Jurnal Multi-View Faces

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Submission date: 05-Mar-2019 10:07PM (UTC+0700)

Submission ID: 1088103435

File name: Winarno_2018_J._Phys.__Conf._Ser._1114_012068.pdf (957.46K)

Word count: 3165

Character count: 15879

Journal of Physics: Conference Series

Multi-View Faces Detection Using Viola-Jones Method

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Abstract. Face detection has arrested attention because it has many applications in computer vision. Face detection is widely used in many digital image processing as a basis for recognizing and tracing faces. In this paper, we propose multi-view object detection system to count the number of faces in an image. This system uses an AdaBoost algorithm in Viola-Jones method of face detection to built classifiers cascades of faces. The Viola Jones method can reduce face detection errors, the Viola Jones method has several processing steps. It can detect and calculate the number of faces contained in the image. The Viola-Jones method is practically implemented by using Matlab for detecting the human face in images. Testing with the proposed model has been carried out with 40 image data. The test results have shown the level of face detection accuracy of 93.24%

1. Introduction

Face detection is easy for humans but is more difficult for computers because human faces are not fixed Changes will occur on human faces as time passes[1]. Face detection with computers is a research challenge in the field of information technology. Research in this area requires recognizing and identify it with different sizes, shapes, textures and color intensities on it. This can be applied to the face recognition application in the real world [2][3].

Face detection is the first basic step to all the facial analysis methods like face recognition, face alignment, face modeling, face verification and facial tracking etc. To accurately detect faces the computer system requires some training so that the computer system can easily identify whether it's face or non-face. To detect faces, several threshold values have been determined. Based on this value a system can detect human faces [4].

Face detection according to [5]can be categorized into 4 grouping based on the algorithm namely knowledge-based methods, feature invariant methods, template-based methods and appearance-based methods. The appearance-based method use very large number of examples. This examples can be face images or facial features and describe different variations such as face shape, skin color, eye color, closed or open mouth and others. Face detection can be seen as a classification of patterns where the input is the image and the output of the class will be determined from the image. In this case there are two classes, namely face and non-face. During this time many face recognition techniques assume that face data are the same size and uniform background. In reality, this assumption does not always apply because faces can appear in various sizes and image positions with varying backgrounds. Currently there are many applications that use face detection features [6] [7].

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Face detection can be done using the Viola-Jones method. This method combines support vector machines, boosting algorithms, and cascade classifiers. It is applied to any digital image, to get facial positions in the image. The face detection process is done by classifying an image after adjusting it with a classifier of training data. The Viola-Jones is one of the best in detection effectiveness/work speed ratio. Based on this reason, Viola-Jones was chosen as a research method [8] [9]. Experiments conducted by [10] have proven that the Viola-Jones method of face detection produces the highest precision values from the Successive Mean Quantization Transform (SMQT) features & Sparse Network of Winnows (SNOW) Classifier, Neural Network-Based Face Detection and Support Vector Machine-Based face detection. So the best of all this algorithm is Viola-Jones for face detection. [11] have used the Viola-Jones method in their research. This method is used to find out the human face automatically and can calculate the accuracy of the system. Similar research has also been carried out by [12]. They used Viola-Jones to detect face and principal component analysis for face recognition. [13] proposed a simple and fast algorithm for a hand pose estimation problem for mobile device. That algorithm is Viola-Jones. The research developed by [14] is combining face detection and HS skin color detection in an image. Face detection is done using the Viola-Jones method. [15] has developed a hybrid framework consisting of a neural network following a truncated Viola-Jones cascade is constructed attempt to recover the undetected faces.

In this study, face detection will be developed using the Viola Jones method which can count the number of faces that appear on a group of people in an image. This paper is organized as follows: In Section 1, we give an overview of background and related works. In Section 2, we present our method and the basic theory used in our proposed model used to count the number of faces in an image. In Section 3, we discuss the testing and evaluation results. In Section 4, we talk about the conclusion.

2. Method

2.1. The Viola-Jones Method

A method used in face detection uses Haar like feature or better known as Haar Cascade Classifier. The main basis for object detection systems using the Haar Cascade Classifier is the classification system uses pixel intensity values and changes in contrast values between rectangular pixel groups that are close together. The contrast variance between pixel groups determines the white and black areas.

Viola-Jones face detection procedure classifies images based on simple feature values. There are many reasons to use features rather than pixels directly. The most common reason is that features can be used to encode ad hoc domain knowledge that is difficult in the learning process with limited number of training data. Another reason for using features is the operating system based feature is much faster than pixel based systems.

The Viola-Jones method is one of the most popular object detection methods. This method can provide results with a fairly high accuracy of about 93.7% with a speed of 15 times faster. To represent the image in Viola-Jones method Haar-like features are used. Viola-Jones method uses rectangular Haar-like features. The Haar feature can be seen in Figure 1.

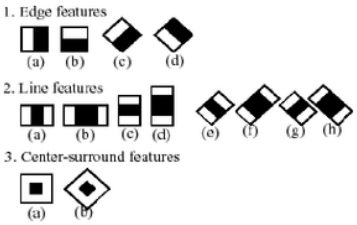


Figure 1. The Haar Feature

Haar is a long wave in the form of a square wave (one high interval and one low interval). In two dimensions, this square wave is depicted with a pair of squares that are adjacent to white and black.
The presence of the features in any of the input image is determined by the Haar features. The result of each feature has been obtained by dividing the sum of black pixels by the sum of white pixels.
Haar has an algorithm like this : [15].
1. Each Haar feature consists of two or three rectangular sections that are colored "black" and "white".
2. The value of the Haar feature is the difference between the number of gray pixel values in the black and white rectangular area:

f(x)=Sumblack rectangle (pixel gray level) – Sumwhite rectangle (pixel gray level)

3. Haar's features can reduce or increase the number of in-class or out-of-class variables, making classification easier. This is compared to raw pixel values.
4. The rectangle on the Haar feature can be calculated quickly using "Integral Image"

The concept of integral images is used to calculate rectangles like features. The number of pixels in a rectangle is determined using the four values that exist in each corner of a particular rectangle. In the integral image, the value of each pixel is given by the number from the left and to the pixel above the image. All pixel values have been added in the D rectangle as shown in Figure 2 [16].

G1=A,
G2=A+B,
G3=A+C,
G4=A+B+C+D
G1+ G4 - G2- G3=A+A+B+C+D-A-B-A-C=D.. ....(1)

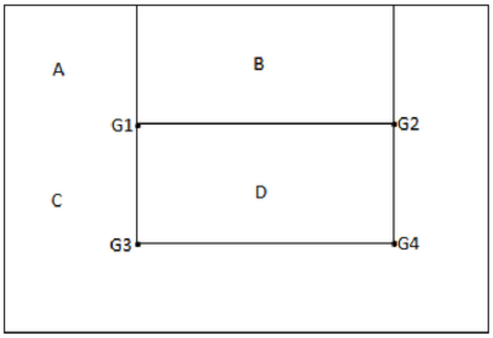


Figure 2. Integral Image

Image Integration is used in determining hundreds of Haar features in an image and used on different scales. Integration is the addition of small units in the form of pixel values simultaneously. The integral value of each pixel is the sum of all pixels from top to bottom, from top left to bottom right. The whole image can be summed using several integer operations per pixel.

Selection of specific features will be used to set the threshold value. Viola and Jones use a machine learning method called Adaboost. Adaboost is one of the boosting algorithms which functions to select large numbers of features that only choose certain features. This is done by evaluating each feature of the training data by using the value of the feature. Features that have the greatest restrictions between objects and non-objects are considered the best features. AdaBoost Learning can also be used to improve classification performance with simple learning to combine many weak classifiers into one powerful classifier.

The next step is combine a complex classifier in a multilevel structure that can increase the speed of object detection by focusing on the area of the image that has a chance.

2.2. Proposed Model

The face object is determined using Viola Jones which refers to the flow as in Figure 4, where the grayscale image will be scanned per-sub-window to look for positive features with AdaBoost and Cascade Classifier. In the Viola Jones the face detection algorithm is controlled by special trained scanning window classifiers. Face detection can be seen as a problem of pattern classification with two classes, namely "face" and "non face". Non-face class consists of images that can explain something that is not a "face", while the class "face" contains or consists of all face images. To detect faces in the input image, all images are scanned and images of areas identified as faces or non faces. Next displays the number of faces in an image based on the results of face detection.

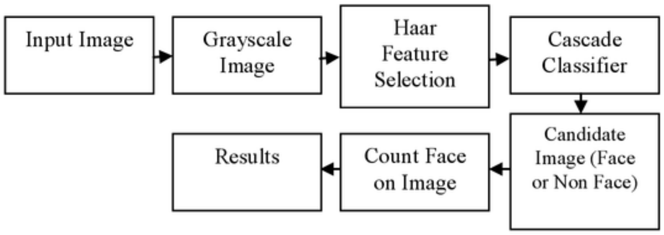
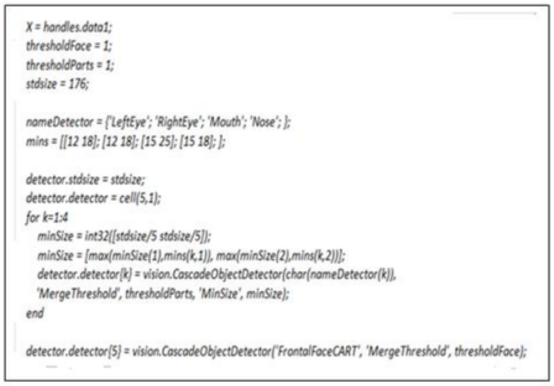


Figure 3. Proposed Model

3. Result and Analysis

Face counters based on face detection systems are made using Matlab R2015. The first step in detecting a face is the process of finding facial shapes from the nose, ears, right eye, mouth using the cascade classifier. The source code script can be seen in the picture. The next step is AdaBoost Learning and Integral Image. AdaBoost learning strengthens the face shape of the previous process with a large and accurate detection number. This is because the previous detection has obtained initial face data. Next is the Integral Image process. In this section there is a calculation process for the number of faces that will be processed in the form of a square pattern. Scrip Haar feature source code can be seen in Figure 4.



```
X = handles.data1;
thresholdFace = 1;
thresholdParts = 1;
stdsize = 176;

nameDetector = {'LeftEye'; 'RightEye'; 'Mouth'; 'Nose'; };
mins = [[12 18]; [12 18]; [15 25]; [15 18]; ];

detector.stdsize = stdsize;
detector.detector = cell(5,1);
for k=1:4
   minSize = int32([stdsize/5 stdsize/5]);
   minSize = [max(minSize(1),mins(k,1)), max(minSize(2),mins(k,2))];
   detector.detector{k} = vision.CascadeObjectDetector(char(nameDetector(k)),
   'MergeThreshold', thresholdParts, 'MinSize', minSize);
end

detector.detector{5} = vision.CascadeObjectDetector('FrontalFaceCART', 'MergeThreshold', thresholdFace);
```

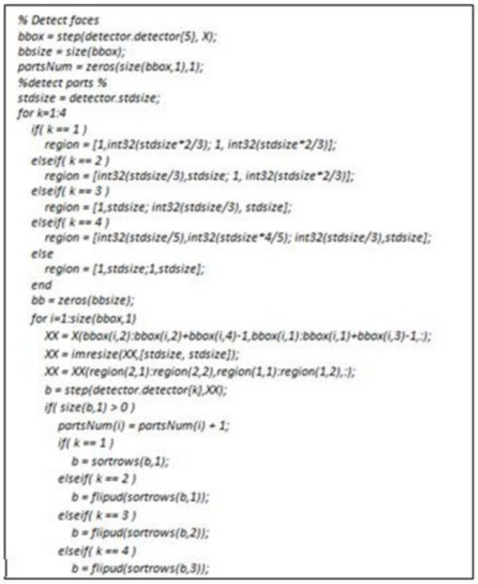
Figure 4. Cascade Classifier Script Code

Processing the haar feature will form a square pattern around the face pattern that has been processed before. The haar feature must ensure that the face data provided in the previous process is valid. This process adjusts the position of the rectangular box on the face pattern in the face area. The results of the face detection processing trial from several images, can be seen in Figure **7.**

Figure 6 shows the results of the number of faces in the image that have been through face detection with the face counting process using Eq. 2.

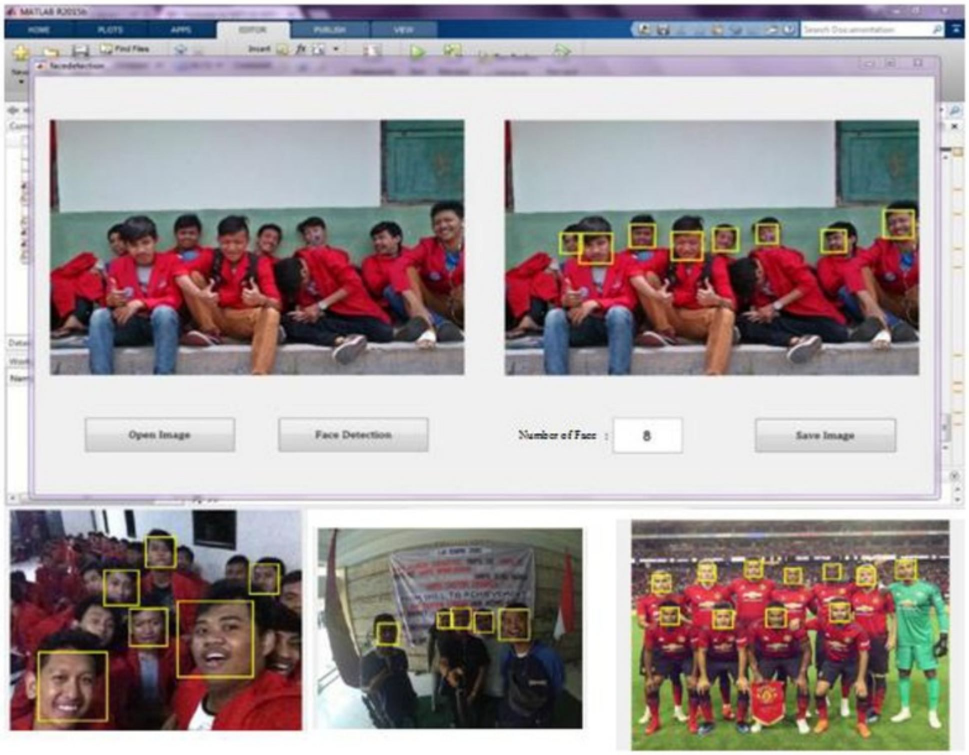
$$L = m_1 + m_2 + m_3 + ... + m_n \qquad (2)$$

m is the variable value of the haar feature for display the number of boxes. The results of the calculation process adjust the number of detection boxes. Face detection accuracy testing is done by inputting several images. Testing with the proposed model has been carried out with 40 image data. Tests were carried out 40 times with different images and lighting. Face detection results using the Viola-Jones method like Table 1.



```
% Detect faces
bbox = step(detector.detector(5), X);
bbsize = size(bbox);
partsNum = zeros(size(bbox,1),1);
%detect parts %
stdsize = detector.stdsize;
for k=1:4
  if( k == 1 )
    region = [1,int32(stdsize*2/3); 1, int32(stdsize*2/3)];
  elseif( k == 2 )
    region = [int32(stdsize/3),stdsize; 1, int32(stdsize*2/3)];
  elseif( k == 3 )
    region = [1,stdsize; int32(stdsize/3), stdsize];
  elseif( k == 4 )
    region = [int32(stdsize/5),int32(stdsize*4/5); int32(stdsize/3),stdsize];
  else
    region = [1,stdsize;1,stdsize];
  end
  bb = zeros(bbsize);
  for i=1:size(bbox,1)
    XX = X(bbox(i,2):bbox(i,2)+bbox(i,4)-1,bbox(i,1):bbox(i,1)+bbox(i,3)-1,:);
    XX = imresize(XX,[stdsize, stdsize]);
    XX = XX(region(2,1):region(2,2),region(1,1):region(1,2),:);
    b = step(detector.detector(k),XX);
    if( size(b,1) > 0 )
      partsNum(i) = partsNum(i) + 1;
      if( k == 1 )
        b = sortrows(b,1);
      elseif( k == 2 )
        b = flipud(sortrows(b,1));
      elseif( k == 3 )
        b = flipud(sortrows(b,2));
      elseif( k == 4 )
        b = flipud(sortrows(b,3));
```

Figure 5. Haar Feature Script Code



Number of Face : 8

Figure 6. Face Detection Results

Table 1. Testing Results Face Counts from Images

No	Image	Count face an image		Accuracy	Processing Time (second)
		Success	Failure		
1	Image 1	8	-	100%	10.2
2	Image 2	6	6	100%	2.7
3	Image 3	4	-	100%	4.2
4	Image 4	5	-	100%	3.1
5	Image 5	11	-	100%	4.2
6	Image 6	24	3	88.88%	12.2
7	Image 7	30	1	93.70%	13.6
8	Image 8	3	-	100%	3.6
9	Image 9	2	-	100%	2.4
10	Image 10	8	2	80%	14,5
11	Image 11	12	-	100%	3.7
12	Image 12	36	2	94%	5.9

No	Image	Count face an image		Accuracy	Processing Time (second)
		Success	Failure		
13	Image 13	5	-	100%	3.3
14	Image 14	4	-	100%	2.4
15	Image 15	12	-	100%	3.7
16	Image 16	8	-	100%	2.9
17	Image 17	5	5	100%	2.3
18	Image 18	24	3	88.88%	4.5
19	Image 19	3	-	100%	2.3
20	Image 20	24	1	96%	4.9
21	Image 21	4	-	100%	1.4
22	Image 22	-	-	0%	1.2
23	Image 23	5	-	100%	1.5
24	Image 24	1	-	100%	2.4
25	Image 25	3	-	100%	7.0
26	Image 26	1	-	100%	1.3
27	Image 27	-	-	0%	1.2
28	Image 28	5	-	100%	1.4
29	Image 29	1	-	100%	22.2
30	Image 30	3	-	100%	3.3
31	Image 31	1	-	100%	1.8
32	Image 32	1	-	100%	1.4
33	Image 33	5	-	100%	2.2
34	Image 34	3		100%	2.0
35	Image 35	10	-	100%	11.5
36	Image 36	50	1	98%	31.5
37	Image 37	2	-	100%	2.1
38	Image 38	31	1	96.8%	13.3
39	Image 39	1	-	100%	1.7
40	Image 40	28	2	93.3%	4.9
Accuracy = 93.24%					

From testing the face count using the viola jones method that has been done successfully detected the number of faces in the image as much as 93.24%. One of the causes of failure to detect faces is that the light in the image is too dark so the number of faces displayed is incorrect.

4. Conclusion

This study develops face counters that can facilitate users to find out the number of faces in an image. This program uses the Viola Jones method to get the number of people that can be detected and cover all faces in the picture. Face detection results that have been processed and counting the number of faces can be saved.

This study applies Matlab algorithm for face detection, and achieves satisfactory results compared to existing techniques with more accurate results. The Viola-Jones method is not functioning properly in images with low light intensity. In the future, this method is expected to detect dark images and function in variable lighting conditions. The test results show the level of face detection accuracy is 93.24%.

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