Design and Development of Student Attention System using Face Recognition Based on MTCNN and FaceNet

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Abstract — Employees use their level of attendance or absence to demonstrate their presence at work or absence from it in an agency. This absence is connected to how discipline is applied, which is decided by each organization or institution. It can be inferred from this that student absenteeism in a setting where there is activity serves to increase discipline and demonstrate attendance. With IP Camera technology, it can be applied to the attendance system using the MTCNN method as face detection and FaceNet to extract high-quality features from the face. The system created can detect faces at a distance of 40 cm – 180 cm with an accuracy of 90.5% and can detect more than 1 object in 1 frame so that the IP Camera function is in accordance with the design in real-time. Tested the object of 3 pairs of twin faces produces a maximum accuracy of 90% where the level of match between the faces and the data is appropriate.

Keywords — Attendance system, FaceNet, IP camera, MTCNN

I. INTRODUCTION

The level of attendance or absenteeism is an activity or routine carried out by employees to prove that they are present or not present at work in an agency. This attendance relates to the application of discipline determined by each company or institution [1]. Thus, it can be concluded that absenteeism in an activity environment has the function of increasing discipline and showing student attendance.

The biometric system to identify a person with a body part that already exists in a person is an interesting thing to study [2]. This system identifies and recognizes a person by using one of the physical characteristics, namely the face. The system requires equipment for the identification process of a person by using an IP Camera that can take the shape of a person's face within a certain distance [3]. Face recognition has several advantages in identifying, it can be in the form of face images, photos, or image data taken directly through an IP Camera [4] at a certain distance.

Many methods can be used to recognize faces, one of which is by applying deep learning methods. In recent years, deep learning methods have won several contests in pattern recognition and machine learning [5]. One application of deep learning methods is artificial neural networks (Artificial Neural Networks) [6]. A standard neural network consists of many connected processors called simple neurons, each of which produces a sequence of real-valued activations [7].

Deep learning methods that can be used to recognize faces include the Convolutional Neural Network (CNN) method [8]. This CNN method [9] has several different types depending on the architecture formed, one of which is the Siamese Neural Network (FaceNet) [10]. Siamese Neural Network (FaceNet) has good potential to be used in facial recognition [11]. Because with this method, facial features can be extracted properly using two twins Convolutional Neural Networks, then the distance from the two data extraction results from the two faces is calculated to get the similarity value [12].

In addition to the Siamese Neural Network (FaceNet) method, many other methods can be used to recognize faces, including the Direct Correlation Method, Eigenface, and Fisherface [13]. However, the three methods have fairly high error rates. Fisher's face has error rates of 20.1%, followed by Eigenface (25.5%) and Direct Correlation (25.1%) [14]. In addition, Direct Correlation also requires large processing and storage time [15]. Therefore, the authors chose to use the Siamese Neural Networks (FaceNet) method to solve the issue of repeatedly counting the same person throughout the face recognition process, the outcomes of facial recognition are then utilized to determine the number of people's faces. This is anticipated to enhance discipline and boost the efficiency of time in the tracking of students' attendance.

II. METHOD

A. Block Diagrams

Before IP cameras do data retrieval, the first thing the user does is process personal data registration and registration process face use the IP camera then the system will save on the system database. The stage dual system carries out the data training process with the use method. Later FaceNet system will carry out the process of mapping and introducing faces. Stage three users perform the attendance process on the face recognition feature then the system will compare with the results of training data. The process is described in Fig. 1.

In Fig. 1, the input made by the user is explained, there is a face scan process, then a face cropping process, then data training and face recognition. After that the application will process the data on the system. The resulting output is in the form of new data storage, face crop results, training with method FaceNet, and comparing training data results.



B. Procedure MTCNN method



Figure 2. MTCNN Method Flowchart

Fig. 2 describes the process for the MTCNN method explained as follows. Taking eyes, nose, and mouth through a results detection camera on the face. Input the dedicated open CV library as a processing image. Next, the process of changing the picture's original face scan changed becomes size 12x12x3 as an input CNN process. In part, this system captures streaming results from an IP camera, then capture the image processed with a method where from results detection face could obtain coordinate face on the picture as score x, y and score w, h where w is width and h are high, after that picture cropped by score x, y, w, h the picture already cropped then changed Becomes size 160x160 pixels. General parameters used in this process namely:

- size (f) represents the height and width of the filter used. 1. The filter size also represents the size of the kernel that will be used.
- 2. Stride(s) in size step to take when crossing horizontal and vertical lines.
- 3. Padding (p) is used to maintain the height and width of pictures because after processing size the input image is reduced.



Figure 3. Cropping Process Using CNN

The result of the face cropping process using CNN with detect eves and nose produces the crop face output described in Fig. 4.



Figure 4. Face Cropping Results

Fig. 4 is inputted in the photo sample directory as the output of the MTCNN process in jpg format, looping the conducted as much as 50 times the results of the capture. Distinguishing Parameters face based on application script as follows: Face Capture Parameters 1.

138 video_capture = cv2.VideoCapture(0) Figure 5. Video Capture

First parameter used for catching live stream with a camera. OpenCV provides a very interface simple this. With the application, uses the laptop's built-in IP Camera, changes it to grayscale video, and displays it. To capture video necessary, make an object Video Capture. An argument could index a device or video file name. The device index is the only number for determining the camera. Study this only using 0 (or 1) as well as one camera will be connected.

2. Detection Parameters Face

141	<pre>check, frame = video_capture.read()</pre>
142	<pre>gray = cv2.cvtColor(frame,cv2.COLOR_BGR2GRAY)</pre>
143	<pre>faces = face_cascade.detectMultiScale(gray,1.3,5)</pre>
	Figure 6. Detect Face

Second parameter used to change the color picture Becomes *grayscale*/gray ash and then detects picture acquired face from video streaming results with the method capture *frame-to-frame* with Multiscale parameters detect object with size differences in the input image and return rectangle length positioned on the face. The argument first is a picture, the second one is factor scale (how much many size pictures will be subtracted from each scaled image), and the third is in neighbors (how much many neighbors must _ owned every rectangle length). Values 1, 3 and 5 are based on experimentation and selecting the most successful.

3. Parameters Save Face Image

144	tor (x,y,w,n) in taces:		
145	face = frame[y -5: y +h+5, x -5: x + w +5]		
146	<pre>resized_face = cv2.resize(face,(160,160))</pre>		
147	<pre>cv2.imwrite(os.path.join(input_directory,name + str(count) + '.jpg'),resized_face)</pre>		
148	cv2.rectangle(frame, (x,y), (x+w, y+h),(0,0,255), 2)		
	Figure 7. Save the Face Image		

Third parameter is used for with picture-detected face with syntax *frames* where there is coordinate x, y, w, h then the picture-detected face is cut in accordance size parameters x,y,w,h. *Resized* face image with size 160 x 160 fits with *training* parameters and (0,0,255) is a color frame in RGB. The last parameter (2) is the thickness rectangle long. x is the position horizontal start, w is the width, y is the position beginning vertical, h is high, then the picture is saved and becomes *training* data materials. 4. Object Training Parameters

29	def	conv2d_bn(x,
30		filters,
31		kernel_size,
32		strides=1,
33		padding='same',
34		activation='relu',
35		use_bias=False,
36		name=None):

Figure 8. Training Object

Object training parameters working for extract feature face explained as following:

- filter: Integer, dimension room output (is a number of output filters in convolution).
- kernel_size: A number round or tuple/list of 2 numbers round, decisive height and width window 2D convolution. Could be in the form of a number round single for determining the same value for all dimensions spatial.
- strides: number pixels that shift above matrix *input*.
- Padding: used to maintain the height and width picture because after processing size the input image is reduced.
- activation: Function the activation that will be used that is relu, its function return value 0 if accepts negative

input, but every score positive the value of x will be returned to score Activation that alone.

5. Parameter Predict Image Object (Classifier)



Next parameter namely the classification process object. In classification, process testing uses the result of the embedding process in the form of the vector value of an image. Then the vector continues through the SVM identifier model whose result is a prediction from the image. Next, that takes score probability highest from the predictions of the results obtained. Then continue to the label encoder process to get the name from image.

6. Parameter Testing (Callback Model)

40	embedding_obj = Extract_Embeddings(model_path = 'models/facenet_keras.h5')			
41	embedding_model = embedding_obj.load_model()			
42	<pre>face_cascade = cv2.CascadeClassifier("models/haarcascade_frontalface_default.xml")</pre>			
43				
44	# Load Model			
45	<pre>json_file = open('antispoofing_models/finalyearproject_antispoofing_model_mobilenet.json','r')</pre>			
46	<pre>loaded model json = json file.read()</pre>			
47	<pre>ison file.close()</pre>			
48	liveness model = model from json(loaded model json)			
49	# load weights into new model			
50	liveness model.load weights('antispoofing models/finalyearproject antispoofing model 74-0.986316.h5')			
51	print("Liveness Model loaded successfully from disk")			
52				
	Figure 10. Testing			
	6 6			

Part this used for call results end of training method FaceNet with a fully connected layer output that is used as an ingredient for the step next is *Predict Image*.

΄.	Para	meters	Predict	Image	Identity
	(KN	eighborsCla	assifier)		
	32	def create	_svm_model(self,1	abels,embeddings):
	33	self.1	abels = labels		
	34 self.		mbeddings = embed	ldings	
	35 model		= KNeighborsClass	ifier(n_neighbor	s=3)
	36 recog		izer = Calibrated	ClassifierCV(mod	el)
	37	recogn	izer.fit(self.emb	eddings,self.lab	els)
		Figu	re 11. Predict Ima	ge Identity	

In method k-Nearest Neighbor prediction, the result from *training* data is used to predict the score of something interesting variable for every member from the target data set. The general data structure consists of variable interest (that is, the amount purchased), and the amount of variable predictor additional (age, income, location). On the app use a K value of 3 working with comparing 3 pictures results from *training* data for then classified and recognized by member data already registered in *databases*. Moment computing increase along with an increase in k, but the advantage is more k value tall gives smoothing that reduces vulnerability against noise in the *training data*. Usually, k is in unit tens of units, isn't it in

hundreds or thousands. So, the method *KNeighborsClassifier is* very suitable applied to the application.

C. Program Planning Method FaceNet

After knowing the methods and procedures performed. Next is the implementation method the use programming language *Python*. Following this is the code used procedure:

1. Add Student Data



Figure 12. MTCNN Process

Fig. 12 about the coding of the process where *the system* will do recording live to take a picture to generate an image capture with a size of 160x160 pixels later picture will capture as much as 50x and be saved into training data.

2. Procedure Method FaceNet

The process of training data from Fig. 13 is explained as follows:

a. Face Cropping

In this process, the system determines features of every face in pictures like eyes, nose, and mouth. Then the alignment process makes the slanted image will face straightforward.

b. DNN inception resnet training V-1

In this process the system takes the output of the cropping file face that is a feature from the picture and will be studied by auto on layer *Deep* CNN (Inception Resnet V1) then the results learned features will be entered to layer *Fully Connected Layer* (FC). The FC layer is well trained so that produces good feature *vector* (*embedding*).

c. L2 Normalization

In the normalization process used for the count the resulting distance goes more vector coordinates short then will continue with the embedding process.

d. Embedding Process

The embedding process is vector that represents extracted features from face. This then could compare with generated vector for face another. For example, another vector close to (with size certain) may be the same person, whereas another distant vector (with size certain) may be different people.

e. Triplet Loss Process

Process of training output from embedding that will be compared with inputs. Then will validate the face with training data.

f. Output

Produce appropriate personal data identity with image input original.



Figure 13. Flowchart FaceNet

III. RESULTS AND DISCUSSION

A. Result of Using a Mask

TABLE I RESULT OF USING A MASK



Table 1 describes the testing process moment use a mask. On testing this could see there are two users who wear masks 2 users who don't wear a mask. Then more systems sensitive against users who do not use a mask so that the data fits with that user. Result of testing wearing a mask is system can detect will, but system too sometimes no can detect face at the moment use of masks.

B. Result of Head Tilt

The test aims to be able to make it easier at the moment detective face. Following testing tilt head. Test on is results from testing slope head done at an angle to right, left, up, down, and straight to front. At the moment head directed to on the system can't detect then next at an angle to lower the system can't detect face then head directed to left neither system can detect face when head faced to the right the system doesn't could detect object last face facing to front system can recognize appropriate. Results of the testing could conclude the system can't be used if face no facing to the camera so that when using the user application must focus on the front-facing camera so you can be detected and recognized his data.

TABLE II RESULT OF HEAD TILT

No	Picture	Information
1		Not Detected
2		Not Detected
3		Not Detected
4	E Capara	Not Detected
5	Ciptore - O X	Detected

C. Result of Multiple Face Detection

Fig. 14 explains that the application could detect and recognize more than 1 object's face with good. With use, MTCNN and FaceNet methods system can detect in real-time and then will display name and accuracy data equation with object. From testing, many faces produce a percentage of more than 90% based on the dataset.



Figure 14. Multiple Face Detection

D. Result of Twins Object

TABLE III RESULT OF TWINS OBJECT



Testing the data Table 3 explains about results testing with object face twin, where the user will carry out the detection process later face, will match with the appropriate data. The system could detect face twins with produce a percentage maximum of 90% were level compatibility face with appropriate data. Data in column picture two has been identified by 90% with pictures before already stored in the system. Test object twin conducted 3 pairs of different twins. There is a 10% difference between each twin. FaceNet here plays a very role important in testing object twin because determining the score for measure level similarity face. Each neural network will use pictures as input then each existing layer will process differences or similarities from the Images.

E. Result of Accuracy

TABLE IV RESULT OF ACCURACY

No	Picture	Accuracy
1		73.52%
2		89.37%
3		89.89%
4		89.93%
5	Carter	89.75%

Accuracy testing was conducted on 5 people where testing this conducted by objective. By doing a face scan will output name and accuracy of taking an image. Research has results where above 70% accuracy already in accordance so that application already worth used.

IV. CONCLUSION

Student Attendance System Using Face Recognition Based on MTCNN and FaceNet could run as designed and could be used without having to use an ID. The system created could detect faces at a distance of 40 cm - 180 cm with an accuracy of 90.5% and could detect more than 1 object in 1 frame so that the IP Camera function was in accordance with the design in real-time. Tested the object of 3 pairs of twin faces produces a maximum accuracy of 90% where the level of match between the faces and the data is appropriate. FaceNet played an important role in testing twin objects in order to determine the value to measure the level of facial similarity. In this study the FaceNet method ran according to the system so that the identification and classification of data is appropriated.

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