IMPLEMENTATION OF AUGMENTED REALITY IN THE INTRODUCTION OF CAKES USING SURF ALGORITHM IN CILLA SNACK

Janah Nurlillah[1], Dadang Hamdani, M.Kom[2], Yati Nurhayati, M.Kom[3]
[1]Informatics Engineering
[2,3] Faculty of Computer Science, University of Kuningan
E-mail: [1]jannahnurlailah @ gmail.com, [2]dadanghamdani75 @ gmail.com, [3]yati.nurhayati @ gmail.com

ABSTRACT

The role of the media is quite important in providing information about cakes stock in Cilla Snack, to the wider community. The delivery of information is usually done in the form of brochures. But brochures are considered inadequate in providing visualization about the cake and not all cake information can be included in the brochure that make consumers do not get complete information. Augmented Reality Technology, is the right technology to provide cake information on Cilla Snack. The implementation of Augmented Reality technology on android smartphones using the SURF (Speeded Up Robust Features) algorithm, this algorithm can recognize images with good recognition speed. In the development of AR applications that use the SURF algorithm, there are 3 stages, namely initialization, tracking markers, and object rendering. At the initialization stage, the image used as the introduction database will be processed. At the tracking marker stage, the smartphone camera will take a picture and process each input image then matching process with the image in the database. The last step is after a match is found, the application will display information text along with the cake object that matches the results of the match. Application development uses C # programming language, known as one of the object-oriented programming languages, so it is considered suitable for developing this application. With this application, brochures can provide visualization of cakes in the form of 3-dimensional objects making it more interesting and interactive than ordinary brochures.

Keywords*: Augmented Reality, SURF Algorithm, 3D Objects, Android.*

1. INTRODUCTION

Marketing or marketing is a series of activities to meet customer needs and satisfaction. You do this by making products, determining prices, where to sell them and promoting these products to consumers.

One of the media used by utilizing technology in the promotional process of Cilla Snack is only using brochures and through social media such as Facebook, Instagram and WhatsApp. Brochures are a media that is still controversial, but it turns out that this media is still familiar and many business actors do. Although information is more readily available via the internet, brochures have proven themselves to be still an important part of the marketing industry.

The existence of brochures that have been widely circulated among the public is quite helpful in terms of finding information about cakes. However, along with the development of technology, the existence of the brochure looks unsatisfactory, due to the appearance of the brochure which only presents text or images in two-dimensional form.

Augmented reality is a technology that allows people to visualize the virtual world as part of the real world around them effectively so as to make the real world seem to be connected to the virtual world and an interaction can occur. From a technical point of view, augmented reality is a transformative technology. One of the most important characteristics is the way in which augmented reality assists an entertaining transformation in the interaction process between computer users.

The advantages of augmented reality technology are what want to be a solution to the problems faced at Cilla Snack in promoting its business. There are various kinds of algorithms.

2. RESEARCH METHOD

A. Research Methods

The research method used in the development of this application is to use the Rational Unified Process (RUP) method, this method is used by the author because the object-oriented concept is compatible with the application concept to be built, here are 4 phases:

1) Inception

This stage is the initial stage where at this stage the authors carry out the data collection process that will be carried out in this study, namely by conducting interviews, observation and literature study.

2) Elaboration

This stage the authors focus on planning the system architecture that will be made based on the results of the inception stage, and can detect problems that may occur in the project, this stage is the most critical stage because the goal is to analyze the problem, at this stage software design will also be carried out. iteratively through activities such as business modeling, requirements, analysis and design. And the plan that is carried out is quite stable and can reduce the risk so that it can predict the costs and schedule required.

3) Construction

For the Construction stage, this is the stage for building software until the software is ready to use. As well as more focused on the development of system components and features, this stage is more on the implementation and testing of the system which focuses on software implementation in program code and this stage also produces products that will be submitted to the user.

4) Transition

At the end, namely the transition, this stage will focus on how to deliver the finished software to the user. The activities carried out at this stage are conducting maintenance and testing whether the system is in accordance with user needs.

B. Needs Analysis

Requirements analysis describes the requirements outside the system needed to run applications that are built. The need for augmented reality application development in the introduction of the food menu at Artha stores includes hardware requirements, software requirements, and system users who will use the application.

1) Hardware Requirement

- Laptop with specifications
  - Processor: Intel Core i3 2.4 GHz
  - RAM: 4 GB
  - OS: Windows 7
  - Hard drive: 1.5 GB Free Space
  - Webcam: 5 MP

- Smartphone with specifications
  - OS: Jelly Bean

• RAM: 2 GB
• Camera: 5 MP

2) Software Requirements
• Unity 5.6.5f1 64 Bit
Autodesk Maya 2018 (64-bit)
• ARToolkit
• Monodevelop
• EmguCV

3. RESULTS AND DISCUSSION

A. System Design

1) *Use Case* Diagram AR Cilla Snack

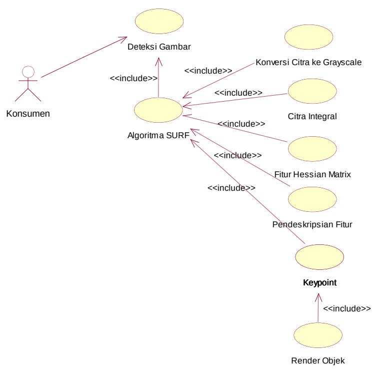


Figure 1 Use Case Diagram AR Cilla Snack

In the diagram above, there are 8 use cases, namely running images, detecting markers with the SURF algorithm, iterating the SURF algorithm and rendering objects.

2) Sequence Diagram

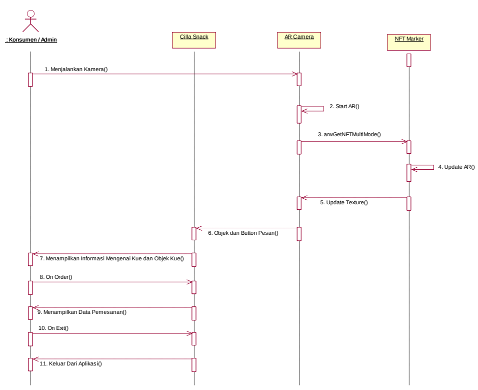


Figure 2 Sequence Diagram Detecting Markers

A. Implementation of the Speeded-up Robust Features (SURF) Algorithm

Testing of the Speeded-up Robust Features (SURF) algorithm on objects is carried out to detect object features which will later be used as pattern recognition of the image.

1. Initial Process

Before testing the SURF algorithm, the image is converted into a gray image (Grayscale Image).

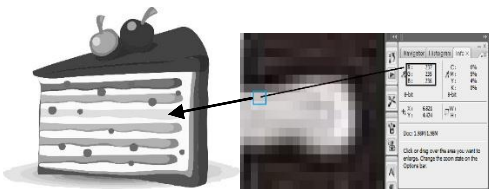


Figure 3 Image Input RGB

After the RGB image is obtained, then converting the image into a grayish (grayscale) image, the conversion result of the image above is obtained in the form of a matrix as in the following image:

236	198	197	216	210	213	214	215	213
222	206	204	196	197	206	208	210	212
203	201	196	192	193	195	194	192	191
202	206	196	199	203	191	183	170	162
219	178	148	156	160	139	125	106	96
208	137	57	66	65	48	39	28	26
215	76	16	34	24	23	21	19	19
209	69	26	57	37	42	43	44	43
206	56	27	63	39	34	35	37	39

Figure 4 Grayscale Image Values from an RGB Image

In the image obtained, it becomes a grayscale image, then represented as an integral image. Each feature will be very effectively calculated using an integral image.

s (x, y) = i (x, y) + s (x, y) + s (x, y-1) + s (x-1, y) -s (x-1, y-1). ....(2)
s (x, y) = is the sum of the values of each pixel
i (x, y) = is the intensity value obtained from the pixel value of the input image
s (x-1, y) = is the pixel value on the x-axis
s (x, y-1) = is the pixel value on the y-axis
s (x-1, y-1) = is the diagonal pixel value

236	198	197	216
222	206	204	196
203	201	196	192
202	206	196	199

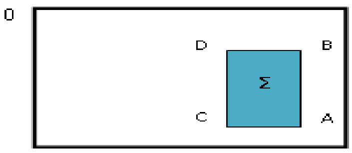
Figure 5 Direction of Integral Image Calculation

If the calculation is done for all the pixels contained in the feature boxes, the calculation results of the integral image will be obtained, which can be seen in the table below.

236	434	631	847	1057	1270	1484	1699	1912
458	862	1263	1675	2082	2501	1923	3348	3773
661	1266	1863	2467	3067	3681	4297	4914	5530
863	1674	2467	3270	4073	4878	5677	6464	7242
1082	2071	3012	3971	4934	5878	6802	7695	8569
1290	2416	3468	4493	5521	6513	7476	8397	9297
1505	2707	3775	4834	5886	6901	7885	8825	9744
1714	2985	4079	5195	6284	7341	8368	9352	10314
1920	3247	4368	5547	6675	7766	8828	9849	10850

Figure 6 Integral Image Calculation Results

After everything is filled in, for example, if you want to find the sum of the areas given a red box below, you can find the formula:



∑=A-B-C+D

Figure 7 Integral Image Formula

236	434	631	847	1057	1270	1484	1699	1912
458	862	1263	1675	2082	2501	1923	3348	3773
661	1266	1863	2467	3067	3681	4297	4914	5530
863	1674	2467	3270	4073	4878	5677	6464	7242
1082	2071	3012	3971	4934	5878	6802	7695	8569
1290	2416	3468	4493	5521	6513	7476	8397	9297
1505	2707	3775	4834	5886	6901	7885	8825	9744
1714	2985	4079	5195	6284	7341	8368	9352	10314
1920	3247	4368	5547	6675	7766	8828	9849	10850

Figure 8 Compute the integral area of the image box

Then:
∑ = A - B - C + D
= 236 - 847 - 863 + 3270
= 1796

The value of 1796 is the computation of the value obtained in table 8, in the table image below:

236	198	197	216	210	213	214	215	213
222	206	204	196	197	206	208	210	212
203	201	196	192	193	195	194	192	191
202	206	196	199	203	191	183	170	162
219	178	148	156	160	139	125	106	96
208	137	57	66	65	48	39	28	26
215	76	16	34	24	23	21	19	19
209	69	26	57	37	42	43	44	43
206	56	27	63	39	34	35	37	39

Figure 9 Compute Integral Image area box

When the value in the box is calculated, it is 206 + 204 + 196 + 201 + 198 + 192 + 206 + 196 + 199 = 1796.

1. Detecting Feature Points

SURF detection does not take advantage of scale space theory. To detect SURF points, the Hessian Fast-Matrix method is used.

The determinant of the Hessian matrix is used to decide whether a point can be selected as a point or not. Lxx (x, σ) is a convolution of Gaussian second-order derivatives with a figure at a point with coordinates (x; y).

$$H(x,\sigma) = \begin{bmatrix} L_{xx}(x,\sigma) & L_{xy}(x,\sigma) \\ L_{xy}(x,\sigma) & L_{yy}(x,\sigma) \end{bmatrix}$$

Di mana $L_{xx}(x,\sigma)$ adalah konvolusi dari turunan kedua fungsi Gaussian $\frac{\partial^2}{\partial x^2}\, g(\sigma)$ dengan citra I pada titik x. Definisi ini berlaku juga untuk $L_{xy}(x,\sigma)$ dan $L_{yy}(x,\sigma)$. Fungsi Gaussian didefinisikan sebagai :

$$g(\sigma) = \frac{1}{\sqrt{2\pi\sigma}} e \frac{x^2}{2\sigma^2}$$

SURF uses the Laplacian of Gaussian approach by using a Box Filter. The filter box has a kernel that has been given a weight. The smallest filter size that SURF can handle is 9x9 according to the following formula. Using this formula, it can be calculated the filter size on the octave and the interval.

Filter Size = 3 (2octave x interval + 1)

If octave = 1, interval = 1
So, filter size = 3 (21 x 1 + 1), Filter size = 9
If, octave = 1, interval = 2
So, filter size = 3 (21 x 2 + 1), filter size = 15.

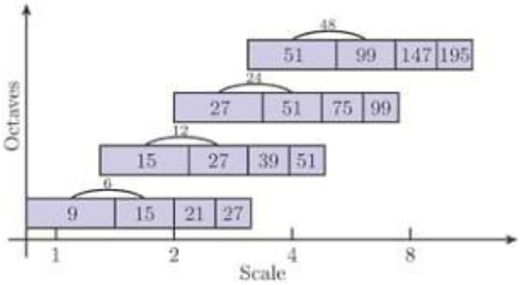


Figure 10 Scale Space

By default there are 3 octaves and 4 intervals per octave. The scale space is divided into octave numbers, where one octave represents the filter response obtained by convoluting the input image with a filter whose size increases.

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1	1	1	-2	-2	-2	1	1	1
1	1	1	-2	-2	-2	1	1	1
1	1	1	-2	-2	-2	1	1	1
1	1	1	-2	-2	-2	1	1	1
1	1	1	-2	-2	-2	1	1	1
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Figure 11 Value of X direction Filter Box, Octav = 1 Interval = 1

0	0	1	1	1	1	1	0	0
0	0	1	1	1	1	1	0	0
0	0	1	1	1	1	1	0	0
0	0	-2	-2	-2	-2	-2	0	0
0	0	-2	-2	-2	-2	-2	0	0
0	0	-2	-2	-2	-2	-2	0	0
0	0	1	1	1	1	1	0	0
0	0	1	1	1	1	1	0	0
0	0	1	1	1	1	1	0	0

Figure 12 Value of Y direction Filter Box, Octav = 1 Interval = 1

0	0	0	0	0	0	0	0	0
0	1	1	1	0	-2	-2	-2	0
0	1	1	1	0	-2	-2	-2	0
0	1	1	1	0	-2	-2	-2	0
0	0	0	0	0	0	0	0	0
0	-2	-2	-2	0	1	1	1	0
0	-2	-2	-2	0	1	1	1	0
0	-2	-2	-2	0	1	1	1	0
0	0	0	0	0	0	0	0	0

Figure 13 Value of the XY direction Filter Box, Octav = 1 Interval = 1

To determine the length of the black lobe at each interval, use the filter size formula divided by 3 in the following formula:
Filter size = (2octave x interval + 1)
Octave = 1, Interval = 1
Lobe size = (21 x 1 + 1)
Lobe size = 3
Next, the convolution calculation of the image that has become the integral image is carried out using the x-direction filter box,

by multiplying each pixel.

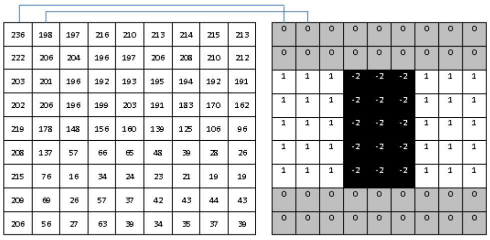


Figure 14 Calculations on the Filter Box

For the results of the convolution between the integral image and the 9x9 filter box with X, Y, XY directions can be seen in the following table:

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
661	1266	1863	-4934	-6134	-7362	4297	4914	5830
863	1674	2467	-6540	-8146	-9756	5677	6464	7242
1082	2071	3012	-7942	-9868	-11756	6802	7695	8569
1290	2416	3468	-8986	-11042	-13026	7476	8397	9207
1505	2707	3775	-9668	-11772	-13802	7885	8825	9744
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Gambar 15 Hasil Konvolusi Box Filter dengan Integral Image Arah X

0	0	631	847	1057	1270	1484	0	0
0	0	1263	1675	2082	2501	2923	0	0
0	0	1863	2467	3067	3681	4297	0	0
0	0	-4934	-6540	-8146	-9756	-11354	0	0
0	0	-6024	-7942	-9868	-11756	-13604	0	0
0	0	-6936	-8986	-11042	-13026	-14952	0	0
0	0	3775	4834	5886	6901	7885	0	0
0	0	4079	5195	6284	7341	8368	0	0
0	0	4368	5547	6675	7766	8828	0	0

Figure 15 Convolution Box Filter Results with X-Direction Integral Image

0	0	0	0	0	0	0	0	0
0	862	1263	1675	0	-5002	-5846	-6696	0
0	1266	1863	2467	0	-7362	-8594	-9828	0
0	1674	2467	3270	0	-9756	-11354	-12928	0
0	0	0	0	0	0	0	0	0
0	-4832	-6936	-8986	0	6513	7476	8397	0
0	-5414	-7550	-9668	0	6901	7885	8825	0
0	-5970	-8158	-10390	0	7341	8368	9352	0
0	0	0	0	0	0	0	0	0

Figure 17 Convolution Box Filter Results with XY Direction Integral Image

1. Description of the Features

To create a descriptor, SURF uses Haar Wavlet as shown below in the process, to find the value of v, with the following formula:

$$V = \{\sum dx, \sum |dx|, \sum dy, \sum |dy|\}$$

To extract the descriptor, the first step taken is to make a square area centered around the feature point and its orientation to a predetermined orientation. An example of the size of the square window is 9s. the area is then further divided into 3x3 dub-regions. This area contains space information according to the original. For each of these sub-regions some simple features will be calculated at the space sample point. For simplicity, the horizontal Haar Wavlet response is called dx and the vertical Haar Wavlet response is called dy. It is defined according to the orientation of the feature points concerned.

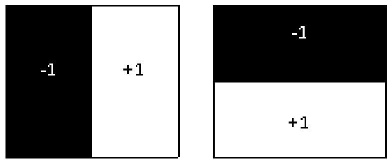


Figure 18 Haar Wavelet

To form a haar-wavlet, it is necessary to add up the pixels in the calculation of the convolution box filter with the image x, y, xy earlier.

Starting from the top left, namely:

0 + 0 + 0 = 0 (Add per pixel in tables 3.19, 3.20 and 3.21)

Then continue to the bottom kepixel. After the features are determined, the values will be obtained as follows.

For the top left first box:

0	0	631	847	1057	1270	1484	0	0
0	862	2526	3350	2082	-2501	-2923	-6696	0
661	2532	5589	0	-3067	-11043	0	-4914	5830
863	3348	0	-9810	-16292	-29268	-17031	-6464	7242
1082	2071	-3012	-15884	-19736	-23512	-6802	7695	8569
1290	-2416	-10404	-26958	-22084	-19539	0	16794	9207
1505	-2707	0	-14502	-5886	0	23655	17650	9744
0	-5970	-4079	-5195	6284	14682	16736	9352	0
0	0	4368	5547	6675	7766	8828	0	0

Figure 19 Haar Wavelet 3x3 sub area 9 plots

Dx = (0-0) + (631-0) + (862-0) + (2526-862) + (2532-661) + (5589-2532)

Dy = (0-0) + (661-0) + (862-0) + (2532-862) + (2526-631) + (5589-2526)

∑|dx| = 0 + 631 + 862 + 1664 + 1871 + 3057 = 8085

∑|dy| = 0 + 661 + 862 + 1670 + 1895 + 3063 = 8151

V = {8085, 8085, 8151, 8151}

Furthermore, it is done the same for all pixels. The results of the 9 plots are as follows:

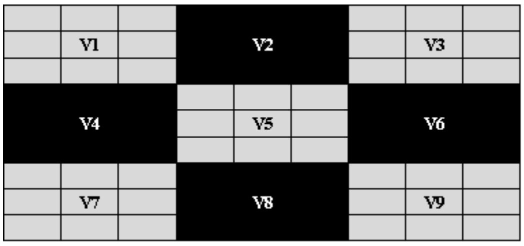


Figure 20 Value Vector Haar wavelet 3x3 sub area 9 plots

V = {∑dx, ∑|dx|, ∑dy, ∑|dy|}

V1 = {8085, 8085, 8151, 8151}

V2 = {-22975, -16826, -22975, -16826}

V3 = {7269, 7269, -568, -568}

V4 = {-16651, -16651, -16157, -21588}

V5 = {-19667, -32831, -19667, -32831}

V6 = {20609, 48851, 55878, 55878}

V7 = {-1216, -1216, -3493, 5565}

V8 = {36598, 36598, 40126, 40126}

V9 = {-39470, 39470, -42224, 42224}

The implementation of this recognition process is that when there is a new input image, the system will process the detection of the number of pixels in the image. If after extracting the feature using the SURF feature and the value at one pixel is the same pixel, then it shows the process in the image can be recognized. So that the 3D cake image object will appear along with information and reservations.

Image ≡ New Image = 3D Image Object

A. Interface Interface Design

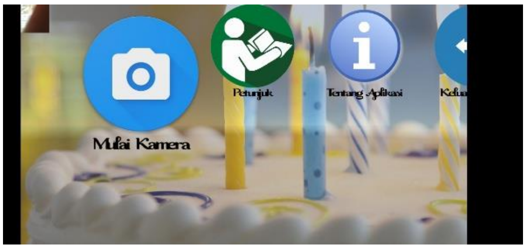
This stage is carried out by implementing the results of the interface design into applications that are built using software. Here are some interfaces that have been implemented.

Splash Screen

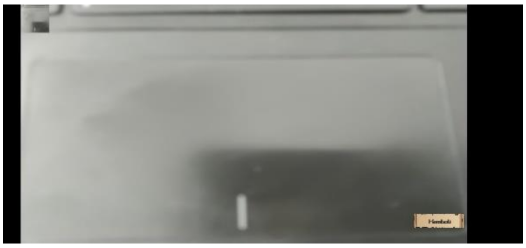
Figure 21 Splash Screen

When the application is first run by the user, the application will display a splash screen.

• Main course



•Start Camera



• 3D Object view appears when marker or marker is detected

4. CONCLUSION

The conclusions of this study are as follows:

1. Applications are more attractive than brochures and help system-based ordering.
2. Applications can provide a visualization of the cake in the form of 3-dimensional objects.
3. The SURF algorithm can be implemented into the application, but there are problems in marker reading caused by light factors, camera angles and resolution.

5. Suggestions

This application is of course still far from perfect, therefore it requires further development and refinement, some developments that can be done are as follows:

1. The use of a more detailed 3D model so that the cake can be visualized more clearly, and features are added to change the color of the cake, change the details of the cake decoration and can rotate the object of the cake.
2. The ordering server uses a server that is open and fully accessible by the developer.
3. The algorithm used in the development of similar applications is expected to use two algorithms so that markers can be detected more clearly, more stable and more quickly.

Thank-you note

The author would like to thank all those who have helped in this research.

REFERENCE

[1] Herbert Bay, Andreas Ess, Tinne Tuytelaars and Luc Van Gool., 2008.*Speeded-Up Robust Features* (SURF).

[2] Munir, Rinaldi., 2011. Algoritma dan Pemrograman. Bandung: Informatika Bandung.

[3] Nazarudin Safaat H., 2014:1. Pemrograman Aplikasi Mobile Smartphone dan Tablet PC Berbasis Android. Bandung: Informatika.

[4] Rahardianto., 2012. Membuat Game 3D Berbasis Web Menggunakan Unity. Jawa Tengah: Interactify Publisher.

[5] Siahaan, Daniel. 2012.Metode RUP.

[6] Andriyadi, Anggi., 2011. *Augmented Reality*. Bandar Lampung: Augmented Reality Team.