IMPLEMENTATION OF AUGMENTED REALITY IN KUNINGAN DISTRICT TOURISM BROCHURE USING SURF ALGORITHM (SPEEDED-UP ROBUST FEATURES) (Case Study: DISPORAPAR KUNINGAN DISTRICT)

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Abstract

The Youth Sports and Tourism Department (DISPORAPAR) is an institution that provides information in a variety of fields, including Youth, Sport, Tourism Destination, Institutional and Partnership, and Marketing. In the field of marketing, the promotion of tourist attraction that has been carried out by DISPORAPAR Kuningan Regency is by using brochure media and Instagram social media, where using the media is less than optimal visualization. This study aims to build an android based application that can provide information about tourist attractions in Kuningan Regency. In this application, it will display 3D objects and videos of each tourist attraction. In making this application the technology used is Augmented Reality using the Marker Based Tracking method which is a method in Augmented Reality that requires markers as markers, these markers usually feature black edges and white backgrounds. The Speeded-Up Robust Features (SURF) algorithm is used to detect local features of an image and to design a system using the Unified Modeling Language (UML). The final result of this research is an Augmented Reality application that displays information in the form of 3D objects and interactive tourist attraction videos. It is hoped that this application can help DISPORAPAR in socialization activities and make it easier for people to get information about tourist attractions in Kuningan Regency.

Keywords : *The Kuningan District Sports and Tourism Department (DISPORAPAR), Travel Attractions, Augmented Reality, Based Tracking Marker, Speeded-Up Robust Features (SURF).*

1. INTRODUCTION

Kuningan Regency is one of the areas in West Java Province that has fertility and natural beauty, a wealth of cultural arts and cool air because it is located at the foot of Mount Ciremai, the highest mountain in West Java and has several Tourist Attractions (DTW).

DISPORAPAR is an institution that provides information in various fields. In the field of marketing, the promotion that has been carried out by DISPORAPAR Kuningan Regency is by using brochures and through social media, where the visualization is not optimal. Therefore, it is necessary to have a new breakthrough in informing tourist attraction (DTW), one of

which is by utilizing augmented reality technology.

The use of technology can help provide more interactive information, such as the use of augmented reality technology. Augmented Reality is a breakthrough and innovation in the growing field of multimedia and image processing. This technology is able to lift an object that was previously flat or two-dimensional, as if it had become real and blended with the surrounding environment (Budi Arifitama, 2017).

In the use of augmented reality technology, an algorithm is needed that aims to detect the local features of an image. The algorithm used is the Speeded-Up Robust Features (SURF) algorithm. The SURF algorithm was first published by researchers from ETH Zurich, Herbert Bay. Based on the description that has been described above the writer will implement augmented reality technology in the promotion of tourist attractions in Kuningan Regency, so in this study the author takes the title "IMPLEMENTATION OF AUGMENTED REALITY IN KUNINGAN TOURISM BROCHURE USING ALGORITHM. **SURF (*SPEEDED-UP ROBUST FEATURES*)**".

2. RESEARCH METHODOLOGY

Research methodology is a way to find out the results of a specific problem, where this problem is also called a research problem.

A. Data Collection Method

1. Interview Method

The author conducted an interview with Mrs. Ani Nurhayati, SE., MM as the Tourism Promotion and Information Section in Kuningan Regency.

2. Observation Method

The author made direct observations by visiting DISPORAPAR Kuningan District, and several tourist attractions.

3. Literature Method

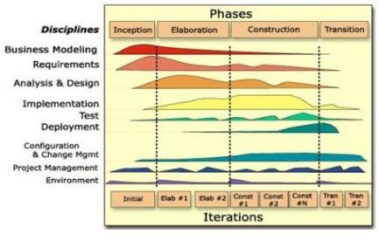
The author collects data from books, journals, the internet, and brochures that are relevant to the study in this study.

B. Software Development Methods

The system development method used in designing this software application uses the Rational Unified Process (RUP) work methodology.

The iterative process in the RUP globally can be seen in the following figure:

Gambar 1.1 *Fase RUP* (A. S.



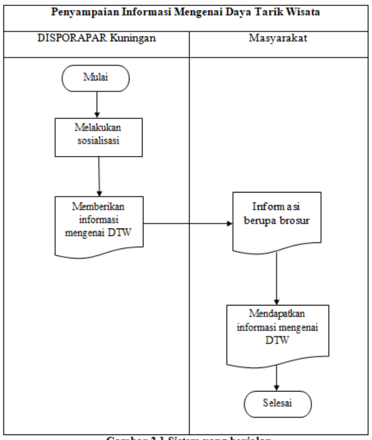
Rosa dan M. Salahuddin, 2013)

Based on figure 1.1 the RUP phase has four stages in software development, namely:

1. Inception (data collection)
2. Elaboration (Analysis and Design)
3. Contruction (Coding and Implementation)
4. Transition (Testing and Maintenance)

3. RESULTS AND DISCUSSION

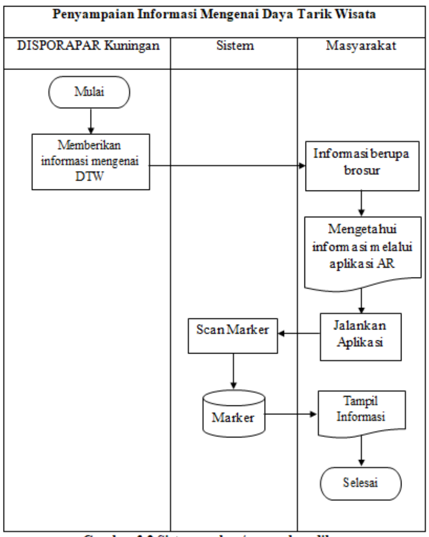
A. Ongoing System Analysis



Gambar 3.1 Sistem yang berjalan

Based on Figure 3.1, the socialization process carried out by DISPORAPAR Kuningan is still using brochure media, and usually the information contained in the brochure is not optimal and less visualized.

B. Analysis of the System To Be Built



Gambar 3.2 Sistem usulan / yang akan dibangun

Based on Figure 3.2, the proposed system to be built is by utilizing augmented reality technology as a medium to inform DTW to make it more attractive and to maximize visualization.

C. Problem Solving Analysis

Speeded-Up Robust Features (SURF) Algorithm

SURF works on an image as follows:

1. The initial process of this algorithm is to prepare the input image. This input image format changes the RGB image format to a grayscale image.


Gambar 3.5 Citra Masukan

Gambar 3.4 Titik awal

Tabel 3.4 Citra Masukan

91 47 21	96 53 9	230 190 129	231 192 123	236 197 128	228 189 124	208 168 106	113 74 32	190 162 138
116 71 37	158 112 77	104 58 15	227 182 125	214 171 103	194 150 76	172 127 36	134 81 31	151 101 75
102 60 19	131 86 62	91 43 23	110 63 31	171 128 73	180 138 65	184 132 29	170 109 45	156 96 60
132 96 43	83 41 63	110 63 47	101 53 33	90 44 3	162 120 62	199 142 55	178 117 49	129 72 17
177 142 74	154 155 58	103 60 17	94 47 15	156 107 76	130 80 44	157 93 44	179 123 62	151 101 37
132 95 12	171 133 49	174 131 62	98 48 3	145 91 62	112 55 34	117 47 31	162 109 56	167 124 55
126 94 42	123 92 34	191 158 89	188 150 87	96 49 12	94 39 26	105 43 23	130 74 36	157 111 52
215 183 134	138 107 52	131 100 32	178 148 77	178 135 90	121 74 47	120 65 25	111 56 19	111 62 21
221 187 139	201 170 116	151 120 55	133 102 34	156 121 65	148 110 65	142 93 32	115 65 26	78 26 3

Converting into image form

grayscale, with the formula:

$$Grayscale = \frac{R+G+B}{3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Bottom right pixel example:

RGB = 91, 47, 21

Grayscale = (R+G+B)/3

= (91+47+21)/3
= 159/3
= 53

If done on all pixels, then below is the result of the calculation of converting an RGB image to a grayscale image:

Tabel 3.5 Hasil Citra Grayscale

53	53	183	182	187	180	161	73	163
75	116	59	178	163	140	112	82	109
60	93	52	68	124	128	115	108	104
90	44	73	62	46	115	132	115	73
131	122	60	52	113	85	98	121	96
80	118	122	50	99	67	65	109	115
87	83	146	142	52	53	57	80	107
177	99	88	134	134	81	70	62	65
182	162	109	90	114	108	89	69	36

The image obtained becomes a grayscale image, then it is represented into 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)

Tabel 3.6 Arah Perhitungan Citra Integral

	y							
x	53	53	183	182	187	180	161	73	163
	75	116	59	178	163	140	112	82	109
	60	93	52	68	124	128	115	108	104
	90	44	73	62	46	115	132	115	73
	131	122	60	52	113	85	98	121	96
	80	118	122	50	99	67	65	109	115
	87	83	146	142	52	53	57	80	107
	177	99	88	134	134	81	70	62	65
	182	162	109	90	114	108	89	69	36

Tabel 3.7 Perhitungan Citra Integral

Nilai Pixel	Keterangan
i(x,y) = 53 | 0 0 | 0	s(x,y) = i(x,y) + s(x,y-1) + s(x-1,y) – s(x-1,y-1) s(x,y) = 53+0+0-0 s(x,y) = 53
s(x,y) = 53 | i(x,y) = 53 0 | 0	s(x,y) = i(x,y) + s(x,y-1) + s(x-1,y) – s(x-1,y-1) s(x,y) = 53+0+53-0 s(x,y) = 106
s(x,y) = 53 | s(x,y) = 106 i(x,y) = 75 | 0	s(x,y) = i(x,y) + s(x,y-1) + s(x-1,y) – s(x-1,y-1) s(x,y) = 75+53+0-0 s(x,y) = 128
s(x,y) = 53 | s(x,y) = 106 s(x,y) = 128 | i(x,y) = 116	s(x,y) = i(x,y) + s(x,y-1) + s(x-1,y) – s(x-1,y-1) s(x,y) = 116+128+106-53 s(x,y) = 297

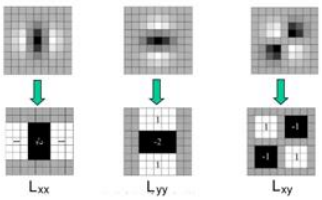
Below is a calculation of all the pixels in the feature boxes.

Tabel 3.8 Hasil Perhitungan Citra Integral

53	106	289	471	658	838	999	1072	1235
128	297	539	899	1249	1569	1842	1997	2269
188	450	744	1172	1646	2094	2482	2745	3121
278	584	951	1441	1961	2524	3044	3422	3871
409	837	1264	1806	2439	3087	3705	4204	4749
489	1035	1584	2176	2908	3623	4306	4914	5574
576	1205	1900	2634	3418	4186	4926	5614	6381
753	1481	2264	3132	4050	4899	5709	6459	7291
935	1825	2717	3675	4707	5664	6563	7382	8250

1. Detecting Feature Points

$$H(x, \sigma) = \begin{bmatrix} Lxx(x,\sigma) & Lxy(x,\sigma) \\ Lxy(x,\sigma) & Lyy(x,\sigma) \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$



Gambar 3.8 Aproksimasi untuk orde kedua turunan Gaussian dengan kotak filter

Tabel 3.9 Perhitungan pada Box Filter

53	106	289	471	658	838	999	1072	1235
128	297	539	899	1249	1569	1842	1997	2269
188	450	744	1172	1646	2094	2482	2745	3121
278	584	951	1441	1961	2524	3044	3422	3871
409	837	1264	1806	2439	3087	3705	4204	4749
489	1035	1584	2176	2908	3623	4306	4914	5574
576	1205	1900	2634	3418	4186	4926	5614	6381
753	1481	2264	3132	4050	4899	5709	6459	7291
935	1825	2717	3675	4707	5664	6563	7382	8250

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

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

Tabel 3.10 Hasil Konvolusi Arah X

0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
188	450	744	-2344	-3292	-4188	2482	2745	3121
278	584	951	-2882	-3922	-5048	3044	3422	3871
409	837	1264	-3612	-4878	-6174	3705	4204	4749
489	1035	1584	-4352	-5816	-7246	4306	4914	5574
576	1205	1900	-5268	-6836	-8372	4926	5614	6381
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0

Tabel 3.11 Hasil Konvolusi Arah Y

0	0	289	471	658	838	999	0	0
0	0	539	899	1249	1569	1842	0	0
0	0	744	1172	1646	2094	2482	0	0
0	0	-1902	-2882	-3922	-5048	-6088	0	0
0	0	-2528	-3612	-4878	-6174	-7410	0	0
0	0	-3168	-4352	-5816	-7246	-8612	0	0
0	0	1900	2634	3418	4186	4926	0	0
0	0	2264	3132	4050	4899	5709	0	0
0	0	2717	3675	4707	5664	6563	0	0

Tabel 3.11 Hasil Konvolusi Arah XY

0	0	0	0	0	0	0	0	0
0	297	539	899	0	-3138	-3684	-3994	0
0	450	744	1172	0	-4188	-4964	-5490	0
0	584	951	1441	0	-5048	-6088	-6844	0
0	0	0	0	0	0	0	0	0
0	-2070	-3168	-4352	0	3623	4306	4914	0
0	-2410	-3800	-5268	0	4186	4926	5614	0
0	-2962	-4528	-6264	0	4899	5709	6459	0
0	0	0	0	0	0	0	0	0

1. Description fitur:

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

Gambar 3.10 Wavelet Response

To form a Haar-wavelet, it is necessary to add up the pixels in the convolutional filter box calculation with the x, y, xy images. Starting from the top left, namely: 0 + 0 + 0 = 0 (Adding per pixel in tables 3.10, 3.11, 3.12 provided that minus numbers are not added). Then continue to the bottom pixel.

Tabel 3.13 Haar Wavelet 3x3 sub area 9 petak

0	0	289	471	658	838	999	0	0
0	297	1078	1798	1249	1569	1842	0	0
188	900	2232	2344	1646	2094	4964	2745	3121
278	1168	1902	1441	0	0	3044	3422	3871
409	837	1264	0	0	0	3705	4204	4749
489	1035	1584	0	0	3623	8612	9828	5574
576	1205	3800	2634	3418	8372	14778	11228	6381
0	0	2264	3132	4050	9798	11418	6459	0
0	0	2717	3675	4707	5664	6563	0	0

For the top left first box:

$$Dx = (0-0) + (289-0) + (297-0) + (1078-297) + (900-188) + (2232-900)$$
$$= 3411$$

$$Dy = (0-0) + (188-0) + (297-0) + (900-297) + (1078-289) + (2232-1078)$$
$$= 3031$$

$$\sum|dx| = 0 + 289 + 297 + 781 + 712 + 1332 = 3411$$

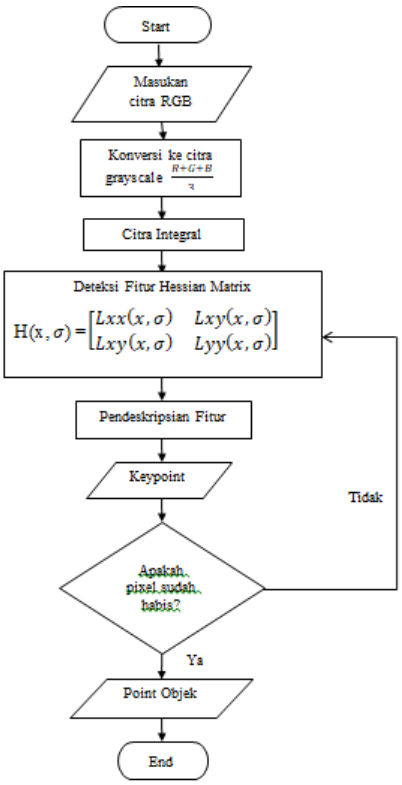
$$\sum|dx| = 0 + 188 + 297 + 603 + 789 + 1154 = 3031$$

Tabel 3.14 Nilai Vektor Haar Wavelet 3x3 sub area 9 petak

	V1			V2			V3	
	V4			V5			V6	
	V7			V8			V9	

V = {∑dx, ∑|dx|, ∑dy, ∑|dy|}
V1 = {3411, 3411, 3031, 3031}
V2 = {-112, 2382, 4117, 4117}
V3 = {-4684, 5436, 9831, 9831}
V4 = {3574, 3574, -240, 1698}
V5 = {2182, 5064, 2182, 5064}
V6 = {-1667, 7341, 13677, 13677}
V7 = {8205, 8205, 1264, 4346}
V8 = {14393, 14393, -378, -378}
V9 = {-26378, 26378, -25824, 25824}

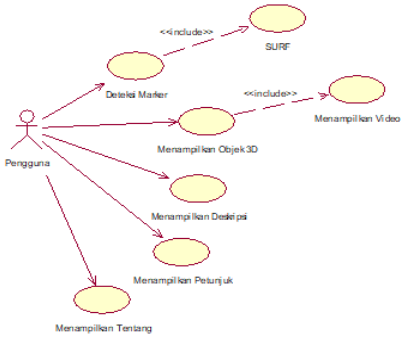
The following is an algorithm flowchart to solve the problems the authors face.



Gambar 3.4 Flowchart Algoritma *SURF*

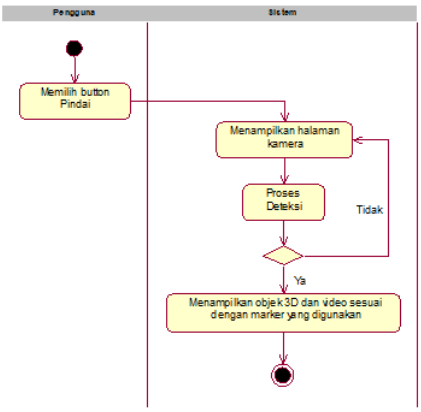
A. System Design

Use Case Diagram



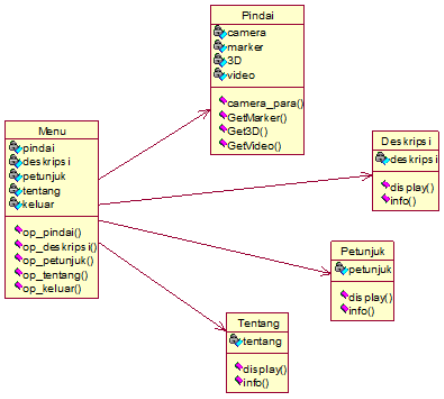
Gambar 3.11 Use Case Diagram

Activity Diagram



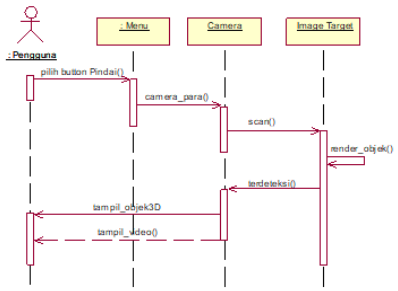
Gambar 3.12 Activity Diagram Deteksi Marker

Class Diagram



Gambar 3.17 *Class Diagram*

Sequence Diagram



Gambar 3.18 Sequence Diagram Deteksi Marker

A. Main Menu Interface

Gambar 4.1 Antarmuka Menu Utama

In Figure 4.1 there are several menus that will be displayed in the application, namely:

a. Scan: To start the camera and detect markers.

b. Description: To display information on a tourist attraction.

c. Instructions: To display instructions for using the application.

d. About: To display application maker information.

e. Exit: To exit the application.

B. Scan Interface

Gambar 4.2 Antarmuka Pindai

C. 3D Object and Video Page Interface

Gambar 4.3 Antarmuka Halaman Objek 3D dan Video

D. Black Box Testing Results

Tabel 4.1 Pengujian *Black Box*

No	Fungsi yang diuji	Cara Pengujian	Hasil Yang diharapkan	Kesimpulan
1.	Menu	Memilih *Button* Pindai	Proses tampil objek 3D dan video daya tarik wisata sesuai marker	[√] Diterima [ ] Ditolak
		Memilih *Button* Deskripsi	Proses tampilan deskripsi daya tarik wisata	[√] Diterima [ ] Ditolak
		Memilih *Button* Petunjuk	Proses tampilan cara menggunakan aplikasi	[√] Diterima [ ] Ditolak
		Memilih *Button* Tentang	Informasi tentang pembuat aplikasi	[√] Diterima [ ] Ditolak
		Memilih *Button* Keluar	Proses untuk keluar aplikasi	[√] Diterima [ ] Ditolak
		Button Kembali	Proses kembali ke scene sebelumnya	[√] Diterima [ ] Ditolak
2.	Fungsionalitas Menampilkan Video	*Button Play*	Memulai video dan menampilkan informasi daya tarik wisata sesuai marker	[√] Diterima [ ] Ditolak
		Button Pause	Menghentikan sementara video ketika sedang berjalan	[√] Diterima [ ] Ditolak
		Button Stop	Menghentikan	[√] Diterima

E. White Box Test Results

1. The first node includes a section

```
1.  public void PlayPause() {
```

2. The second node includes a section

```
2.      if(!firstRun && !isPaused) {
```

3. The third node includes a section

```
3.          videoPlayer.Pause();
4.          audioSource.Pause();
5.          playIcon.SetActive(true);
6.          isPaused = true;
```

4. The fourth node includes a section

```
7.      } else if (!firstRun && isPaused) {
```

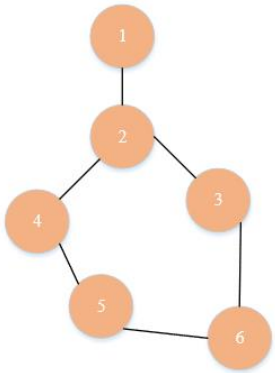
5. The fifth node includes a section

```
8.          videoPlayer.Play();
9.          audioSource.Play();
10.         playIcon.SetActive(false);
11.         isPaused = false;
```

6. The sixth node includes a section

```
13.     else {
14.         StartCoroutine(playVideo());
```

From the table and after division into nodes, a flow graph can be formed as shown in Figure 4.8.



Formula **V(G) = (E – N) +2**

So : V(G) = (6 – 6) + 2
V(G) = 2

So, clyclomatic complexity for Figure 4.8 is 2.

Based on testing with a white box, the program is valid or accepted.

4. CONCLUSION

Based on the results of this thesis research entitled "IMPLEMENTATION OF AUGEMENTED REALITY IN KUNINGAN TOURISM BROCHURE USING SURF ALGORITHM (SPEEDED-UP ROBUST FEATURES), the authors can draw the following conclusions:

1. The augmented reality application is made by applying the SURF algorithm.
2. This application provides new innovations in the socialization process in order to help the Youth Sports and Tourism Agency (DISPORAPAR) to convey information about the Tourist Attractions (DTW) in Kuningan Regency.
3. Using augmented reality technology in tourism brochures can provide more interactive information and visualization to be more attractive.

5. ADVICE

The suggestions from the author based on the research results of the thesis that have been made are as follows:

1. It is hoped that this application can be used / applied in the

socialization of tourist attractions in Kuningan Regency.

2. In the next development stage, 3D objects can be made better so that the results are more like the real objects.
3. The interface in the application is made more user friendly.
4. As well as a development in the use of algorithms used for more accurate feature detection / matching.

REFERENCES

A. S. Rosa, dan M. Salahuddin. (2013). *Rekayasa Perangkat Lunak*. Bandung : Informatika Bandung.

Arifitama, Budi. (2017). *Panduan Mudah Membuat Augmented Reality*. Yogyakarta : Andi.

Dr. Suarga, M.Sc., M. Math., Ph.D. (2012). Algoritma Pemrograman.

Hapsari, Rinci Kembang, Nur Sulaiman, Luky Agus Hermanto. (2016). Aplikasi Findgo_ITATS Berbasis Android dengan Algoritma SURF untuk Menampilkan Informasi Lokasi di ITATS. Diambil dari https://www.researchgate.net/publication/321996004_Aplikasi_Findgo-ITATS_Berbasis_Android_Dengan_Algoritma_SURF_Untuk_Menampilkan_Informasi_Lokasi_Di_ITATS.

Nidhra, Srinivas dan Jagruthi Dondeti. (2012). Black box and White box Testing Techniques – A Literature Review. Internasional Journal of Embedded System and Applications (IJESA) Vol.2, No.2.

Widodo. (2011). Model UML (Unified Modeling Language).