

Improving the accuracy of old and young face detection in the template matching method with Fuzzy Associative Memory (FAM)

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Abstract. Every human has a face pattern and certain characteristics even though identical twins, but the human face pattern still has its own distinctiveness as well as old face patterns and young face patterns even though the human face pattern is very diverse but for young and old face patterns will be a difference between one face and the other face. Face detection (face detection) is one of the initial stages that very important in face recognition that is used in biometric identification. Face detection can also be used to search or index face data from images or videos that contain faces of various sizes, positions, and backgrounds. Face detection (face detection) automatically with the help of a computer is a problem that is not easy because the human face has a high level of variability both intra-personal and extra-personal variability. This study shows that systems with template matching methods combined with FAM can successfully detect differences in human faces, 80% accuracy, 10% better by using ordinary template matching.

I. INTRODUCTION

The era of information technology is growing rapidly and complex, the reliability of data processing systems well will produce good information too. Modern data processing used is closer to image, sound and text data. In solving complex problems requires a fast, precise and accurate method. Artificial intelligence is one part of computer science that makes computer machines able to do work quickly, precisely and accurately. Imagery plays an important role in presenting forms of visual information because images have characteristics that are not possessed by text data. Digital image processing involves modifying digital data to improve image quality with the help of computers (Rani, 2013).

The face is a marker for recognizing someone. if someone is acquainted with someone else, the thing that is best remembered is that person's face. Besides being used to recognize someone, faces are also used for other things such as for the purposes of population data, attendance and security systems by using a face recognition system. Because the human face represents something complex, the development of an ideal computational model for face recognition is still a difficult thing.

Whereas in this study, the writer will use a combination of Template Matching method by using Fuzzy Associative Memory (FAM) in real-time for the detection of young and old faces on webcams that tend to be more dynamic and change faster in the orientation of the front-facing face.

II. PROBLEMS IDENTIFICATION

The formulation of the problem in this study is how to improve the accuracy of detection of old and young faces by combining the Template Matching method with Fuzzy Associative Memory and identifying older and younger faces more accurately.

III. RESEARCH METHODS

a. Digital Image

The image is a two-dimensional image produced from continuous two-dimensional analog images into discrete images through a sampling process. Analog images are divided into N rows and M columns so that it becomes a discrete image. A cross between a line and a certain column is called a pixel. Examples are images/ discrete points in rows n and columns m called pixels $[n, m]$.

Understanding the rows and columns in the canvas or the image on the Bitmap is shown in the image below. The first column and the line start from zero.

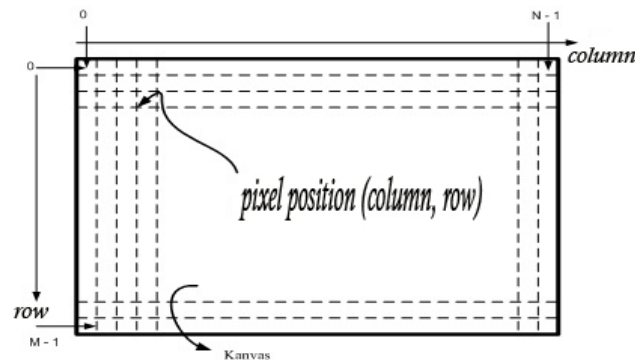


Figure 1 Pixel coordinates on Canvas for $M \times N$ Size Images

b. Motion Detection (Video)

In detecting the movement of objects there is a matching process called the Difference Frame which reduces one frame to another frame and labels different frames larger than the object. This process will capture the edge of a moving object. The video image will first display the image/image captured by the webcam.

c. Face Detection

The face is a complex multidimensional visual model and to describe computational facial recognition is difficult. Face recognition is an activity active in the field of biometrics. The most important part of facial recognition is the detection of parts of the face. Face recognition techniques can be broadly divided into 3 categories based on face data acquisition methodologies, including:

- a. Methods that operate at intensity
- b. Sequence in shooting
- c. 3D information or infrared imagery This face recognition is basically used to identify people from pictures or videos (Paridhi, 2016).

According to Safwandi (2016) The challenges faced in face detection problems are caused by the following factors:

1. Position of the face. The position of the face in the image can vary because its position can be upright, tilted, turned, or seen from the side.

2. Components on the face that can or may not exist, such as mustaches, beards and glasses.
3. Another object is blocked. Face images can be partially blocked by other objects or faces, for example in images containing a group of people.
4. Image capture conditions. The image obtained is greatly influenced by factors such as light intensity, direction of light source, and sensor characteristics and camera quality.

d. Template Matching Method

Template matching is the process of searching for an object on all objects that are in an image. The template is compared to the whole object and if the template matches (close enough) to an unknown object in the image then the object is marked as a template. Comparison between the template and the entire object in the image can be done by calculating the difference in distance.

One of these methods is the Sum of Absolute Difference (SAD). This method determines the difference in pixel values between an image and the template. In this method, we suppose that the image is searched for as G and template as T , and (x, y) describes the pixel value in the x, y coordinates, so the equation can be used.

$$SAD(x, y) = \sum_{i=0}^{T_{row}} \sum_{j=0}^{T_{col}} |G(x + i, y + j) - T(i, j)|$$

Where:

- G = Pattern looking for or testing. T = Template Pattern
 (x, y) = Pixel coordinates on the image pattern
 I, x = Matrix Value I x coordinate
 J, x = Matrix Value J coordinates y

e. Fuzzy Associative Memory (FAM) Method

Fuzzy Associative Memory (FAM) was first introduced by Bart Kosko. FAM is a fuzzy system that maps Fuzzy sets to other Fuzzy sets. FAM is a Fuzzy version of Bidirectional Associative Memory (BAM). Simple FAM will map a Fuzzy rule or pair of pairs (A_i, B_j) that connects the Fuzzy B_j set to the Fuzzy A_i set. Thus, a FAM system can consist of several different FAM collections $(A_1, B_1), (A_2, B_2), (A_3, B_3), \dots, (A_i, B_j)$.

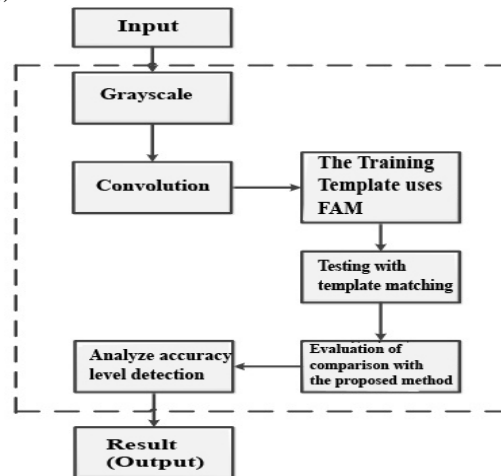


Figure 2. Scheme of Proposed Method

Starting from implying the original image or new image, after inputting the new image grayscale calculation will be performed, and continued by calculating the convolution, then the image that will be used as a training pattern will be calculated using Fuzzy Associative Memory. By using the template matching method to match the test image with the training image, until all the pixels are counted if there is no similarity, then the matching method will be repeated with the template matching method if the face image has been detected, the system will output face detection.

IV. RESULTS AND DISCUSSION

a. Face Training Samples

Face training samples used in this study amounted to 40 image samples among 10 young male faces, 10 old male faces, 10 young female faces and 10 old female faces, as for faces representing the image or vector characteristics (face pattern). different. In Figure 4.1 shows several facial samples that are used as training, this training itself is carried out using the template matching algorithm with the learning board $n = 0.1$.



Figure 3. Facial Samples Used

b. Results of Real-time Detection of Old and Young Faces

The detection results or the results of testing real-time face and young face detection systems can only be done on one face image with face requirements with 0 orientation and do not contain patterned backgrounds so as to facilitate the system to get a good and perfect image, while on the test sample very emphasized is that the face is straight and doesn't move much so the system can do calculations without making false detections that are too much because the system with real-time is very sensitive with significant movements. Figure 4.6 shows the results of system testing that was tested in this study.



Figure 4. Detection Results of Old and Young Face Detection Systems in Real Time

In the picture above shows the true detections results, namely system performance that successfully detects young and old faces, we can see Box 30x30 which covers all faces with various colors that have been set on the system, namely in the form of:

1. Green detection box as a young woman.
2. Blue detection box as an old woman.
3. Red detection box as an old man.
4. Blue detection box as a young man.

Table 1. Performance Results of Face and Young Face Detection Systems

Face pattern	image processing	Test Image	Detection rate	False positive rate
The face of a young man	1	10	0.70%	0.30%
Old man's face	1	10	0.60%	0.40%
The face of a young woman	1	10	0.70%	0.30%
Old woman's face	1	10	0.60%	0.40%

It can be concluded from the table above that the face and young face detection system uses the template matching method that is less capable or less effective in face detection in real-time because the percentage detections rate has not reached 90% and still allows a false positive rate to be tested. on other facial samples

The measurement of system performance is done by training samples per vector of face patterns related to the system, namely 4 vector patterns, young male faces, old male faces, young female faces and old female faces, each vector will be implanted in the system. While testing on this system is carried out on 40 different image faces to test the accuracy of detection to see the results of detection can be seen in table 2 which illustrates some of the results of detection that has been done by the system.

Table 2. Results of Performance of the FAM Detection System

Face pattern	image processing	Test Image	Detection rate	False positive rate
The face of a young man	1	10	0.90%	0.10%
Old man's face	1	10	0.80%	0.20%
The face of a young woman	1	10	0.70%	0.30%
Old woman's face	1	10	0.70%	0.30%

It can be concluded from the table above that the system of detecting old and young faces using the template matching method is effective in face detection in real-time due to the level of detections rate that reaches

V. CONCLUSION

The conclusions of the real-time face and young face detection system using the template matching method obtained from several training processes and testing based on selected samples to detect young and old faces using the template matching method, the results achieved are as follows:

1. This study shows that systems with template matching methods combined with FAM can successfully detect differences in human faces, 80% accuracy, 10% better by using ordinary template matching.
2. With the template matching method and real-time system sensitivity when planting training samples on the system, it is emphasized because the results of the training sample will test many other samples, it can be emphasized the sample must be in good light and the training object clearly does not use attributes or objects can block face attributes, a clear test sample pattern (vector) of his face will greatly affect the success when testing.

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