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SUSPECT IDENTIFICATION ALERT SYSTEM

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Abstract : Identifying a suspect in a crowded place like an airport, mall or even a small significant and crowded place can prove to be a tedious job if automation is not devised. The following project aims to identify a suspect specifically without having to make assumptions and creating any unnecessary panic. We implement machine learning algorithms and neural networks to train and identify a suspect from thousands of daily visitors.

***IndexTerms* - Augmented dataset, Convolutional Neural Network**

I. INTRODUCTION

Face identification is a critical component of current security systems, but because machine learning algorithms require a huge dataset to achieve high accuracy, our approach provides an easy way to identify the suspect.

The solution includes code for accurate face prediction utilizing data augmentation techniques. This research develops a new strategy combining convolutional neural network (CNN) with the augmented dataset to address the problem of human face recognition on tiny original datasets. Through multiple modifications of the facial photos, the initial tiny dataset is enhanced to become a huge dataset.

Using the clever CNN, the features of the faces can be efficiently retrieved based on the enhanced face picture dataset, and greater face recognition accuracy can be attained. Several trials and comparisons with commonly used facial recognition systems demonstrate the usefulness and superiority of the suggested strategy. Haar cascade is an object detection technique/model that is used to determine the position of faces in order to train a face recognition system. It is based on edge detection, which means that it uses lines/edges in the face and treats areas with amplified pixels as a feature. The Haar feature is then navigated to the next block after calculating the Haar value for each block of area in the pictures.

II. RESEARCH METHODOLOGY

1.1 Augmentation

Augment implies "to increase the size of anything." In the context of our project, we plan to enlarge our dataset using the few images we have of the individual and create several transformed copies of it. This guarantees that neural networks can learn better even with a small number of samples.

Data Augmentation is a method we use to artificially increase the amount of data we have as the training set by minutely transforming the existing images. It is a good idea to apply DA if you want to prevent overfitting, if the available dataset is too small to train on, or if you want to increase the efficiency of your model. To be clear, Data Augmentation is utilized for more than only preventing overfitting. A large dataset is usually significant for the success of all ML models. However, we can increase the model's performance by supplementing the data we currently have. This indicates that Data Augmentation can also help to improve the model's performance.

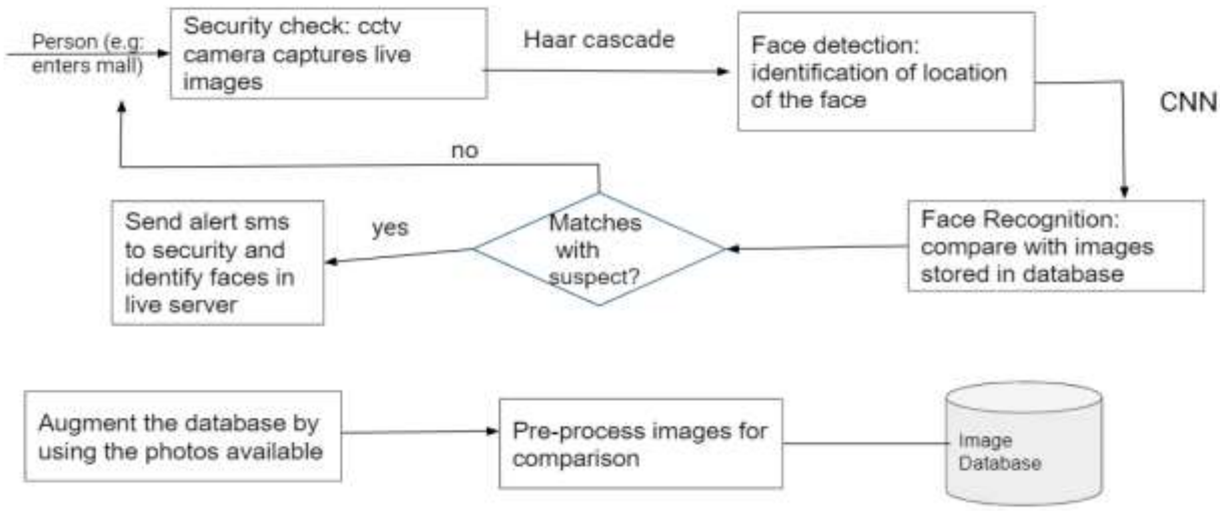

Fig.1 Data flow diagram

1.2 Haar Cascade

Paul Viola and Michael Jones developed the object detection method using Haar Feature-Based Cascade Classifier. The published paper "Rapid Object Detection Using a Boosting Cascade of Simple Features" in 2001 is still one of the most popular face recognition methods used.

A Haar Cascade is a collection of Haar-Like Features that are used to build a classifier. The feature is the sum of the white pixels' values subtracted from the black pixels' values(the method works only on black and white photos, so conversion is mandatory).

The face detector's base is 24* 24. There are approximately 160,000 potential Haar-like Feature from that base face detector. However, not every one of these features is used. Hence AdaBoost Machine learning is used to identify the best features from a set of 160,000 attributes. A Haar feature is basically a set of computations carried out on adjacent rectangular regions in a detection window.

1.3 Convolutional Neural Networks

The approach uses a Convolutional Neural Network (CNN), which consists of two types of hidden layers, i.e convolutional layer and pooling layer that are ordered alternatively. Like a neural network in biology, the connection weights in Convolutional Neural Network can be distributed throughout the network. This reduces the number of connection weights of the network as well as the complication of it. Therefore, the time taken to train the CNN can be exceptionally reduced in the majority of cases. In cases where the input of CNN is an image, it can be directly processed through the neural network while avoiding additional steps such as data reconstruction and feature extraction. Due to advantages such as weight sharing, pooling, and local receptive field, CNN performs well on numerous image transformation tasks such as translation, rotation and scaling.

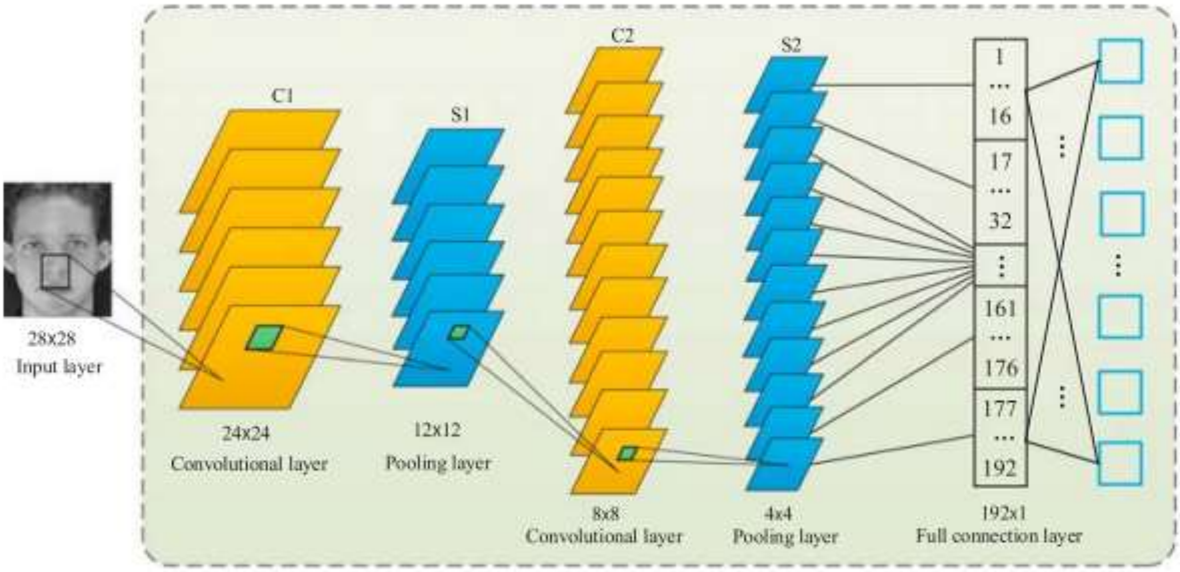

Fig.2 CNN model for face recognition

1.3.1 Activation Function

Besides the structure of a neural network, its performance also depends on the activation function selected, which is adopted as a nonlinear function to deal with some complicated problems. The activation functions that are often used in Convolution networks are sigmoid, hyperbolic tangent (tanH), and rectified linear unit (ReLU), which can be represented as:

$$\text{sigmoid}: f(x) = \frac{1}{1+e^{-x}}, \quad \text{Eq. 1}$$

$$\tanh: f(x) = \frac{e^{x}-e^{-x}}{e^{x}+e^{-x}} \quad \text{Eq. 2}$$

$$\text{ReLU}: f(x) = \max(0, x). \quad \text{Eq. 3}$$

1.3.2 Back Propagation Algorithm

For neural network training, the backpropagation algorithm is commonly always used. The plotting of the input and output features is a nonlinear optimization problem of the linked weights. Formulated according to the gradient descent of the backpropagation algorithm, weights of the neural network are changed recursively by reducing the Mean Square Error (MSE) obtained through the difference in the actual and target numbers . The MSE, which is the cost function used in neural network training, can be represented as:

$$E(\mathbf{W}, \mathbf{B}) = \frac{1}{N_L}\sum_{i=1}^{N_L}(a_{iL} - t_{iL})^2, \quad \text{Eq.4}$$

Where **W** is weight matrix, **B** is bias matrix, a_{iL} and t_{iL} denote the actual and target output values of the ith neuron in the output layer that has N_L neurons.

$$a_{il} = f_{il}\left(\sum_{j=1}^{N_{l-1}} w_{ijl} a_{j,l-1} + b_{il}\right), \quad \text{Eq. 5}$$

b_{il} is bias of a_{il}; w_{ijl} is the connecting weight that links the ith neuron of the lth layer and the jth neuron of previous layer; l denotes layer number; N_l is the number of neurons in the ith layer. On the forward propagation of the input and cost function, the weights and biases of the neural network would be changed as:

$$w_{ijl}(k+1) = w_{ijl}(k) + \Delta w_{ijl}(k), \quad \text{Eq. 6}$$

$$b_{il}(k+1) = b_{il}(k) + \Delta b_{il}(k), \quad \text{Eq. 7}$$

Where Δw_{ijl} and Δb_{il} are obtained by using the chain rule of calculus,

$$\Delta w_{ijl} = -\eta\frac{\partial E}{\partial w_{ijl}} = -\eta\frac{\partial E}{\partial a_{il}}\frac{\partial a_{il}}{\partial w_{ijl}}, \quad \text{Eq. 8}$$

$$\Delta b_{ij} = -\eta \frac{\partial E}{\partial b_{ij}} = -\eta \frac{\partial E}{\partial a_{ij}} \frac{\partial a_{ij}}{\partial b_{ij}}, \quad \text{Eq. 9}$$

and η is learning rate that is used to manage the changes in gradient descent. Refer [1] for detailed study.

1.3.3 Convolution Operation

A mathematical operation, that is Convolution, is frequently used in processing of images. The result can be classified as Full, Same and Valid, which is used in various circumstances. For instance, for forward propagation, Valid mode is used to further the feature extraction, and to obtain optimal weights in back propagation, Full mode is applied. For the input image in convolution operation, edge zeroing is applied, where the layer amount of the edge is computed in accordance to the size of the convolution kernel.

Edge zeroing guarantees quality results, i.e. the components of the fed image and the convolution kernel can be weighted and summed in sequence. The convolution kernel is physically manipulated as in, the kernel is rotated 180 degrees around the center. It is notable that sparse multiplication and parameter sharing can be achieved with convolution operation, which compact the size of the input data.

1.3.4 Pooling

Following the convolutional layers, are the pooling layers, which are used to compact the output feature data of the former. The enhanced results lessen the possibility of over-fitting in the neural network. Via pooling operation, without modifying any information that is gathered from the image, the features of the image can be extracted. Reduction processing of the image is known as pooling, which are sorted as mean-pooling, max-pooling, overlapping-pooling, stochastic-pooling, and global average pooling. For example, max-pooling extracts the highest value of feature points and attains greater texture extraction; mean-pooling extracts the mean value of the feature points while maintaining the relative background. In particular, for mean-pooling, if a feature map of 4 x 4 size is sampled using a kernel of 2 x 2 size, then the result is a feature map of 2 x 2 size.

1.4 Hardware Requirements

- Camera suitable for taking pictures/videos
- System with windows/macOS, 500GB and above hard disk
- GPU for faster processing (optional)

1.5 Software Requirements

- Python IDE - jupyter notebook/google colab (for GPU)
- OpenCV
- Keras
- Tensorflow

III. RESULTS AND DISCUSSION

The end results of the project would be to launch a tool that will make security systems more rapid, safe and convenient. Although similar models have been created before this, we aim to use a unique combination of available algorithms and methods to make a better and more secure system of suspect identification.

IV. ACKNOWLEDGMENT

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