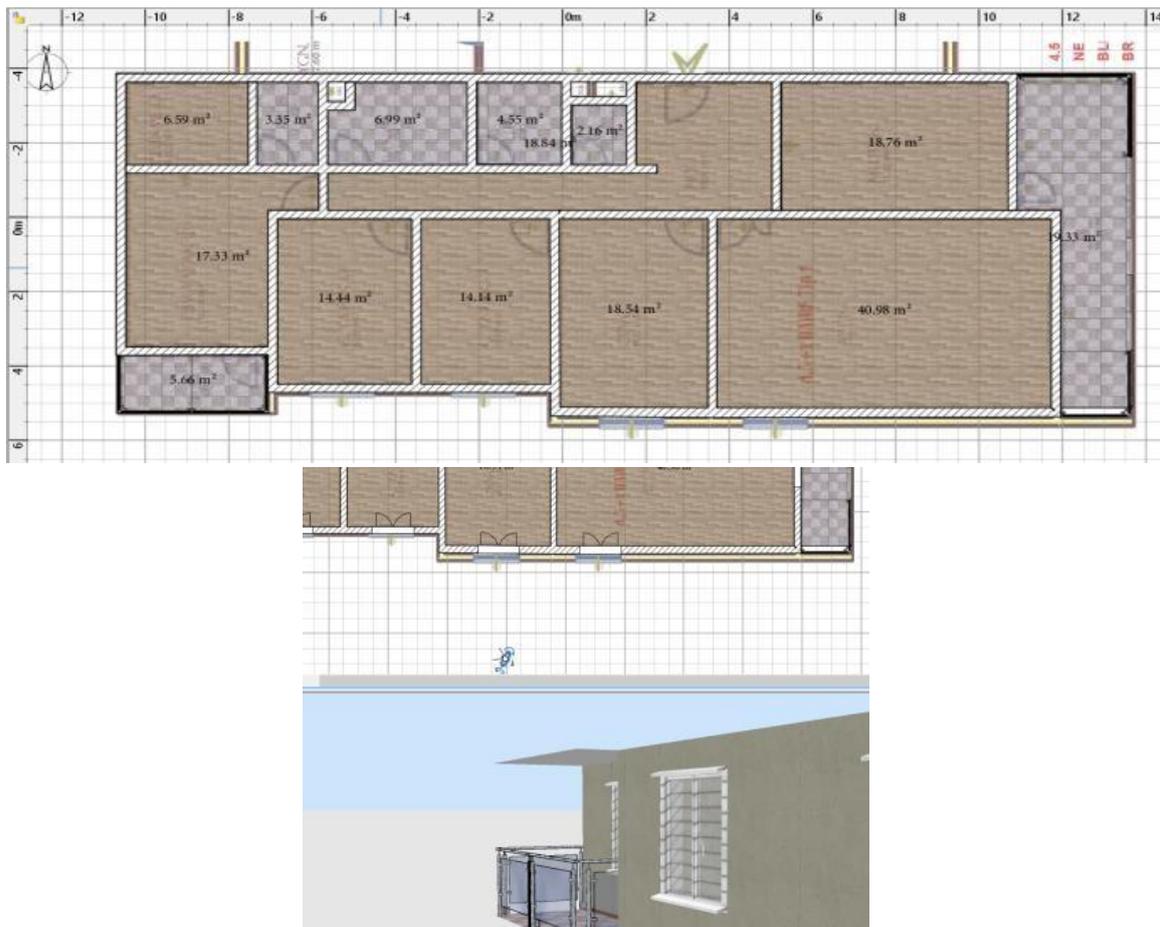


Fig. 2. 2D floor plan (upper), and its 3D view with split screen in SketchUp 3D. (Bottom)

Creating Interactive and Realistic 3D Environment

Unity 3D is a cross-platform free game engine and is designed to be as user friendly as possible for novices. It basically lets us to create a realistic 3D environment as well as to build an interactive content. There is a set of steps given below to create such environment.

Steps:

1. Scaling the model that made with SketchUp 3D and importing it to unity 3D.
2. Applying High Definition textures onto the interior models so that they can have a realistic view.

3. Using simple shading application for creating diffuse, normal and ambient occlusion maps to create realistic 3D textures.
4. Creating Vuforia account for target (Floor Plan) mapping for 3D model.
5. Implementing accurate system so that user can move their devices from one room (same plan) to another room (same plan) easily without any interrupt.
6. Setting package dependencies for android.
7. Finally, export .apk file from unity and install on your mobile device.

Here,



IV. CONCLUSION

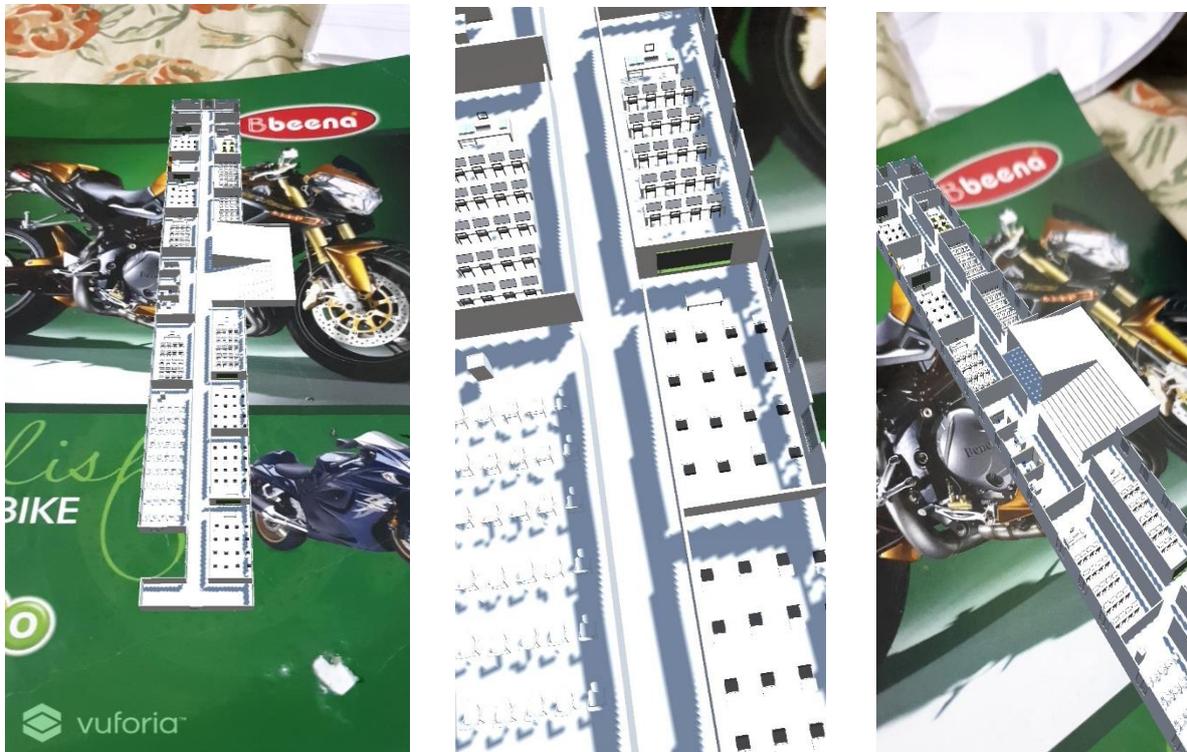
It is difficult to visualize and imagine the design of college, house, etc. by just look at the floor plan blueprint for ordinary people. The main purpose of this system is to develop an application, that presents floor or architectural plans virtually without using the actual means which are incredibly exhaustive and time-consuming activities. The major problem faced by the clients is “Unavailability of an app that is made for clients which can build the 3D model on top of an architectural plan. Moreover, an Interior Management Augmented. Augmented Reality App that can overlay digital content i.e., images onto physical objects or locations, and it is typically works by using camera module of an electronic device such as a smartphone or a tablet. Proposed AR App work on high rate of model mapping and accuracy using Unity and Vuforia SDK. This system provides a 3D view of the 2D architectural floor plan with the help of augmented reality. The system will create 3D models in real-time, providing an interactive experience to the users. It aids the process of conversion of 2D plans to 3D plans without any human assistance to make the process fast and efficient.

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RESULTS



DISCUSSION

As seen from the images above, the results are obtained in VR. The targetted plan is generated on top of an image which is used as ImageTarget for the 3D architectural plan. Different views of the 3D model can be obtained by moving the phone camera in various directions and angles. Various objects such as furniture, computers, etc. can be seen when the phone camera is brought closer to the ImageTarget.