

Augmented reality using features accelerated segment test for property catalogue

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ABSTRACT

Promotional media used in the marketing of housing using catalogs that display 2D images of houses from one side of the house make potential customers unable to imagine the design of all parts of the house. Augmented Reality can be used as an interactive marketing media so that it can be used to display homes in 3D so that they appear more real from all sides so that prospective customers can consider the type of house to be chosen. Development of this application using the Multimedia Development Life Cycle. Application development uses the FAST algorithm as detection of home catalog markers to define how well images can be detected and tracked. The FAST algorithm will calculate every pixel on the target image in determining the corner when scanning the home catalog then it will produce a 3D object home to see the real shape design of the house.

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1. INTRODUCTION

Housing represents the most basic of human need and it has a profound impact on the health, welfare, and productivity of individuals [1]. Houses as shelters should be able to fulfill the space requirements for activities of their residents [2]. The nature of housing includes not only houses from the physical side of the building but includes all supporting facilities both inside and outside [3]. Along with the high market demand for the property business [4], many companies offer their products using various methods. In the business world, competition between companies is increasing, therefore every company is required to make changes to achieve a success in doing business [5]. Promotion is one of the components that form a marketing mix and marketing activities will focus on communicating [6]. Examples of promotional media that are carried out is to offer homes to consumers by showing a catalog that contains information or explanations about the appearance of 2D houses images and the design of the size of the house.

While doing property marketing, the obstacles faced by sales marketing when prospective customers are choosing a house are still confused about the shape of the house being built. This is because the house that is displayed from a catalog that only contains a picture of one side of the house does not yet look detailed and real, both outside and inside the house. Consumers who want to see the location of the house directly, sometimes do not have time due to heavy activity, coupled with the location of the house is far from the location of consumers at this time. Figure 1 show data on prospective customers who visit the location of the house. From the data in Figure 1 shows the number of prospective customers who visit housing locations. Prospective consumers look directly at the housing location because they want to see the shape and size of the house in real

terms compared to just looking at the pictures in the catalog. Images contained in the catalog are only from the front side of the house and the image of house plans.

Augmented reality is a technology that combines two-dimensional or three-dimensional virtual objects into a real environment in real time [7] so there is no boundary between the real world and the virtual world [8]. The development of augmented reality already exists in several sectors such as medic [9], educations [10], military [11], games [12] and manufacturer [13]. The Augmented Reality system will scan the environment which has a marker that will be imaged by a virtual object. A marker is a pattern made in the form of images and can be recognized by optical devices or cameras in the augmented reality method [14]. In this system camera continuously snapshots the target object and process the image to estimate the position, orientation and movement of the visualization display with respect to the target object [15]. The development of Augmented Reality technology in the home catalog, will make consumers see the 3D display of houses contained in the catalog so that the displayed house will look more detailed and real from all sides by using brochures as markers.

This is confirmed by Vitono [16] has examined the use of the FAST algorithm in markerless augmented reality to use it as an information media museum collection. Then Zuli [17] also uses the FAST algorithm as a 3D information media at the University of Satya Negara Indonesia. Then in 2018 Setiawan [14] also examined the use of augmented reality with the FAST algorithm in the ablution manual. Then Adiwijaya [18] using FAST corner detection to augmented reality implementation for interactive brochure. Also in Nainggolan [19] The implementation of augmented reality in the learning media of introduction animal can give the visual information interactively.

From previous research, the development of this research carried out an idea to apply the FAST algorithm to augmented reality in its use as a home catalog. The FAST algorithm is implemented in scanning AR markers as detection of home catalog markers to define how well images can be detected and tracked. Different from previous research, researchers will add the home tour feature as an additional multimedia experience that surrounds the house and goes into the house to see in detail and more real. With the application of the augmented reality, the user can more easily get the information about the home in the form of 3D models by aiming the camera to the marker on the catalog.

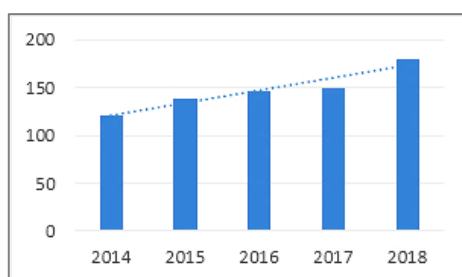


Figure 1. Data on prospective customer visits to residential locations

2. RESEARCH METHOD

2.1. Multimedia development life cycle

This study uses the MDLC (Multimedia Development Life Cycle) method. This method is easier to understand and implement, the steps are clear and easy to follow, structured and sequential logically, and can be used by small developers. According to Luther in Nurajizah [20] the development of the multimedia method was carried out based on six stages, arranged systematically as follows:

- The first step of this method is Concept. It starts with determining goals, users, types of multimedia and general specifications. The purpose of the application is tailored to the needs of organizations that need it so that multimedia information is conveyed.
- The second step is Design, a mature concept will then describe what will be done at this stage. The purpose of the design phase is to make specifications regarding the style, shape, appearance and material requirements for development. For the design of markers that will use from the existing home catalog and for the design of 3D objects can be described with the shape of the house based on specifications on manual data retrieval.
- The third step is Material Collecting, namely collection in accordance with the materials needed to be worked on, among others, images, clip art, icons and 3D forms of interior design in the house and other objects outside the home such as trees and plants.

- The fourth step is Assembly, carried out making the whole multimedia material. Making an application based on the design that has been made and the material that has been collected. At this stage use the Blender software to create 3D objects. Unity3d and Vuforia for augmented reality. The fifth step is Testing, the trial is done after the completion of the manufacturing phase by running the application and testing is done to see whether there is an error or not. Tested using the FAST algorithm to test the markers used in AR.
- The last step is Distribution. If the testing phase has been completed without error, the system is ready to be distributed or applied according to the purpose of this research. The application will then be operated on an Android device for later use. The evaluation is also very much needed for product development that has been made to be better as an input for the stage concept in the next development. The six steps of the multimedia development life cycle method arranged systematically are shown in Figure 2. The concept stage must indeed be the first thing done [21].

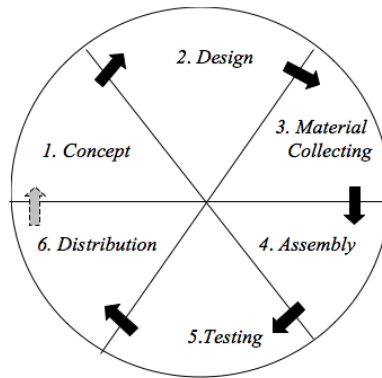


Figure 2. MDLC stage [20]

2.2. FAST (features from accelerated segment test) algorithm

Vuforia using FAST (Features from Accelerated Segment Test) Algorithm Corner Detection to define how well images can be detected and tracked using [14]. Vuforia is an Augmented Reality Software Development Kit (SDK) for mobile devices that allows the creation of Augmented Reality applications [17]. The advantages of using the FAST algorithm are a rapid operation and low computations compared to other corner detectors [22] with the consequence of reducing the accuracy of angle detection [17]. In Vuforia there are ratings displayed in the Target Manager [16] and return for each upload target via the web API. Ratings range from 0 to 5 for each picture given. The higher the rating of the target image, the stronger the detection and tracking capabilities it contains. Figure 3 show 1-star rating indicates that the target is hard to tracked at all by the Augmented Reality system, while the 5-star rating shows that an image is easily tracked by an Augmented Reality system because many of insert points or corners on an image.

Analyzed Image	Star Rating	Analyzed Image	Star Rating
	★☆☆☆☆		★★★★★
Image with small number of features		Image with high number of features	

Figure 3. The augmentable rating on the target manager

FAST Corner Detection is detection by looking for insert points or corners on an image [14]. The process of determining the angle is by changing the image to grayscale and running the algorithm. The criterion of the corner should be more relaxed to block this broad trial. A pixel's criteria must be a corner based on an accelerated segment test (AST) which there must exist at least S pixels that have more brilliant circle connection or darker than a threshold. Other values of 16 pixels are disregarded. So the value of S can be used to determine the detected corner at the maximum angle [23].

FAST Corner Detection starting with determining a pixel p at coordinates (X_p, Y_p) in the image and compare the intensity pixel p with 4 pixels from 16 pixels Bresenham circle surrounding the pixel p , whose radius is 3 [24]. First pixel located in the coordinates (X, Y_{p-3}) , a second pixel located in the coordinates (X_{p+3}, Y) , a third pixel located in the coordinates (X, Y_{p+3}) , and a fourth pixel located in the coordinates (X_{p-3}, Y) . As illustrated in Figure 4 in pixel number 1, 5, 9, and 13.

If the intensity pixel p is below or above than the intensity of at least three pixels from 1, 5, 9, and 13 plus a Threshold intensity, then it can be said that pixel p is an interest point [23]. It is defined in (1):

$$C_p = \begin{cases} 1, & I_n < I_p - t \text{ or } I_n > I_p + t \\ 0, & \text{otherwise} \end{cases} \quad (1)$$

after that pixel p will be at the coordinates (X_{p+1}, Y_p) and repeat the procedure by comparing the intensity with the other four pixels surrounding. The same procedure can iterate for the whole image's pixels.

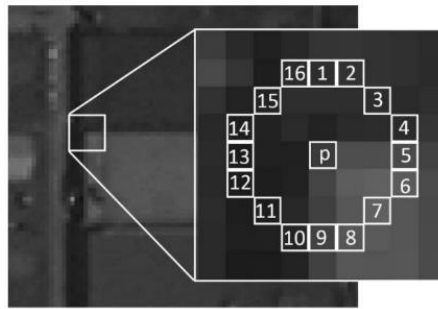


Figure 4. FAST Detector [22]

In the machine learning approach, FAST algorithm comparing sixteen pixel that surrounding the candidate interest point (corner) pixel p —as illustrated in Figure 4—the corner detector define pixel p as a corner if there exists a set of n contiguous pixels in the circle, which are brighter than the intensity of the candidate corner I_p plus a threshold t , or are darker than I_p minus the t [25]. The n is chosen as 12 because it allows a high-speed test that can be used to exclude a very large number of non-corners. It defined in this equation:

$$S_{p \rightarrow x} = \begin{cases} d, & I_{p \rightarrow x} \leq I_p - t & \text{(darker)} \\ s, & I_p - t < I_{p \rightarrow x} < I_p + t & \text{(similar)} \\ b, & I_p - t \leq I_{p \rightarrow x} & \text{(brighter)} \end{cases} \quad (2)$$

where I_p is the intensity of p , $I_{p \rightarrow x}$ is the intensity of the sixteen pixels that surrounding the example pixel and t is a threshold. If $S_{p \rightarrow x}$ is equal to d , the pixel belongs to the darker group; if $S_{p \rightarrow x}$ is equal to s , the pixel belongs to the similar group; if $S_{p \rightarrow x}$ is equal to b , the pixel belongs to the brighter group. If there are 12 contiguous pixels that belong to the darker or brighter group, p is classified as a corner.

3. RESULTS AND ANALYSIS

3.1. Testing FAST algorithm

The development of this augmented reality application uses a home catalog as a marker that will bring up the virtual form of a 3D home. There are 3 markers used in accordance with the number of types of houses being marketed. The catalog image will be targeted if appropriate the requirements of Vuforia by uploading it

to the Vuforia website. Vuforia is able to recognize and track targets by analyzing the contrast of the features or detected corner seen in the camera. A feature is a sharp, spiked, detailed detail in the image. The way to determine the features used by Vuforia is the FAST corner detection algorithm. The level of ease of image tracking that is used as a marker is given a rating by Vuforia called an augmentable rating. The higher the rating, the easier it will be to track. The Catalog design that will be use as markers show in Figure 5. To increase the rating to its maximum value, you can create a design that is rich in features, good contrast, smooth distribution of features, and avoiding repetitive patterns in one image. Figure 6 shows the results of testing the home catalog marker detection for each type of house based on the augmentable rating of Vuforia.



Figure 5. Catalog design as markers

Target Name	Type	Rating
 rafflesia	Single Image	★★★★★
 orchid	Single Image	★★★★★
 edelweis	Single Image	★★★★★

Figure 6. Marker rating augmentable from vuforia

The augmentable rating shows a high rating of 5 stars indicating that the existing marker images are easily tracked by the Augmented Reality system. This is because catalog images contain many features of marker objects (complex patterns and details) with good contrast and smooth distribution of features. The algorithm used in Vuforia is the FAST corner detection algorithm. The way it works is to determine one by one all the pixels in the image and then determine whether the point is a corner or not. An example of an experiment conducted is as illustrated in Figure 7.

In Figure 7 select a pixel as p with coordinates (X_p, Y_p) for example in the marker image, and then compare the intensity pixel p with 4 pixels from 16 pixels surrounding the pixel p . First pixel number 1 in Figure 7 located in the coordinates (X, Y_{p+3}) , second pixel is number 5 located in the coordinates (X_{p+3}, Y) , third pixel is number 9 located in the coordinates (X, Y_{p-3}) , and fourth pixel is number 13 located in the coordinates (X_{p-3}, Y) . The next step is comparing pixel p with pixel 1, 5, 9, and 13. If the intensity pixel p is below or above than the intensity of at least three pixels from 1, 5, 9, and 13 plus a Threshold intensity, then it can be said that pixel p is an interest (corner). In this case, the intensity of pixel p is brighter than 1, 5 and 13 which mean pixel p is a corner according to (1).

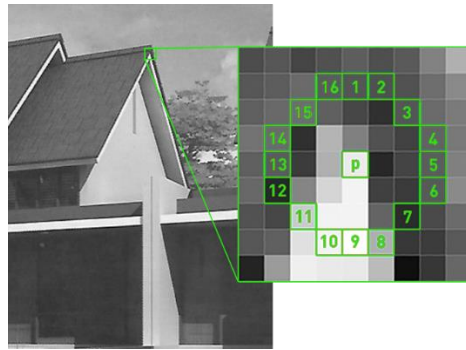


Figure 7. FAST algorithm on a marker

Because of the large number of pixel points that must be tested, to facilitate testing of the FAST algorithm, the next test is to look at the angles detected using open source MATLAB for FAST algorithm by Edward Rosten. A pixel is defined as a corner if (in a circle surrounding the pixel), N or more contiguous pixels are all significantly brighter then or all significantly darker than the center pixel. The ordering of questions used to classify a pixel is learned using the ID3 algorithm. This detector has been shown to exhibit a high degree of repeatability. Similar results are indicated by all markers. The green dots show in Figure 8 is the Non-maximally suppressed corners. The interest points were generated with an open source MATLAB code for the FAST algorithm by Edward Rosten.

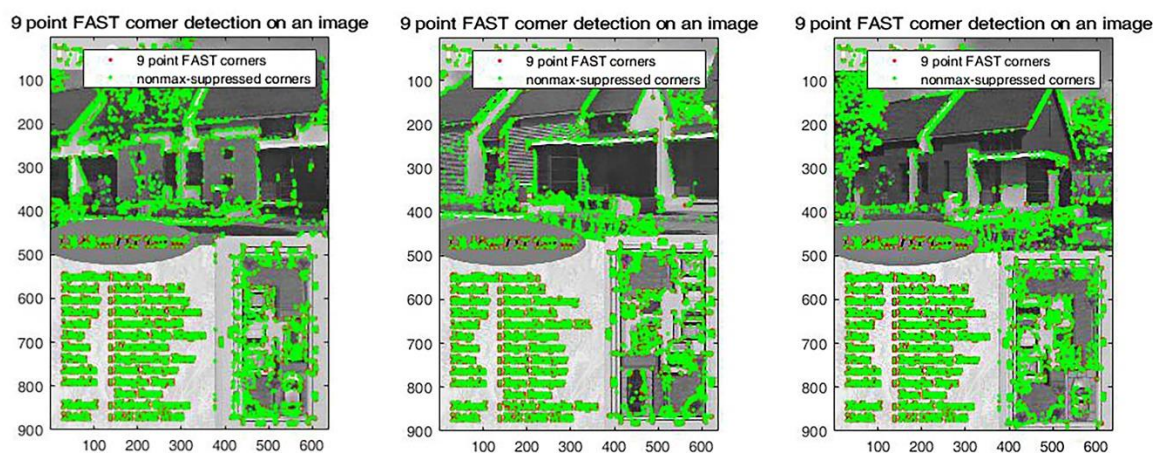


Figure 8. Marker with interest point detected

3.2. Augmented reality implementation

The augmented reality application as a home catalog that has been made using the application of the FAST algorithm on marker detection is operated on mobile with the Android operating system. There are 5 main menus, namely Introduction to information about the house, AR camera to detect catalogs, Home Tours for the experience of seeing and go around the house from the outside and into the inside, Guide for information on how to use and the latest Information about the application as shown in Figure 9. Augmented reality that will come out when detecting home catalog markers can be seen in Figure 10. The 3D display can be enlarged and rotated so that the appearance of the house can be seen from all sides.

Augmented reality uses marker detection using the FAST algorithm method in Vuforia. The marker image is rich in features and spread evenly. Existing home brochures appropriate these requirements so that there is no need for a lot of modifications. When uploaded in Vuforia, catalog design received an augmentable rating with a score of 5. A high score provides easy Vuforia in detecting images so that it will make it easier to display existing 3D animations. After being downloaded again from Vuforia and made in Unity3D. The ways of Vuforia working when the application opens the camera, the task of the camera is to capture images in real time and then tracking and detecting captured camera objects will be carried out by tracker in

Vuforia containing computer vision algorithms namely the FAST algorithm. The FAST algorithm will work to check images by working according to (1). The image that is visible in the camera will be detected against each pixel and determine whether it includes a corner or not. Detecting the corner that has been done makes a pattern then it will do the matching with the database image that is on vuforia. When it finds an image match, the results of detection will then be used to start rendering a predetermined 3D object that is the house from the catalog scan. Then the rendering results will be displayed via mobile devices in real-time.

The added feature is that there is a home tour to feel a real experience such as walking around the house to look inside the contents of the house can be seen in Figure 11. When choosing the home tour menu, the house will appear according to the type you have previously chosen. Users can travel by moving the button to walk into the house and see the contents of each existing room accompanied by examples of interior design.



Figure 9. Display of the main menu



Figure 10. Display of augmented reality after marker detected



Figure 11. Display of the home tour

4. CONCLUSION

The detection of marker augmented reality with the application of the FAST corner detection algorithm used in Vuforia SDK is useful as a trigger for augmented reality. The working method of the FAST algorithm is to examine each pixel in an image and determine whether the pixel is an interest point (corner) or not. The count used from the example pixel is tested compared with sixteen pixels around it then determines four points. From these four points, if there are at least three darker or brighter ones, the example pixel that is in the middle is an angle. In Vuforia pixels, which is an interest point, it is called features. The use of images as markers must have many features, contrast images, and smooth distribution of features so that markers having a high augmentable rating will make it easier for Vuforia to detect images. The FAST algorithm performs matching features that exist in the target image with the database. Then the application will render 3D objects. If the detection of a suitable target image will render the 3D object of the house. The results of visualizing the house in 3D are easier to explain the original appearance of the house compared to the appearance of the photo. This application facilitates sales marketing as an explanation to prospective customers who are confused about the original description of the house both from outside the home and inside

the house and by using the home tour menu prospective customers can feel the experience of going around the house in animation.

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