Journal of Physics: Conference Series

PAPER • OPEN ACCESS

# Augmented Reality Virtual House Model Using ARCore Technology Based on Android

To cite this article: M F Syahputra *et al* 2020 *J. Phys.: Conf. Ser.* **1566** 012018

# Augmented Reality Virtual House Model Using ARCore Technology Based on Android

**M F Syahputra[1*], F Hardywantara[1*] and U Andayani[1*]**

[1] Department of Information Technology, Faculty of Computer Science and Information Technology, Universitas Sumatera Utara, Medan, Indonesia.

*Email: nca.fadly@usu.ac.id, felixhdyww@gmail.com, ulfi.andayani@usu.ac.id

**Abstract.** Scale model is a necessary building design in architecture as a way for architects to represent the results of the design as a physical model. The making of scale model requires components that costs some money. With the development of Augmented Reality (AR) technology, designer could bring the model design without having to make a scale model through marker tracking on a brochure. However, with the development of the technology itself, the researcher applies an AR method that can put an object in real environment by detecting flat surfaces. The method is Markerless AR. With this method, the use of marker tracking which requires a marker to remain on the frame of the camera is no longer needed. The technique in the new method will use plane detection that can detect flat surfaces by specifying points on the textures of the frame which is captured by the camera. The necessary stage is to define point cloud that will be used to mark the textures and the plane as a place to put the model in the form of virtual object. Object placed above the plane will remain stable despite having the camera moves around it, the plane will not move around because it is a result of virtual projections. The result of using plane detection will provide a space for the user to observe the model more clearly, such as on a floor or on a table because the model can be rescaled and rotated. Users also can move freely without being hindered by the marker tracking.

## 1. Introduction

In the field of architecture, scale model is the most important thing to do for architect to present the result of the design. In Indonesia, many use computer technology to create building designs. In particular, the design of 3-dimensional object is used to display the design in the form of augmented reality as a substitute for scale model in general.

The method of marker-based in augmented reality uses a marker and then is implemented to display 3-dimensional buildings that has been previously designed (Abboud, 2014) [1]. In Indonesia, this method is often used to display 3-dimensional building objects on a brochure as the marker. The current most developed method is markerless augmented reality. This method can be used to display the 3-dimensional design without having to use the marker so that the design can be placed in different locations (Kote et al., 2014) [4]. The use of markerless AR in presenting 3-dimensional models in Indonesia has been done before with an apartment model, the users can observe and read the information about the apartment before deciding to purchase it. (Lenurra et al., 2017) [5].

The usual obstacle with the marker-based method is marker-based needs a marker that must remain within the range of the camera. While the markerless method is unstable and often gives wrong positions against the real environment. When the camera moves to a different position, the markerless AR objects sometimes also move as they are unstable. To solve this issue, it is necessary to make an application that can display 3-dimensional building models in real-life environment, for example in a room or a field by using a new method that can detect floor textures so that the model can be placed directly in front of the user and will remain stable even if the user moves around it. The technology used in this application is ARCore which is a markerless native developed by Google.

ARCore can be used to detect flat surface such as floors and tables. The virtual object placed in the flat surface is given an anchor that is used to mark the position of the object against the surrounding environment by utilizing the tools available on the user's smartphone, in this case the Android.

Research using augmented reality to produce 3-dimensional objects has already been done before by (Febrian et al., 2015) [3]. His research uses more than 2 markers to produce the components commonly used in making a scale model. In 2017, Ferry Lenurra [5] implemented markerless AR to replace 2-dimensional image visualization as a promotional media for his building model. The markerless AR implemented in his research used brochures to attract customers. In his research, (Rinaldi et al., 2017) [8] visualized home models using brochures to made it more interesting, easy to understand and interactive. Brochures that have markers are tracked by the camera and will display house models along with the house plans.

## 2. Problem identification

The use of marker on augmented reality has limitations and less interactive. The Marker must remain within the range of the camera so the user is not able to move freely. To provide a more interactive system for the users, it is required to use a new method that can display multiple objects at once, can detect flat surface for real-life experience and can present features that cannot yet be done in the previous method of displaying 3-dimensional objects in augmented reality.

## 3. Previous research

In 2014, Rana Abboud [1] did a research on architecture by implementing augmented reality (AR) in it. He mentioned that the potential use of AR in architecture is very large, and by applying AR, information can be added inside. In his research, Rana focused his topic on Mobile Augmented Reality (MAR).
In 2013, Eric McClean [6] from National University of Ireland Maynooth created an AR system for an urban environment using planar building façade. Eric utilized AR to detect the building and then extract the schema of the building. The schema is then added augmented image so that additional information can be embedded in the building.

In 2017, Milovanovic et al. [7] used virtual and augmented reality in architectural design, his aim is to assist the architectural field in creating a more immersive building design than the design in general. Another research is markerless AR in architecture by (Sato et al., 2016) [9] titled “A Markerless Augmented Reality System Using Image Processing Techniques for Architecture and Urban Environment”. The research can determine the shape of buildings based on different viewpoints and can obtain the information used to perform the reconstruction of buildings that save cost and time. The established environment is an urban area so there are several buildings that meet the criteria.

In 2017, augmented reality implementation in displaying 3D model of Sultan Deli has been done by (Syahputra et al., 2017) [10]. The method used is marker-based which is placed close to the historical objects in Maimoon Palace.

In the same year (Rinaldi et al., 2017) [8] used marker-based method to visualize house models using brochures to made it more interesting, easy to understand and interactive. Brochures that have markers are tracked by the camera and will display house models along with the house plans.

## 4. Methodology

To display virtual objects that can be placed on a flat surface, there are several steps to be done, namely to define feature points and estimate position and orientation, then use anchors and trackables. As for the general architecture used to describe the stages of the method on this research is shown in Figure 1.

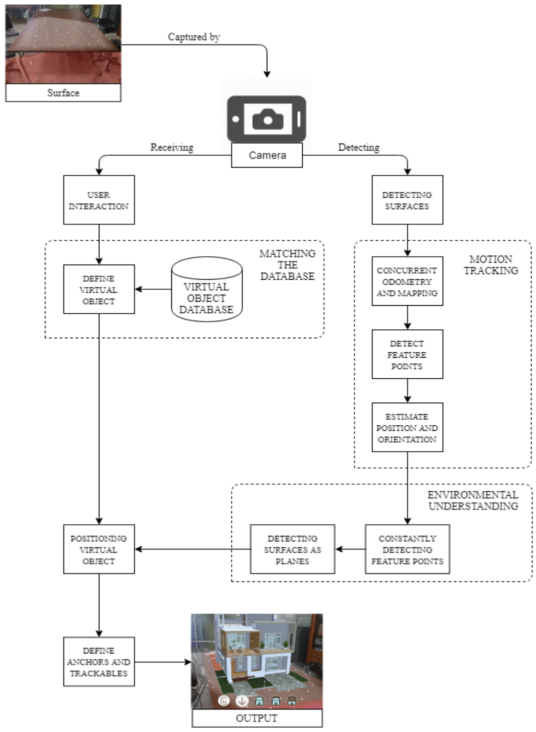


**Figure 1.** General Architecture.

The general architecture in this research is divided into 3 parts namely input, process and output.

### *4.1. Input*

The user must specify a flat surface that will then be detected by the system and display virtual objects over the detected surface. The flat surface is in the form of floor, desks and other surfaces.

### *4.2. Process*

*4.2.1. Detecting surfaces.* This stage takes a flat surface captured by the camera and is then used to display the existing virtual objects in the application. This process detects textures on a flat surface by utilizing the distance of the camera to the texture.

*4.2.2. Motion tracking.* Along with detecting surfaces, the system performs a process called concurrent odometry and mapping (COM) and detecting the location of feature points. COM has the function to define the position of the camera and its surroundings then use the result of feature points detection to update the location of the camera continuously. The information obtained is then merged and measured through the Inertial Measurements Units (IMU) on smartphone to obtain the position and orientation of the camera relative to the real environment over time. With motion tracking, virtual objects can be observed from various camera angles.

a) Concurrent odometry and mapping

This stage is a process used to track real-world environments and build a 3-dimensional environment as a visual representation to be used for the next process.

b) Detect feature points

At this stage the camera detects the existing surfaces around and forms a visual point on objects captured by the camera such as carpet surfaces, desks, sofas and other objects. This point can be found a lot when the camera captures a variety of textures that can be used as feature points. This set of feature points will be used to form the planes that are used to place the virtual objects. To form this point that is called point cloud, the mesh renderer and shader settings can be seen in Figure 2.

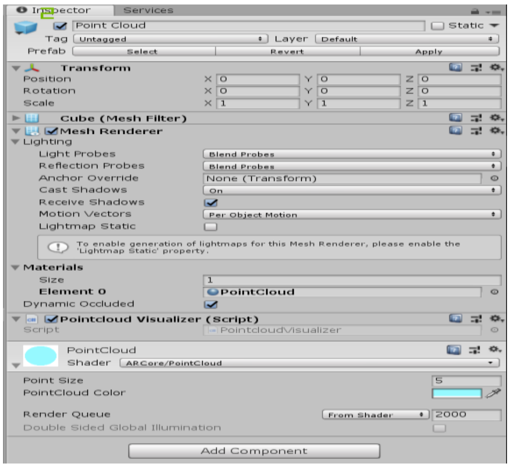


**Figure 2.** Point cloud settings.

c) Estimate position and orientation

In this stage, after forming a set of feature points, the system will combine the set with the Inertial Measurement Units (IMU) in a smartphone to achieve position estimation and orientation of the camera. IMU is an electronic tool that can measure angular levels by combining accelerometers and gyroscopes.

*4.2.3. Environmental understanding.* At the environmental understanding stage, the set of feature points that have been spread previously is transformed into planes and will be detected continuously following the camera. The planes are generated by using special materials and shaders that can adjust the size with the detected surfaces. The settings of the planes can be seen in Figure 3.

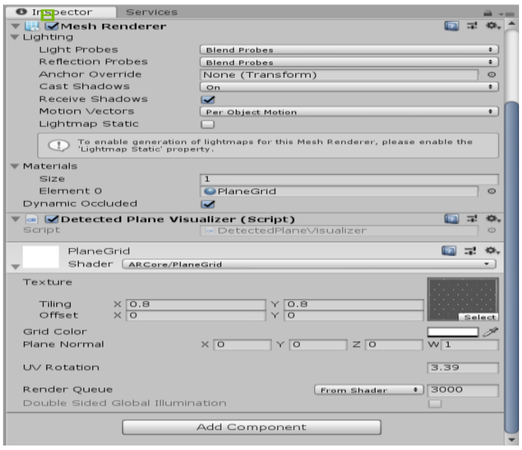


**Figure 3.** Plane settings.

Planes that have been formed will remain in their place even when the camera position is changed. Different surfaces such as tables or higher or lower surfaces will also be detected as planes with different shader colors to mark the difference of the planes.

*4.2.4. User interaction.* At this stage, the user can see a selection of virtual objects that will be displayed above the planes. Along with the process in previous stages, users will be able to use the features in user interaction when at least there is already a surface that is made into planes.

*4.2.5. Matching database.* Virtual object choices performed in previous stages will be checked for compliance with the database. The settings used to specify those objects can be seen in Figure 4.

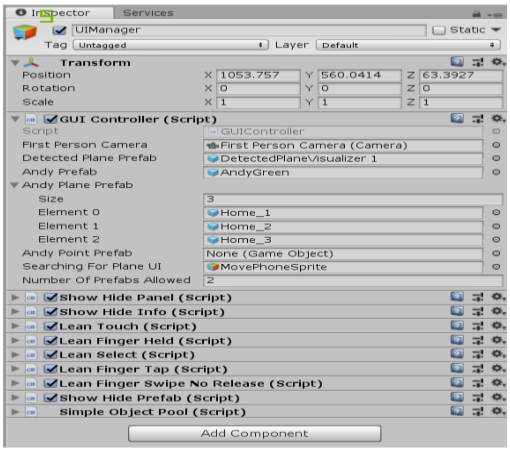


**Figure 4.** Virtual object database settings.

*4.2.6. Positioning virtual object.* At this stage, the object can be placed over the planes according to the selection of objects in the previous step.

*4.2.7. Anchors and trackables.* To ensure the position of the virtual object placed remains in the planes over time, an anchor must be specified when placing the object in a trackable. Its function is to mark the position where the object is placed to remain stable even if your smartphone or camera is moving here and there. Planes and feature points are trackable objects where virtual objects are placed.

### *4.3. Output*

The resulting output is a 3-dimensional augmented reality object that can be placed on different flat surfaces. Virtual objects can also be moved according to the detected planes, is rotatable, and can be rescaled for more detailed observing purposes.

## **5. Result and analysis**

### *5.1. Plane Detection Testing*

In this test, a plane detection test is performed to determine the accuracy of the resulting flat surface. Testing accuracy and stability in detecting a flat surface is done starting from the first time the application is run, the system will instruct the user to find flat surfaces around them. The testing is performed on the floors and tables. The distance needed to detect is 1 meter from the camera and the camera's altitude distance is 1.5 meters. Test result on the floor can be seen in Figure 5.

**Figure 5.** Plane testing on a floor.

Testing done on 2 different surfaces will provide different plane colors. Testing on the floor and table can be seen in Figure 6.

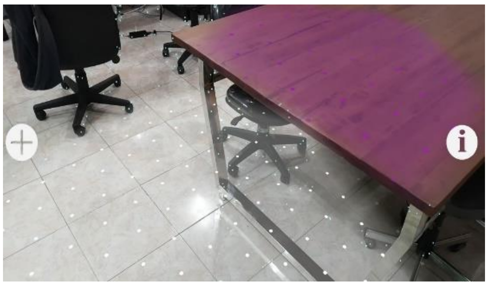

**Figure 6.** Plane testing on a floor and a table.

*5.2. Corner Detection and Wall Border Testing*

This test is done to find out if the application can restrict plane detection at a corner of a room and wall border. The result of plane testing in the room corner can be seen in Figure 7.

**Figure 7.** Room corner plane detection.

The result of plane testing in the corridor can be seen in Figure 8 and the test results of corner detection and wall border testing can be seen in Table 1.

**Figure 8.** Wall border detection on a corridor.

**Table 1.** Stability testing with different distances.

| Detection Type | Number of Test (n) | Accuracy of the Plane | Plane Desciption |
|---|---|---|---|
| Corner room | 10 | Accurate | Stable |
| Corridor | 10 | Accurate | Stable |
| Wall room | 10 | Accurate | Stable |
| Stairs border | 10 | Accurate | Stable |

### 5.3. Optimal Area of Plane Detection Testing

This test is done to know the optimal area of the resulting plane. The testings are conducted in several different areas, such as tables, rooms, and large courtyards. Test results can be seen in Figure 9 and Table 2.

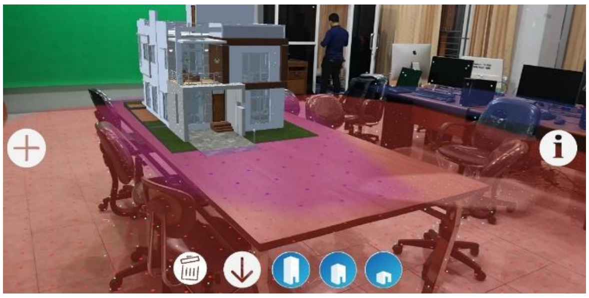

**Figure 9.** Optimal area testing on a room.

**Table 2.** Optimal area testing on several areas.

| Detection Type | Plane's Scale ($m^2$) | Android Performance | Plane Stability | Description |
|---|---|---|---|---|
| Table | 2 | Stable | Stable | Optimal |
| Floor | 20 | Stable | Stable | Optimal |
| Field 1 | 42 | Stable | Stable | Optimal |
| Field 2 | 100 | Stable | Stable | Optimal |
| Field 3 | 160 | Stable | Stable | Optimal |

The optimal area plane detection test for placing the object as can be seen in Table 2 delivers stable and optimal performances. The table detection type and room floor are using virtual objects with height size of under 2 meters, while on a large field using objects with height size above 2 meters for optimal results.

### 5.4. Point Cloud Testing

Cloud point testing is conducted to prove that cloud point detection requires textures to produce planes. The testing will be performed on areas with diverse textures and those with 1 color texture. Cloud point test results in areas with diverse textures can be seen in Figure 10.

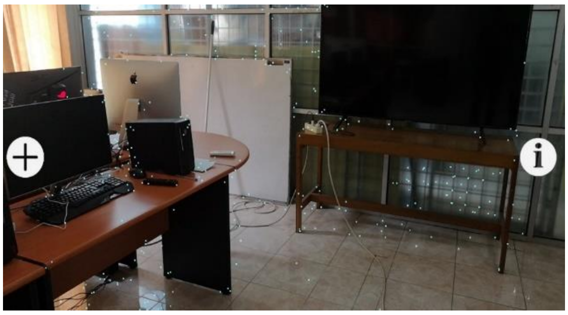

**Figure 10.** Point cloud on areas with diverse textures.

Tests on textures that are not diverse, such as a green colour texture can be seen in Figure 11.

**Figure 11.** Point cloud on areas with 1 color texture.

The test results in areas with diverse textures as can be seen in Figure 10 produce a lot of cloud points while areas with few textures as can be seen in Figure 11 will result in point cloud being hard to detect. Point cloud detection is affected by the intensity of light captured by the camera, with a dark light intensity, the texture will be difficult to detect by the camera so that the point cloud will also be difficult to produce as well. Point cloud testing with a dark light intensity condition can be seen in Figure 12.

**Figure 12.** Point cloud in a dark condition.

From tests done in a dark condition, point clouds can be partially detected, but the plane is difficult to generate and requires the camera to move around until the plane can be detected.

## 6. Conclusion

Based on the results of the system testing, there are several conclusions, such as; Plane detection can detect flat surfaces as expected, Point cloud can only clearly detect diverse textures and for textures that have a single color for example a white colour will be difficult to determine the point; In the case of a dark room, planes will be difficult to produce because point clouds can not detect the texture well in that condition.

## 7. Acknowledgement

This research was supported/partially supported by USU research institute. We thank our colleagues from University Sumatera Utara who provided insight and expertise that greatly assisted the research, although they may not agree with all of the interpretations/conclusions of this paper.

## References

[1] R. Abboud, "Architecture in an Age of Augmented Reality: Oppotunities and Obstacles for Mobile AR in Design, Construction, and Post-Completion," 2014.

[2] R. Azuma, "A Survey of Augmented Reality," Teleoperators and Virtual Environments, pp. 6: 355-385, 1997.

[3] S. Febrian, Liliana and K. Gunadi, "Implementasi Pengenalan Multiple Marker untuk Sistem Augmented Reality," Universitas Kristen Petra.

[4] S. Kote and B. Borkar, "A Survey on Marker-less Augmented Reality," International Journal of Engineering Trends and Technology (IJETT) – Volume 10 Number 13, 2014, p. 640, 2014.

[5] F. Lenurra and D. Pratiwi, "Penerapan Teknologi Augmented Reality Sebagai Media Promosi Apartemen Dengan Metode Markerless," Seminar Nasional Cendekiawan, Grafika komputer, Teknik Informatika, Universitas Trisakti., 2017.

[6] E. McClean, "An Augmented Reality System for Urban Environments using a Planar Building Facade Model," National University of Ireland Maynooth, Department of Computer Science, p. 72, 2013.

[7] J. Milovanovic, G. Moreau, D. Siret and F. Miguet, "Virtual and Augmented Reality in Architectural Design and Education," An Immersive Multimodal Platform to Support Architectural Pedagogy. 17th International Conference, CAAD Futures 2017, 2017.

[8] M. Rinaldi, M. Syahputra, M. Muhctar, U. Andayani and R. Rahmat, "Visualization of Virtual House Model on Property Brochure Using Augmented Reality," Department of Information Technology, Faculty of Computer Science and Information Technology, Universitas Sumatera Utara, Medan, Indonesia, 2017.

[9] Y. Sato, T. Fukuda, N. Yabuki, T. Michikawa and A. Motamedi, "A Markerless Augmented Reality System Using Image Processing Techniques For Architecture and Urban Environment," The Association for Computer-Aided Architectural Design Research in Asia, 2016.

[10] M. F. Syahputra, N. P. Lumbantobing, B. Siregar, R. F. Rahmat and U. Andayani, "Implementation of Augmented Reality to Models Sultan Deli," Journal of Physics: Conference Series, Departement of Information Technology, Faculty of Computer Science and Information Technology, 2017.