IJCCS (Indonesian Journal of Computing and Cybernetics Systems)
Vol.x, No.x, July xxxx, pp. 1~5
ISSN (print): 1978-1520, ISSN (online): 2460-7258
DOI: 10.22146/ijccs.xxxx

Gaussian Blur Filter Effect Analysis on Facial Detection Accuracy Using Viola Jones Method

Saryanto[1], Widyastuti Andriyani *[2]
[1,2]Master of Information Technology, FTI UTDI, Yogyakarta, Indonesia Jl. Janti No.143, Karang Jambe, Kec. Banguntapan, Bantul, Istimewa Yogyakarta Region 55918
e-mail: **[1]saryanto@itda.ac.id, *[2]widya@utdi.ac.id**

Abstrak

Deteksi wajah manusia merupakan salah satu topik yang paling banyak dipelajari di bidang computer vision. Tujuan deteksi wajah adalah untuk mengetahui ada atau tidaknya wajah pada suatu gambar. Blur dapat disebabkan oleh banyak hal, seperti pergerakan yang terjadi saat kamera mengambil gambar atau penggunaan kamera yang tidak fokus saat mengambil gambar. Untuk pengenalan wajah, blur menjadi sulit untuk mendapatkan informasi tentang objek, mendapatkan deskripsi tentangnya, atau mengidentifikasi wajah yang ada dalam gambar. Semakin blur sebuah gambar, semakin sulit untuk mengidentifikasinya. Penelitian ini menerapkan Metode Viola-Jones relatif untuk deteksi wajah dengan tingkat akurasi yang tinggi dan komputasi yang cepat. Penelitian ini menganalisi pengaruh filter gaussian blur dengan menghitung berapa radius sebuah objek yang telah diberikan filter gausian blur sehingga tidak dapat lagi diidentifikasi sebagai objek, dan juga mencari nilai PSNR minimal yang masih dapat diterima dalam proses deteksi objek. Penelitian ini menemukan bahwa ketika filter gaussian blur diterapkan dengan rasio 68% dari objek, sudah tidak ada yang terdeteksi sebagai wajah. Nilai PSNR minimum untuk gambar adalah 16,6 dB, dan nilai PSNR minimum sebelum wajah tidak dapat terdeteksi lagi adalah 17,84 dB..

Kata kunci*: Gaussian Blur, Viola Jones, Deteksi Obyek, PSNR, Pengukuran Kualitas Citra.*

Abstract

Human face detection is one of the most studied topics in computer vision. The purpose of facial detection is to find out whether or not a face is present in an image. Blur can be caused by many things, such as motion that occurs when the camera takes a picture or the use of a camera that is not focused when taking a picture. For facial recognition, blur becomes difficult to get information about an object, get a description about it, or identify a face in the image. The more blur a picture, the more difficult it is to identify it. This research applies the Viola-Jones relative method for facial detection with a high degree of accuracy and fast computation. This study analyzed the influence of a gaussian blur filter by calculating how much radius an object has been given a gausian blur filter so that it can no longer be identified as an object, and also looking for the minimum PSNR value that is still acceptable in the object detection process. The minimum PSNR value for the image is 16.6 dB, and the minimum PSR value before the face can no longer be detected is 17.84 dB.

Keywords : *Gaussian Blur, Viola Jones, Object Detection, PSNR, Image Quality Measurement.*

Received June 1st,2012; Revised June 25th, 2012; Accepted July 10th, 2012

IJCCS (Indonesian Journal of Computing and Cybernetics Systems)
Vol.x, No.x, July xxxx, pp. 1~5
ISSN (print): 1978-1520, ISSN (online): 2460-7258
DOI: 10.22146/ijccs.xxxx

1. INTRODUCTION

One of the most common problems with images is the blur effect, which is an important step in the process of object detection, namely improving image quality. The worse the image quality, the more difficult it is to identify and retrieve information, both by humans and machines.[1]. One of the major areas of computer vision is face recognition, which has many benefits, such as security surveillance, human-computer interaction, and facial recognition technology. Face detection is done to find out if faces are in the picture, and this is the first step in the identification process, so it's very important. Viola-Jones' method is associated with highly accurate facial detection and fast computing. In the Viola Jones method, image integral calculation is used to determine whether there is a Haar feature in the Region of Interest (ROI) image field. This problem can lead to an object detection error. The value of the image element (pixel) interfered with the blur effect is used for the image integral computation. This blur effects cause errors in the Haar feature detection process, which causes the error detection of the object to be either positive (no object detected) or negative (there is an object detected but cannot be detected).

There is no need to improve the image quality significantly on each pixel of the image during the object detection process [2] as this will result in longer computational processes and useless results [3]. The image integral calculation process does not require the maximum value to obtain the Haar feature detection result. Furthermore, excellent image quality is not suitable for the object detection process, especially if this process is used for fast detection of objects requiring high computing speeds. The threshold value of Haar feature detection obtained in the training process is only required slightly above in the image integral process. The Haar feature is designed to detect cumulative intensity differences between different regions in the image. Image integrals allow quick calculation of the number of pixel intensities in a square-length area, which is the core of the Haar feature calculation. Focusing on the difference in the amount of pixels makes object detection more effective without requiring the maximum intensity of the pixel.

The objective of this study is to investigate how the application of Gaussian Blur filters affects the accuracy of object detection using the Viola-Jones method. The study also focuses on testing the various levels of obscurity produced by the gaussian blur filter and the effect of these levels on the accurate assessment of objects. This research helps to determine the ideal level of obscurity that can improve accuracy without slowing down the detection speed. Studi ini berdampak langsung pada berbagai aplikasi yang ada di dunia nyata, seperti sistem pengawasan video, sistem navigasi kendaraan otonom, dan aplikasi telepon yang membutuhkan pendeteksian objek yang cepat dan akurat.

2. METHODS

In Figure 1 is an overview of the system to be designed, the stages of the image can be described as follows:

1. Data preparation stage The data preparation phase is with a good image, Grayscale image used in this study is JKT48 Group Photo.
2. Destroy the image by giving the Gaussian blur filter. Before the image is given the gaussianblur filter ranging from 1% to 100%.
3. Convert the image given by the Gasussian blur filter to a video file. Before the image data is ready to be entered into the image object detection application in the video file converter
4. Object detection process (Face), image data that has been converted to video is subsequently entered into the object detection application. Then the number of faces

IJCCS (Indonesian Journal of Computing and Cybernetics Systems)
Vol.x, No.x, July xxxx, pp. 1~5
ISSN (print): 1978-1520, ISSN (online): 2460-7258
DOI: 10.22146/ijccs.xxxx

detected from the video image that has already been given a gaussian blur filter is calculated from the level of 1% to 10%.
5. The process of calculating PSNR values on images that contain Blur
6. The accuracy calculation. The calculation is done after the completion of the Object Detection process and then calculated using the K-Means and Fuzzy K- Means methods.

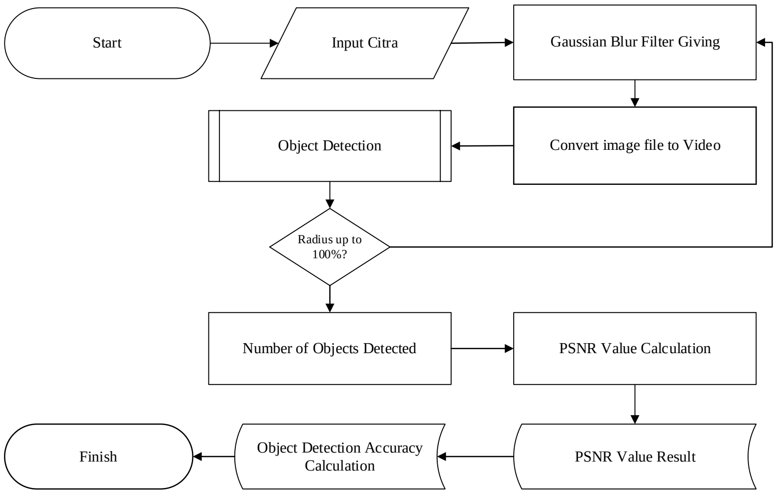


Figure 1. System Diagram

3. RESULTS AND DISCUSSION

3.1 Blur Effect Giving

In this study, the blur effect was deliberately created on an image, and the image quality was measured to determine to what extent the Viola Jones method is still able to locate objects disturbed by the bleur effect. Gaussian blur effect of level 1 % applied to the image. This effect increases gradually over time as shown in Figure 2.

(a) Image before exposure to Gasssian Blur Filter (b) Image after Gaussian blur Effect
Figure 2. Figure of Gaussian Blur Effect Giving Process

After the blur effect is added, image quality is assessed by calculating the Peak Signal to Noise Ratio value (PSNR). Next, as shown in Figure 1, the image is inserted into the object detection program. Here are the algorithms for generating blur effects:

1. Gives a gaussian blur effect on the initial image from 0 to 100.
2. If the gaussian blur radius level continues to detect the object, repeat the image until it can not be detected again.
3. Save the new image created.

Received June 1st,2012; Revised June 25th, 2012; Accepted July 10th, 2012

3. 2 *Process of converting image data from a jpg file to a video file*

Before the data is entered into the object detection application, the image data that has already been given the gaussian blur filter is then converted into video as shown in Figure 3.

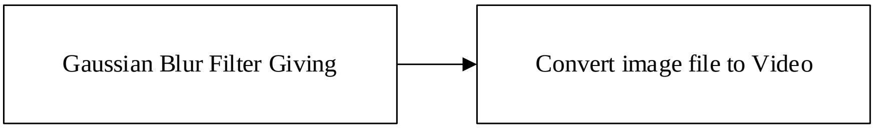


Figure 3. Conversion jpg file to video

3. 3 Object Detection

A process of finding and identifying a particular object in an image. Haar like Feature method is a technique that is often used to detect objects. Its name comes from Haar Wavelet, a mathematical function with a box shape that has a Fourier function principle [4]. The Haar-like features principle is that a square feature, or square function, can indicate specifically on an image or image. They recognize objects by the simple value of a feature, not the pixel value of an image. This method has the advantage, that is, it is a very fast computational process because it depends on the number of square pixels than the pixel value of each image [5].There are four main keys in Viola Jones's object detection method [5], namely:

1. A simple quadratic feature is called a Haar feature.
2. Integral image for fast feature detection.
3. AdaBoost machine learning method.
4. Cascade Classifier for connecting and grouping many features efficiently. The Haar-like feature variation type is shown in Figure 4 [6] :

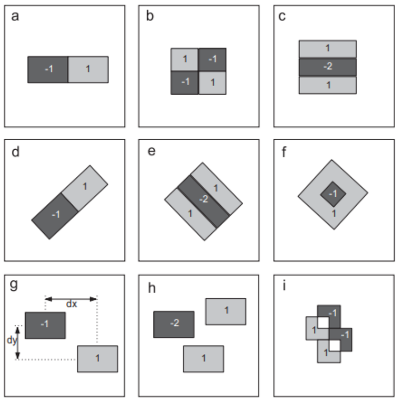


Figure 4. Type of Square Hair Variation

Figure 4 shows the process of searching for Haar feature values in a Region of Interest (ROI), which includes some basic steps. Object detection and pattern recognition on images are two examples of common application of this method. Here's the general procedure:

1. Specify the area within the image that represents the ROI. You can do this manually or by using pre-processed object detection methods such as facial detection algorithms.

Received June 1st,2012; Revised June 25th, 2012; Accepted July 10th, 2012

2. Do pre-processing on ROI to improve image quality and reduce noise if necessary. Smoothing, giving contrast, and normalizing pixel intensity are some examples of pre-processing operations.
3. Haar filters are round or rectangle-shaped filters that can be used on ROI to calculate feature values. Each Haar filter, whether horizontal, vertical, or diagonal, consists of two parts: the black and white parts.
4. Convolutions between Haar filters and ROI. This includes the calculation of the integral value of the pixel intensity within each subblock entered by the Haar filter.
5. After the convolutions are completed, find the Haar feature value by decreasing the total pixel intensity in the black part from the total pixels in the white part. This feature value shows the difference between the black and white parts of the Haar filter in the ROI.
6. Use the resulting Haar feature value to scan or detect objects on ROI. This feature value will help in identifying the presence or absence of the object.
7. Determine the appropriate threshold to distinguish between an object and a background based on the Haar characteristic values. This limit will be used to decide whether an area is considered to contain an object or not.

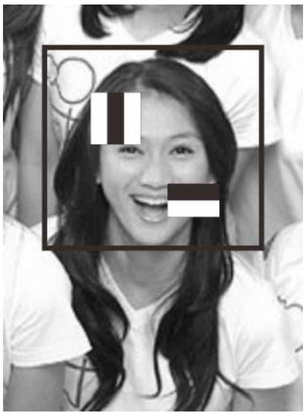


Figure 5. Face Object Detection Process

3. 2 Process of calculating PSNR Values On Images Containing Blur

The difference between the maximum value of the signal and the size of the noise that affects the signal is called PSNR. A high PSR value is required for a good reconstruction or compression image quality, but a low PSR is required to evaluate the image segmentation result [7] A way to determine the image quality is to compare the original image with the image given the blur effect; the actual image is the best image, and the lower image quality indicates a larger value. There are two algorithms that can be used to measure image quality, namely Mean Square Error (MSE) and Peak Signal to Noise Ratio (PNSR) [8]

1. Calculates the value of the Mean Square Error (MSE). MSE has the formula shown on the equation (1) as follows:

$$MSE = \frac{1}{m\,x\,n}\sum_{i=0}^{n-1}\sum_{j=0}^{m-1}[f\,(i,j) - g(i,j)]^2 \quad (1)$$

Where:
m and n are the dimensions (width and height) of the image to be observed.

Received June 1st,2012; Revised June 25th, 2012; Accepted July 10th, 2012

IJCCS (Indonesian Journal of Computing and Cybernetics Systems)
Vol.x, No.x, July xxxx, pp. 1~5
ISSN (print): 1978-1520, ISSN (online): 2460-7258
DOI: 10.22146/ijccs.xxxx

I (i,j) : Value of the gray level of the original image pixel on the coordinates (i,j)
K (i,j) : The gray level value of the pixel image to measure its quality at the coordinates (i,j).

2. Peak Signal to Noise Ratio (PNSR)

To find the PSNR value use the formula (2) as follows:

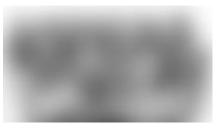
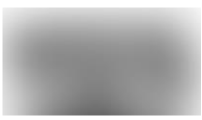
$$PSNR = 10.log_{10}\left(\frac{MAX_1^2}{MSE}\right) \quad (2)$$

Where:
MAXI: Maximum pixel value on the original image
The MSE value obtained at the equation (1) is replaced at equation (2).
The PSNR value has a unit (dB) which is the quality value of an image.

3.3 Gaussian blur level effect on PSNR values

After the original image is given the Gaussian blur effect, the resulting image is evaluated by the image quality assessment method. This method measures image quality for various image processing applications, measures digital image degradation to improve image quality. The process of image acquisition results in a reduction in the quality of an image. Decreased digital image quality and improved image quality measured using the Image Quality Assessment Method (IQA) [9]. Table 1 shows the image quality value with the image blur effect ratio comparison.

Table 1. Image Quality Value With Blur Effect Ratio Comparison

No	Original	With Gaussian Blur	Name File	Ratio Efek Blur (%)	MSE	PSNR
1			Jkt48.jpg	1	0,037864685	62,34846012
2			Jkt48.jpg	51	3901,600194	12,21837597
3			Jkt48.jpg	100	7710,546861	9,259951799

In Table 1 it is known that for images with a 100% blur effect level, information from images with blur coding. The graphic comparison of image quality with disturbance is shown in Figure 6.

Received June 1st,2012; Revised June 25th, 2012; Accepted July 10th, 2012

IJCCS (Indonesian Journal of Computing and Cybernetics Systems)
Vol.x, No.x, July xxxx, pp. 1~5
ISSN (print): 1978-1520, ISSN (online): 2460-7258
DOI: 10.22146/ijccs.xxxx

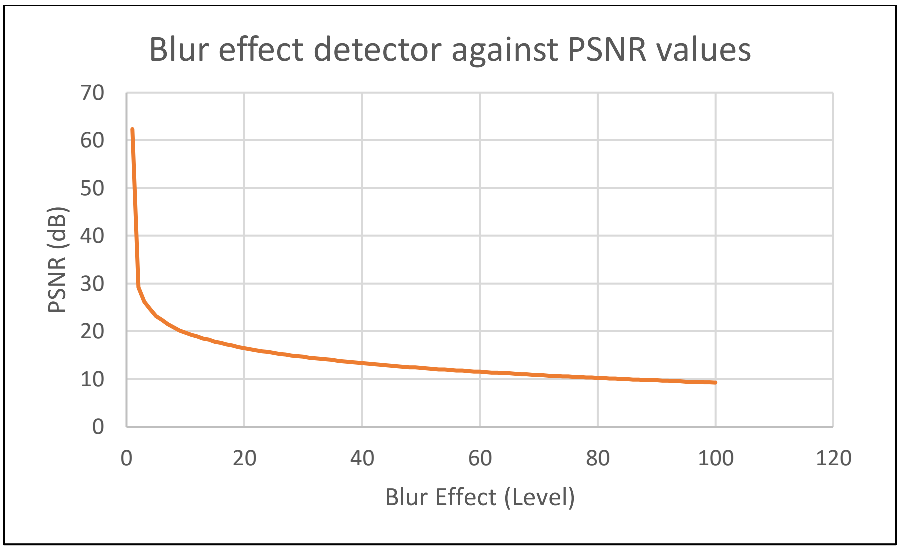


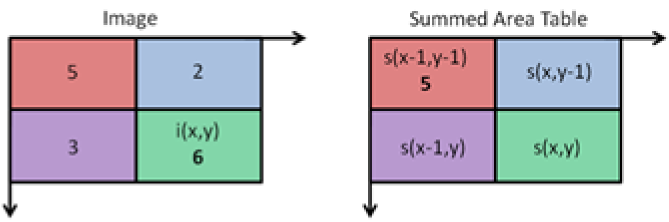
Figure 6. Comparison of PSNR values with image level blur effect ratio

From Figure 6 it is known that the higher the effect blur level of an image, the lower the PSNR value of the image. This is due to the effectblur then will make a difference between the observed image and the original image [8]

3. 5 Integral Image

The image integration process is used to facilitate the calculation of Haar feature values at each image location in this study. The weight addition, which is the value of the pixel to be added to the original image, is an integral component. The number of pixels above and to the left of each pixel is its integral value. The integer per pixel operation can be used to combine the image as a whole.

Calculation of the integral value of each pixel on the gray image matrix by adding the original value of the previous pixel to the adjacent pixel cumulative value described in Figure 7 [10].



(a) Original Image (b) Integral Image
Figure 7. Integral Image Matrix Calculation Process

To calculate the Haar value feature using the Summed Area Table or known as the Integral image (Figure 7.b). (3).

s(x,y) = i(x,y) + s(x-1,y) + s(x,y-1) - s(x-1,y-1).. (3)

Where:

Received June 1st,2012; Revised June 25th, 2012; Accepted July 10th, 2012

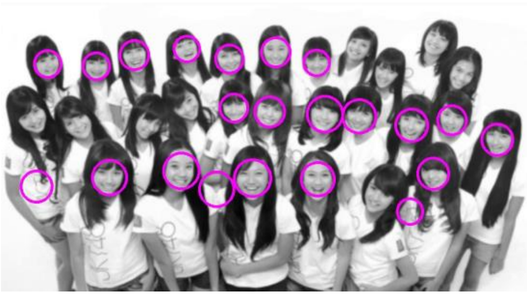
IJCCS (Indonesian Journal of Computing and Cybernetics Systems)
Vol.x, No.x, July xxxx, pp. 1~5
ISSN (print): 1978-1520, ISSN (online): 2460-7258
DOI: 10.22146/ijccs.xxxx

s(x,y) : The pixel value of the Summed Area Table to be searched for for its integral value at the position (x,y).
i(x,y) : Pixel value on the original image at the position (x,y).
s(x-1,y): Pixel values on the summed area table at the left-hand position of the pixel position (x,y).
s (x, y-1) : pixel value in the Summet Area Table at the top-hand position of the pixels (x & y). (x,y).

Using this integral value, we can calculate the number of pixels in a square or square-long area by taking integral values from the four corner points of that region and performing a reduction operation to remove the overlapping parts. At this stage of image integration calculation, Haar feature detection errors due to blur noise effects can occur and eventually result in object detection error.

3.6 Object Detection Results

The detection results with noise variations from radius 1.0 to 6.8 are shown in Figure 8. For each tested image (in various variations of PSNR values), the number of faces that were successfully detected, number of non-faces detected as faces (positive false) and number of faulty faces as shown in Figure 9 where noise level is 44%.

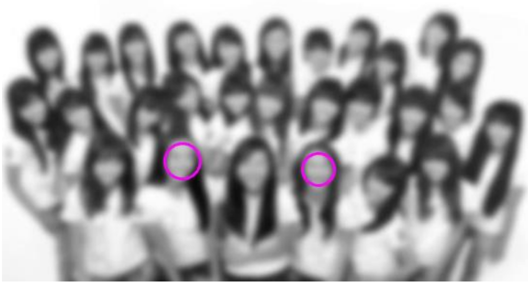

Face detection with Blur Radius 1.0


Face detection with Blur Radius 2.0


Face detection with Blur Radius 3.0


Face detection with Blur Radius 4.0


Face detection with Blur Radius 5.0


Face detection with Blur Radius 6.0

Received June 1st,2012; Revised June 25th, 2012; Accepted July 10th, 2012

IJCCS (Indonesian Journal of Computing and Cybernetics Systems)
Vol.x, No.x, July xxxx, pp. 1~5
ISSN (print): 1978-1520, ISSN (online): 2460-7258
DOI: 10.22146/ijccs.xxxx

Face detection with Blur Radius 6.6

Face detection with Blur Radius 6.8

Figure 8. Face detection results with blur variations from 1 to 6.8%.

On Figure 8. Face detection with Blur Radius 4.0 we can see the number of faces detected is 6, no positive false and the amount of negative false is 22. Object detection results with blur level variations and PSNR values are shown in Table 2.

Table 2. Object detection results with PSNR value variations

Blur Radius (%)	PSNR	Actual Number Of Faces	Face Detected	Positive False	Negative False
10	19,76417295	28	20	3	8
12	18,8797591	28	20	1	8
14	18,23879826	28	20	1	8
16	17,56643092	28	17	1	11
18	16,99994731	28	16	0	12
20	16,48814731	28	15	0	13
22	16,04262999	28	15	1	13
24	15,66781152	28	15	1	13
26	15,28004279	28	14	1	14
28	14,94850968	28	13	1	15
30	14,65054783	28	11	1	17
32	14,31438609	28	10	1	18
34	14,08146276	28	9	1	19
36	13,80069687	28	8	1	20
38	13,5844913	28	8	1	20

Received June 1st,2012; Revised June 25th, 2012; Accepted July 10th, 2012

40	13,34832391	28	6	1	22
42	13,1186206	28	6	1	22
44	12,93723535	28	5	0	23
46	12,71852437	28	4	0	24
48	12,50192218	28	4	0	24
50	12,33553024	28	4	0	24
52	12,15799902	28	4	0	24
54	11,98001584	28	4	0	24
56	11,82276422	28	4	0	24
58	11,69539007	28	3	0	25
60	11,52869157	28	2	0	26
62	11,36378031	28	2	0	26
64	11,23318422	28	1	0	27
66	11,10544877	28	1	0	27
68	10,95058679	28	0	0	28

The accuracy of object detection is also affected by the number of training files used in the Haartraining process [11]. This explains the imperfection of the result at the 0% blur effect level (perfect image) where the object face detection results are only 20 faces where it should be 28 faces.

No more successfully detected objects after noise level of 68% (nilai PSNR lebih kecil dari 10.95 dB). Images are said to be good if the PSNR value is above 30 dB. Images with a PSNRI value below 30dB have been said to have been degraded and cannot be considered for further analysis [12] PSNR characteristics with object detection accuracy are shown in Figure 7.

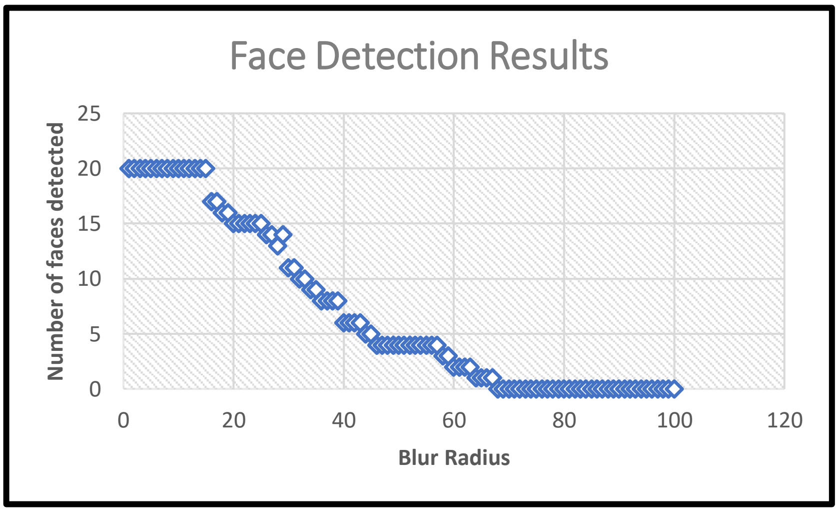


Figure 9. Object Detection Results with Level Blur Variation

3. 7 *K Means Clustaring*

The data from the object detection results are grouped into 3 clusters using the K-Means Clustering method, i.e. images of good, fairly good and bad quality. This grouping is based on how many objects were successfully detected using the Viola Jones method. The image data is

Received June 1st,2012; Revised June 25th, 2012; Accepted July 10th, 2012

grouped based on some features such as color, texture, shape and other that are present in the image in the form of pixels. For purposes of efficiency and better results, image data is segmented before applying grouping [13]. The techniques used here are K-Means and Fuzzy K-means which are very time-saving and efficient. The K-Means algorithm is described as follows:

1. Selection of the number of clusters (K)
2. For each cluster, initialize the initial centroid value.
3. For each experimental record data, determine the distance from each centroid. The distance of each data to the centroid is determined using formula 3.

$$dist(x,y) = \sqrt{\sum_{i=1}^{n}(x_{i-} y_i)^2} \qquad (3)$$

4. From each distance to each centroid, determine the shortest distance (to know the data cluster group). The shortest data is determined using formula 4 as follows:

$$c_{j=} \left\{x: \min_{h} dist^2\ (x, c_h) = j\right\} \qquad (4)$$

5. Find the average value of each cluster group to be the centroid value on the next iteration. Average value is determined by formula

$$cj = \frac{1}{m_j} \sum_{x \in c_j} x \qquad (5)$$

6. Repeat steps 3 to 5 until the data in the group of each cluster does not move the group again (steady).

From the K-Means Clustering algorithm, data on the last iteration (iteration to 6) is shown in Table 3.

Table 3. Cluster Data Iteration K-Means 6th Clustering

Blur Ratio (%)	Cluster Group	Centroid PSNR	Centroid Number of Faces Detected
1	C1	62,34646	20
2-38	C2	17,29159	15,54054
38 -100	C3	11.02940	1,741935

At iteration 6, the data group is no longer steady, so the image quality value is considered excellent for the object detection process is 62.34 dB, and the picture quality is considered good enough for the objects detection is 17.29 dB and the quality of the image is considered bad for the Object Detection is 11.02 dB. When measured using the percentage noise ratio, the picture is considered sufficiently good for the object detection if it has a minimum interference of 68% of the original image.

4. CONCLUSIONS

The conclusion that can be drawn in this study is that images with blur conditions at a rate of 68% processed results that the object (face) in the image is no longer detected and at a minimum PSNR value of 16.62 dB indicated image (faces) suitable for in the process, the value of the minimumPSNR of 17.84 dB stated image/face image can not be detected as an object(face), in addition, it was also found that the higher the PSNRI value then the higher is the accuracy of the object detection on the objects detection in the method Viola Jones

REFERENCES

IJCCS (Indonesian Journal of Computing and Cybernetics Systems)
Vol.x, No.x, July xxxx, pp. 1~5
ISSN (print): 1978-1520, ISSN (online): 2460-7258
DOI: 10.22146/ijccs.xxxx

[1] H. , Effendi, "Restorasi Citra Kabur (Blur) Menggunakan Algoritma Wiener,Jurnal No.32 Vol.1 Thn.XVI November 2009 ISSN: 0854-847, 1, 32, 7–13.," 2009.

[2] H. , 2018 Sajati, "Analisis Kualitas Perbaikan Citra Menggunakan Metode Median Filter Dengan Penyeleksian Nilai Pixel," *Jurnal Ilmiah Angkasa Vol. 10, No. 1, PISSN 2085-9503, E-ISSN 2581-1355* .

[3] Z. Wang, L. Lu, and A. C. Bovik, "Foveation Scalable Video Coding with Automatic Fixation Selection," 2003.

[4] P. Purwanto, B. Dirgantoro Ir, and A. S. Nugroho Jati, "Implementasi Face Identification Dan Face Recognition Pada Kamera Pengawas Sebagai Pendeteksi Bahaya. Universitas Telkom."

[5] P. Viola and M. Jones, "Rapid object detection using a boosted cascade of simple features," in *Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, 2001. doi: 10.1109/cvpr.2001.990517.

[6] S. K. Pavani, D. Delgado, and A. F. Frangi, "Haar-like features with optimally weighted rectangles for rapid object detection," *Pattern Recognit*, vol. 43, no. 1, pp. 160–172, Jan. 2010, doi: 10.1016/j.patcog.2009.05.011.

[7] G.I.W Tamtama, "Perbandingan dan Analisis Untuk Algoritma Deteksi Tepi pada jaringan Saraf Tiruan," *CESS (Journal of Computer Engineering Systemand Science)p-ISSN:2502-7131Vol. 6No. 1Januar 2021*.

[8] M. Roopaei, M. K. Eghbal, M. Shadaram, and S. Agaian, "Noise-Free rule-Based fuzzy image enhancement," in *IS and T International Symposium on Electronic Imaging Science and Technology*, Society for Imaging Science and Technology, 2016. doi: 10.2352/ISSN.2470-1173.2016.13.IQSP-225.

[9] A. V Abraham and P. Student, "FR IQA Classification and Evaluation," 2007. [Online]. Available: www.ijirset.com

[10] H. Sajati, "The Effect of Peak Signal to Noise Ratio (PSNR) Values on Object Detection Accuracy in Viola Jones Method," *Conference SENATIK STT Adisutjipto Yogyakarta*, vol. 4, Nov. 2018, doi: 10.28989/senatik.v4i0.139.

[11] A. 2017 Kusumaningrum, "Pengaruh Jumlah File Training Terhadap Akurasi Pendeteksian Obyek Pada Metode Viola Jones," 2017.

[12] G. Badshah, S. C. Liew, J. M. Zain, and M. Ali, "Watermark Compression in Medical Image Watermarking Using Lempel-Ziv-Welch (LZW) Lossless Compression Technique," *J Digit Imaging*, vol. 29, no. 2, pp. 216–225, Apr. 2016, doi: 10.1007/s10278-015-9822-4.

[13] M. Khalid, I. Rahmani, N. Pal, K. Arora, and M. T. Scholar, "Clustering of Image Data Using K-Means and Fuzzy K-Means," 2014. [Online]. Available: www.ijacsa.thesai.org

Received June 1st,2012; Revised June 25th, 2012; Accepted July 10th, 2012