

Application Of Augmented Reality Technology To Visualisation A 3d Apartment Market With Markeless Method

Elbriant Ramedhan, and Iman Herwidiana Kartowisastro

Abstract--- Augmented Reality (AR) is an environment that inserts 3D virtual objects into a real environment in real time. This research will incorporate AR technology into the Cibubur Apartemen Transpark catalog. The purpose of this research is to build a 3D image visualization process in apartment brochures as a more informative and communicative promotional media so that users can get information about virtual apartments. This application is an application that runs on the Android mobile platform, where the AR application requires streaming video taken from the camera as an input source, then this application will track and detect markers (markers) using the tracking system, after markers are detected, and make images on apartment marker catalog as if the apartment model is real. AR provides a more realistic interaction and is a progression of a promising technological method.

Keywords---- Android, Augmented Reality, 3D Design, 3DS Max, Markerless Method, Virtual, Unity.

1 INTRODUCTION

Augmented reality is an innovation from computer graphics that can present visualization and animation of an object model. Arend & Richard explain about research on augmented reality to develop real-time technology for digital content created by computers with the real world [1]. Augmented reality can allow users to see two-dimensional or three-dimensional virtual objects projected on the real world. The purpose of augmented reality technology is to take the real world as a basis by combining several virtual technologies and adding data so that the understanding of humans as users becomes increasingly clear. Real augmented reality is a system that is closer to the Realistic world, also called reality [2]. The use of augmented reality technology is also carried out in the field of investment in apartment buildings, making and visualizing 3D models in the process of making a digital building can increase visual perception of the physical appearance of buildings (Apartemen) which still uses the two dimenis catalog. Giving rise to more interesting visuals and details to be seen by potentialapartment customers who want to buy [3]. The development of augmented reality in the future is vital if described substantially, in some cases the development of AR can be categorized in several key areas that specialize in certain aspects of life such as you name it. Although still in the research and development stage.

Augmented Reality can now also be applied easily through a smartphone, by scanning one of the markers can be a card, which then through an application using a smartphone camera, we can visualize the various types of images contained in the apartment catalog which so far are still based on two dimensions. And all kinds of other objects are visually 3-dimensional. Not only limited to 3- dimensional visuals, augmented reality functions to combine the dimensions of the

real world with the dimensions of the virtual world, namely by bringing up 3- dimensional objects that are in the dimensions of the virtual world appear above the markers that are in the dimensions of the real world, so as if the 3-dimensional visual objects now in the real world dimension. The main advantage of augmented reality over virtual reality is that it is easier and cheaper to develop. Based on data from REI Association (Real Estate Indonesia) the development of residential property investment apartments or apartments in Indonesia continues to increase to 30 percent every year in big cities in Indonesia. The increasing value of investment property in Indonesia makes business people see it as an opportunity to earn profits, using various ways to market their properties, business people use promotions that offer very little interest or promotion in print and electronic media. However, the promotion is still using two-dimensional objects in the form of print media is a brochure, which has a limited point of view [4].



Fig. 1. Graph of the level sales of Apartemen

It can be concluded that Augmented Reality (AR) has become a booming technology from 2018, and will continue to grow. Coupled with the growth trajectory of the AR industry over the past few years, it is clear that will further strengthen its potential in the future. A few years ago (in 2014), there were around 200 thousand active augmented reality users. And increased to 90 million active users in 2017, and is projected to increase to 171 million users in 2018 (almost double that of 2017). Here is a graph of the growth of Statistic.

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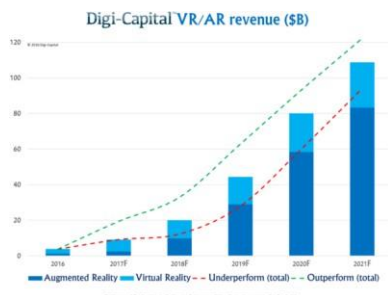


Fig. 2. Graph of the level increased use of AR

2 RELATED WORKS

Previously, many studies were conducted on augmented reality, in this case the authors conducted research on the application of augmented reality technology to visualize the 3D model mockups with markerless methods. In an effort to develop this Augmented Reality Technology, a literature study is conducted as one of the tools in applying research methods. Among them are avoiding plagiarism or reproduction, identifying methods that have been carried out, as well as knowing other people who specialize in the same research in this field [5]. According to Chiang et al, 2014, revealed in his research "that by utilizing AR technology as well, mockups / miniature houses commonly used to provide examples of homes can be replaced with 3D home models that are displayed virtually using an Android mobile device, so property entrepreneurs can save costs because they no longer need to make a miniature house and replace it with this AR home catalog application [6-7]. In this research, Muhammad Rifai used methodology, a prototype model. The stages in this prototype begin with Listen to Customer, Build / Revision, Customer Test-Drives Mock-up (Presman, 2001). This research uses the C # programming language and uses Unity & MonoDevelop tools, and the Android SDK. And making the library used is Vuforiaunity [6-7]. According to Kucuk et al, in his research said "With the help of AR technology (such as computational vision and object recognition) the real environment around us will be able to interact in digital (virtual) form In this research, using ARToolKit is an open-source tracking system library that allows programmers to easily develop Augmented Reality applications [8]. By using fiducial markers. It is a marker that consists of a collection of reference points to facilitate the computation of the measurement of its parameters [8-10].

Tsai said in his research "AR as an appropriate tool to help users interact and perceive or understand the real world. Information displayed by virtual objects helps users carry out activities in the real world" [11]. In this study, Chaerul Hamdah, used quantitative research methods. This research is a research method that seeks to describe and interpret the object. According to Hao et al says using the Augmented Reality technique created using ARTool Kit as a component created using 3DS Max as its main software [12]. To be able to produce good and interesting images. The process of designing and manufacturing this promotional technique, will use the waterfall method According to Bacca et al, utilization of technology began to develop from time to time, just imagine from the past can only listen to the sound over the radio, then develop with the presence of television even if only 2 colors, now it has changed into the hey day of portable technology such as smartphones [13-15]. Therefore the writer wants to make a research to develop an augmented reality so

consumers who buy property apartments can more easily process visualization [13-15].

3 RESEARCH METHODOLOGY

This research was made based on needs as depicted in Figure 2. Figure 2 shows the development of Augmented Reality technology that continues to develop from the last year. That can be sustained Augmented Reality technology can later assist the visualization process of customers who want to see more real and details assembled from the apartment catalog that still uses two-dimensional print media.

A. Processing Modeling3D

3D Modeling of an object can be viewed as a complete process that starts from getting data and ending an interactive 3D model in a computer. Sometimes 3D modeling simply means conversion of a shadow size into triangular (mesh) webs. 3D modeling is required in many areas such as object identification, visualization and animation. Creating a complete, detailed, accurate and realistic 3D model of an image is still a difficult thing, especially for large and complex models. In general 3D modeling consists of several processes, among others, the collection of information needs, framework and modeling, reference search (creative ideas), data processing, texture and visualization. There are several techniques that are commonly used and become the basic reference in 3D modeling [16-17]: 1) Primitive Modelling (Solid Geometry Modeling), 2) Polygonal Modeling, and 3) NURBS Modeling.

B. Benefits of visualization

According to Carmigniani et al, the definition of visualization is using computer technology as a support for performing interactive visual data depiction to strengthen observations. Meanwhile, according to [18] the definition of visualization is a method of using computers to transform symbols into geometric and allows researchers in terms of observing computational summation that can enrich the scientific discovery process so as to develop a deeper and more unpredictable. Some of the goals of visualization are: 1) *Explore*, Exploratory activities can also be called explorers or search, is the act of searching or browsing with the aim of finding something new. In terms of visualization, exploring can be in the form of exploitation of existing data or information that can be used as one part of the decision-making element; 2) *Counting*, Counting is an activity that aims to get a picture of the dimensions / shapes of an object. In relation to visualization, counting can be interpreted as an activity to analyze the existing data in the form of images such as graphs and tables that have been counted so that management only needs to make decision from the data that has been calculated; 3) *Submitting*, Raw data is processed and then displayed in the form of graphics as a form of delivery by way of visual approach which can make people who see the image can easily deduce the meaning in the picture because in general the data is processed in the form of graphs more easily understood because of its nature is not convoluted but directly to the intended point. In the making of 3D apartment Transpark Cibubur tower C based augmented reality requires the planning in all areas and things, one of which is planning in the field of 3D modeling and texturing in Trans Park apartment Cibubur. So as to produce objects of building wake and interior exactly with the

length and wide as the work drawings provided by the Trans Property. Here is an explanation of the concept of 3D-based modeling, stages of design and texturing, and the modeling of 3D objects from Transpark Cibubur apartment.

C. Concept 3D Modeling and Texturing

Businessmen and developers of residential or apartment buildings always use various ways to market their property. However, business people are still using the old way of promotion is to provide very little interest or promotion in print and electronic media. However, the promotion is still using two-dimensional objects in the form of print media is a brochure, which has a limited viewing angle. Therefore, it is necessary to develop content presentation in promoting, by developing content from two dimension to three dimension, to develop content into three dimension one way its making 3D model with Augmented Reality based, which later will use catalog as marker and as the container in bringing up the 3D image of the apartment building is listed in the apartment brochure according to the type and specification of each tower to be built.

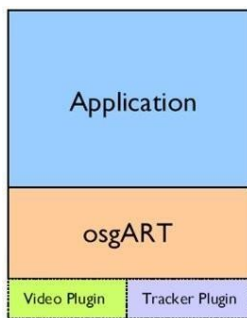


Fig. 3. Macket 2D of Transpark Cibubur

Making a 3D model based Augmented Reality aims to facilitate the visualization of products to prospective customers and make the maket building becomes more interactive and also interesting. Of course with more developed technology as the era progressed. Will be able to give a more interesting impression and also interaktive to prospective customer [18-19].

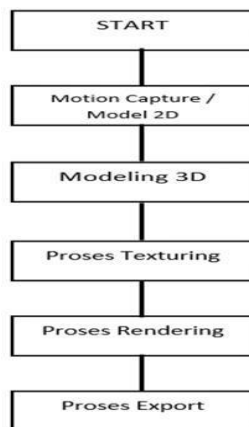


Fig. 4. Result 3D of Transpark Cibubur Room

To get the results shown in Figure 4, augmented reality technology must be added to an Apartment catalog. The

function of the camera in this study is as a medium of vision for the AR application to get video input. The camera takes video frames to be accepted by the computer. Computers are used to process digital images acquired by cameras, frame by frame. A tracking system library for AR applications such as ARToolKit is needed to be able to detect markers in the video frames. But ARToolKit has a weakness in terms of rendering models. So a library that can render high quality 3D home models like OSG is needed. To be able to cover the weaknesses of ARToolKit, the rendering process of the apartment model must be handled by OSG so that the results obtained are optimal. OsgART is the solution to this problem, because osgART can make OSG have an AR function.

In Figure below there is a flowchart Stages of Design and Texturing Modeling 3D Objects used for 3D Market Apartment Trans Park Cibubur based augmented reality.

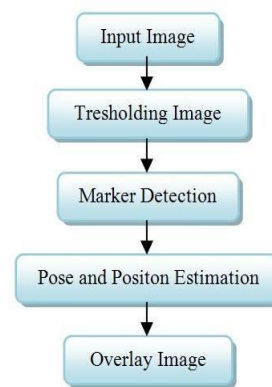


Fig. 5. flowchart Stages of Design and Texturing Modeling 3D Objects

D. OsgART



Fig. 6. Arsitektur OsgART

From Figure 6, recognized as osgART Get two kinds of plugins to be used, namely the video plugin and tracker plugin. The video plugin used as an input source consists of videos, while the tracker plugin is a library tracking system used to track approvals (bookmarks) in this AR application.

E. ARToolKit



Fig. 7. Pipeline ARToolKit

As responding to Figure 7, the initial step to take is to get input from the camera. Videos that are streamed in real-time will be processed by the system to be analyzed frame by frame. Before a camera is used, the camera must be calibrated first. Camera caliber is a very important part in the process of taking video input. This is caused by distortion in the camera lens that each camera has different characteristics (figure 8). The purpose of camera calibration is to calculate the level of distortion of a camera lens that is used so that the resulting image approaches the ideal image. This parameter will be used in calculations in the Pose and Position Estimation process so that the house model can be displayed directly above the marker. The video received will then continue the process of binarization (gray scale), then the threshold value is determined so as to produce a black and white image. Threshold values in the numbers 0 – 255 and default, threshold. The function of this process is to help the system recognize the rectangular shapes and patterns in the markers on the received video. The threshold value can be changed and adjusted to the light conditions around the marker to keep the marker visible as a rectangle, because when the light around the marker decreases or is excessive during the thresholding process, the system cannot detect the marker. This is important because this application works by recognizing markers. After the video undergoes a thresholding process, the next step is to detect the marker, where the system will recognize the shapes and patterns that exist on the marker. The system will look for parts that have a rectangular shape and mark it. The system will also eliminate areas that are not rectangular so that only the area that has a rectangular shape will appear on the screen.

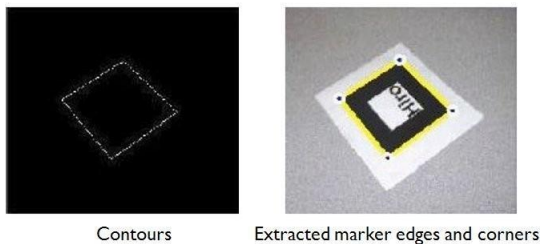


Fig. 8. Results from contour extraction and angle detection

Contour extraction and corner detection are used to obtain the coordinates of the four sides and the four corner points on the rectangle that remain after the image labeling process (Figure 7). After this process is completed, two parallel lines on the marker are projected so that the line equations on the screen

coordinates of the camera are as follows:

$$a_1x + b_1y + c_1 = 0 \quad a_2x + b_2y + c_2 = 0 \quad (1)$$

The parameters in equation 1 will be stored and used in the next process.



FIG. 9. PATTERN NORMALIZATION AND TEMPLATE MATCHING

Because the angle of the camera lens is not perpendicular to the marker when taking video, the angle of the marker formed by the sides of the rectangle is not 90 ° (9). This makes the pattern that is in the marker can not be recognized properly. Pattern normalization has a role to change the angle of the marker that is not 90 ° to 90 ° so that the pattern can be recognized and matched using a template matching with a pattern (template) that already exists in the system to obtain a positive ID from the marker. A picture, photo or name can be used as a pattern on a marker so the system can recognize the pattern. The placement of a 3D object directly above the marker, the system needs to know the coordinates of the marker and the camera.

$$\begin{bmatrix} X_c \\ Y_c \\ Z_c \\ 1 \end{bmatrix} = \begin{bmatrix} V_{11} & V_{12} & V_{13} & W_z \\ V_{21} & V_{22} & V_{23} & W_y \\ V_{31} & V_{32} & V_{33} & W_x \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X_m \\ Y_m \\ Z_m \\ 1 \end{bmatrix} \\ = \begin{bmatrix} & & & \\ & \mathbf{V}_{3 \times 3} & \mathbf{W}_{3 \times 1} & \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} X_m \\ Y_m \\ Z_m \\ 1 \end{bmatrix} = \mathbf{T}_{cm} \begin{bmatrix} X_m \\ Y_m \\ Z_m \\ 1 \end{bmatrix}$$

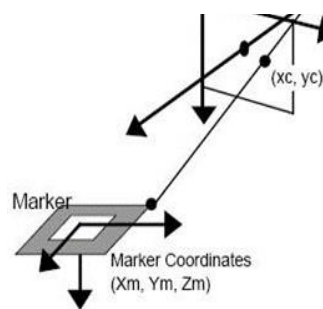


Fig. 10. Connection between marker coordinates and camera coordinates

The transformation matrix (Tcm) from the marker coordinates to the camera coordinates as shown in Figure 10 is given in equation 2. For the markers that have been recognized, the values of the parameters a1, b1, c1 and a2, b2, c2 are obtained during the contour extraction process. The projection matrix P in equation 3 is obtained during the camera calibration process.

By replacing xc and xy in equation 3 for x and y in equation 1 we get a line equation like equation 4.

The rectangular marker used has four sides where the two sides are parallel lines. The normal vector of the marker is \hat{n} which is produced by the multiplication of cross vectors u_1 and u_2 , as shown in figure 11. In fact, vectors u_1 and u_2 should be perpendicular, this is caused by the camera angle when shooting that is not perpendicular to the marker. V_1 and v_2 vectors.

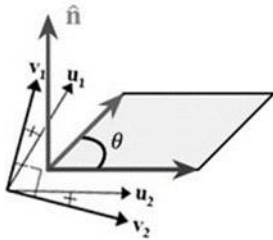


Fig. 11. Two vectors that are perpendicular to the same

Made to have an angle of 90° by using values from vector u_1 and u_2 to minimize errors. After v_1 and v_2 are perpendicular, v_3 is produced from cross $v_1 \times v_2$ multiplication. The values v_1 , v_2 , and v_3 are the rotational component in the transformation matrix T_{cm} from the marker coordinates to the camera coordinates as presented in equation 2. After the rotation component

$V_3 \times 3$ on the transformation matrix is known, the translational component W_1 , W_2 , and W_3 can be obtained using equations 2 and 3. After the matrix transformation is obtained, the final step taken is to draw a 3D virtual object on the video frame just above the marker surface and the results can be seen in the video output. Thus the virtual house model is as if it is above the marker.

F. SystemImplementation

The implementation of the AR home catalog is divided into several stages, that is: 1) *Initialization*, *osgViewer* is a class for creating windows that are used to load rendering results from 3D models. The first step is to create a window viewer because almost all parts of the application this requires this window for the visualization process. 2) *TrackingSystem*, to be able to read the position of the marker, the system must be equipped with a tracking system. *ARToolKit* has provided a separate class called *tracker* to solve this system tracking problem. After the track from *ARToolKit* is loaded, the tracker will be connected to the video plugin to be able to receive input and detect markers. It was explained earlier that the thresholding process is very necessary when the light conditions around the marker are reduced or excessive. For that we need to change the threshold value depending on the state of the light around the marker. The tracker class also needs to be adjusted to the video received from the camera, this is due to an error caused by distortion from the camera lens. Therefore the camera calibration file is also used in this tracking process. 3) *Transform the camera to a marker*, The P projection matrix used by *ARToolKit* needs to be implemented in *OSG*. As previously explained, the projection matrix is obtained during the calibration process. Transformations on markers that have been calculated by *ARToolKit* must also be mapped into the *OSG* transformation. *ARToolKit* uses a different transformation matrix for each marker that is recognized in each camera frame. *OSG* uses transformations to position 3D models. Then *OSGART* maps the *ARToolKit* transformation into the *OSG*

$$P = \begin{bmatrix} P_{11} & P_{12} & P_{13} & 0 \\ 0 & P_{22} & P_{23} & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, \quad \begin{bmatrix} hx_c \\ hy_c \\ h \\ 1 \end{bmatrix} = P \begin{bmatrix} Z_c \\ Y_c \\ Z_c \\ 1 \end{bmatrix} \quad (3)$$

$$\begin{aligned} a_1 P_{11} X_c + (a_1 P_{12} + b_1 P_{22}) Y_c + (a_1 P_{13} + b_1 P_{23} + c_1) Z_c &= 0 \\ a_2 P_{11} X_c + (a_2 P_{12} + b_2 P_{22}) Y_c + (a_2 P_{13} + b_2 P_{23} + c_2) Z_c &= 0 \end{aligned} \quad (4)$$

transformation. 4) *Add 3D Models*, the next step is to load the *OSG* model and draw it on the marker in accordance with the position and pose coordinates of each model.

The LOD (Level-of-Detail) method is also used in this study. In this method, two models are loaded simultaneously, namely the *office.ive* and *office2.ive* models. LOD uses two nodes, namely *closer node* (short distance) and *far node* (long distance). When the distance between the camera and the marker is between 0 cm to 25 cm (close), the model used is *office.ive* while when the distance exceeds 25 cm (far) then the system will replace the *office.ive* model with *office2.ive*.

G. Realization Of Building And Interior Of Tower C Transpark CiburApartment

1) Software/Tools,

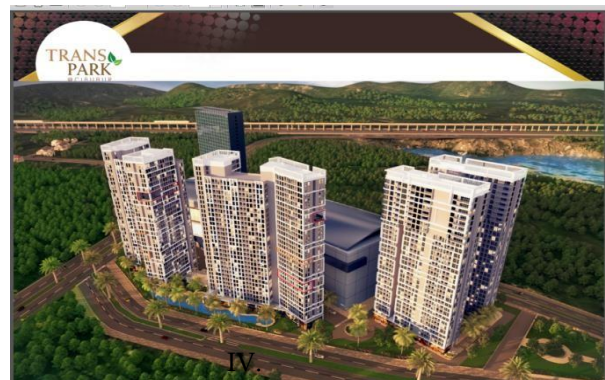
As in the realization of making this 3D object, using software or any tools, as follows :a) PersonalComputer, b) Autodesk 3DS Maxapplication, and c) Smartphone.

2) Final Artwork (FA)by Trans Park Cibur

	TOWER A & B		TOWER C	
UNIT TYPE	STUDIO	22.75 m ²	1 BR A	27.5 m ²
	2 BEDROOM	45.5 m ²	1 BR B	25.2 m ²
	2 BR CORNER	48.45 m ²	2 BEDROOM	50 m ²
	3 BEDROOM	71.2 m ²	2 BR CORNER	53.5 m ²
			3 BEDROOM	85.1 m ²

3) End Result Apartment TransparkCibur,

Rendering and final results after the design process and also texturing so that formed similar from the interior 3 bedroom contained in the tower C Apartment Trans Park Cibur



4) *Testing*, After the process of making a 3D modeled app based augmented reality then the next step is to test what has been done. This test is a test phase of the results of the modeling and texturing object building and interior tower C Apartement Transpark Cibubur.

4.1) *Test Description*, Testing is divided into two parts, namely alpha testing and beta testing. Alpha testing is done to determine the suitability of the model and texture of the object with the working drawings or final artwork (FA) provided by the Trans Property. After doing alpha testing, the next testing stage is beta testing. Beta Testing is a testing phase of the final result by running and showing the application to the party from Trans Park Cibubur then give and spread the questionnaire directly. Testing is done on 23 – 24 June 2018. This test aims to review the application of the technical done on making this application, whether able to provide results in accordance with the wishes of the Trans Property.

4. 2) *TestProcedure*, here are the procedures or test steps used in alpha testing as well as beta testing.4.2.a) *AlphaTesting*, at the alpha testing stage testing of the application functions to ensure all functions are running correctly in accordance with the predetermined concepts and testing of the model and texture room 3Bedroom. The test is done by inviting Regi Gatari as Art Director from Startup Nesvara Kreasi Indonesia who has experienced in 3D. to test the feasibility of 3D models and apps by being monitored by a team of creators.

	Objek	Yang Diuji	Hasil yang diharapkan	Hasil
1	Gedung Tower C	Bentuk dan ukuran gedung		
2	Interior room 3 BedRoom	Ukuran panjang lebar dan Texture ruangan		

4.2.b) *BetaTesting*, Beta testing is done by distributing questionnaires on 10 respondents Trans Park Cibubur with vulnerable ages 21-35 years. Beta testing done on 23 and 24 June 2018. Testing is done to determine the suitability of the application of all aspects Here are aspects that are tested in beta testing. In this beta testing used Likert scale with 5 response options, which can be seen in the following table

4. 3) *Testing 3D Objects*

Table 1
List of questionnaire 1

No	Questions	Yes	No
1	Does the 3d object match the given blueprint?		
2	Does the 3d texture match the given blueprint?		
3	Is the 3D material in accordance with the blueprint provided?		
4	Does the 3d assets element fit the given blueprint		

Source: Created by researcher

4.4) *DistributionResults*

4.4.a) Similarities in the shape of 3D objects, The results obtained in accordance with the shape of the 3D object in the original with the corresponding results, the value obtained from the information is valid or successful without information. 4.4.b) Color compatibility in 3D objects, The results obtained in accordance with the color of the original 3D object with the corresponding results, the value obtained from the information is valid or successful without information [20].

4 CONCLUSION

Based on the thesis making entitled “Modeling and Texturing of Cibubur Transpark Apartement on the Application of Augmented Reality Technology to Visualize 3D Apartment Mockups with Markerless Method: This augmented reality based 3D mockup application can provide easy visualization to prospective customers of Cibubur Transpark Apartments. This augmented reality-based 3D mockup can provide detailed and complete information about the type of room and also the facilities offered by the developer of Transpark Cibubur. This augmented reality based 3D mockup application can be used as a promotional media to further help market the Cibubur Apartment Transpark products.

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