

Offline Signature Validation using Image Processing

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Abstract—

The signature is widely used as a means of personal verification. It emphasizes the need for an automatic verification system because of the unfortunate side effect of being easily abused by those who would feign the identification or intent of an individual. Verification of signature can be performed either by Online or Offline based on the type of application. Online system uses dynamic information of a signature captured when the time of signature has been made. Offline systems work on the scanned images of a signature. In this paper, we are presenting an Offline signature verification where we are using both ANN and CNN algorithm. The geometric features like Area, Eccentricity, Kurtosis, Center of gravity, and Skewness are extracted from image in ANN and an augmentation technique in CNN. Before we extract the features, preprocessing of scanned image is necessary to isolate the signature part and to remove any type of noises present in it. The system is initially trained using a database of signatures obtained from individuals whose signature has to be authenticated by the system. We are using less datasets compared to existing model. We will deal with it in later sections.

Index Terms— ANN, CNN, Pre-processing, Data Acquisition, Feature extraction.

I. INTRODUCTION

Nowadays, person identification and verification is very important in security and resource access control. Biometrics is the science of automatic recognition of individual identity depending on their physiological and behavioral attributes. For centuries, signatures have been an integral part of validating business transactions, contracts and agreements. Among the different forms of biometric recognition system such as fingerprint, iris, face, voice etc., signature is widely used. Main thing is that signature is very important part in bank because withdrawal of money depends on it. But nowadays, cases about fraud signature in banks are increasing. So to overcome this type of situation this project will help to identify whether signature is real or fake. While off-Line signature verification systems taken as input the 2D image of a signature. Offline systems are useful in automatic verification of signatures found on bank checks and documents [3][4]. Offline systems are useful in areas of automatic verification of signatures found in bank checks and documents etc. In our project we used ANN and CNN algorithm. In existing system signatures from database are pre-processed and prior to feature extraction.

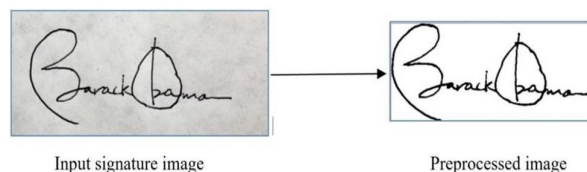


Figure 1. Handwritten Signature and Preprocessed Signature

These extracted features are used to train our neural network. In verification stage, test signature pre-processing and feature extraction are performed. Artificial Neural Network (ANN) [1], is a group of multiple perceptron or neurons at each layer. ANN is also known as a Feed-Forward Neural network because inputs are processed only in the forward direction and not back ward. This type of neural networks technology are one of the simplest variants of neural network. They pass the information in one direction, through various input nodes, until it makes it to the output node. But some of the disadvantage of ANN is that as we mentioned before, with ANN arms hanging along with the execution of parallel processing, and so they need processors that support parallel processing, so the ANN are dependent on the hardware and require external function need to be defined. Since it is similar to the functionality of the human brain, we may not be able to determine what is the proper network structure of an ANN. Not only do ANN, but also the statistical models can be trained with only numeric data, so it makes it very difficult for ANN to understand the problems statements. To overcome such type of problem we use CNN, it is one of the most popular models used today. This neural network computational model uses a variation of multi-layer perceptron's and contains one or more convolutional layers that can be either entirely connected or pooled. These convolutional layers create feature maps that record a region of image which is ultimately broken into rectangles and sent out for nonlinear processing some of advantages of CNN over ANN is that very high accuracy in image recognition problems. Automatically detects the important features without any human supervision and external functions. By combining these two algorithm we print the result based on threshold value whether the signature is genuine or forged.

II. LITERATURE STUDIES

A. Convolutional Neural Network Based Offline Signature Verification Application (Muhammed Mutlu Yapıcı, Adem Tekerek, Nurettin Topaloglu 2018)

In this study, DL application based on CNN architecture, which achieved successful results in many field, was applied for signature verification. In the study, CNN architecture was trained separately as WD and WI as two different models. One of the biggest problems of the CNN is the problem of inadequate training data for signature verification application. To addressing this problem, they used two different CNN models. They aimed to solve the problem of inadequate signature example with WI while increasing the classification success with WD. But in this model they were using large number of dataset.

B. Signature Verification System using Neural Networks (Tushara D, Shridevi Raddy, Shreya KM, Spoorthy Y 2021)

In this paper an online signature verification system is proposed which is based on neural network based classification. This system uses 10 signatures taken from the user database and from that a database of x, y coordinate and velocity values at different points are extracted, from which different specific features set is calculated, which is used to train a neural network using MATLAB software.

III. MOTIVATION

Signature verification is a type of software that compares signatures and checks for authenticity and uniqueness of signatures. This will save time and energy and helps to prevent human error during the signature process and lowers chances of fraud in the process of authentication. CNN usually takes large dataset for training but by combining both ANN and CNN it can use less dataset for training.

IV. PROBLEM DOMAIN

Our project lies on technology domain where we are combining both ANN and CNN technologies to get accurate result based on threshold value. We are modifying existing model so that we can get good result.

V. PROBLEM DEFINITION

The signatures of the same person can vary with time and the state of mind even though they are experts. Our main goal is to verify whether the acquired signature is genuine or forged.

VI. DESIGN

In below block diagram we can see that there are two operation in our project. First operation is based on the CNN and the second operation is on ANN. In first operation first step is data acquisition, Data acquisition is the process of digitizing data from the world around us so it can be analyzed, displayed, and stored in a computer. In

next step preprocessing of image has to be done. The aim of pre-processing of signature is to improve the quality of the image so that we can analyze it in a better way. By preprocessing we can suppress some undesired distortions and enhance some features which are necessary for the particular applications. In next step we will train our model with set of user signature image then we will classify the image whether it is genuine or forged and place that result in Result1 variable. In second operation also we will train our model with set of signature images here also pre-processing of image as to be done. The signature is first captured and transformed into a format i.e. binary format that can be processed by a computer. Now it's ready for preprocessing. In preprocessing stage, RGB images of the signature is converted into the grayscale and then to binary image.

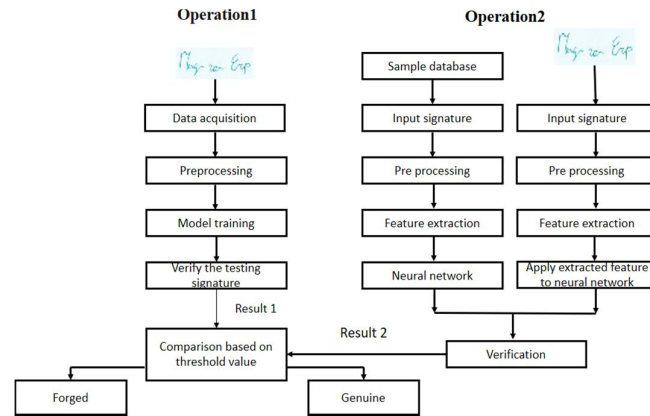


Figure2. Blockdiagram

The aim of this phase is to make signature ready for feature extraction. This preprocessing stage includes two steps: Color inversion i.e. RGB to grayscale, Filtering and Binarization. [1]. Then geometric features like Area, Center of gravity, Eccentricity, Kurtosis and Skewness has been extracted [9][10][1]. Area is the actual number of pixels in the region of signature. Centroid vertical and horizontal and centers of gravity of the signature. Eccentricity is the ratio of the distance between the foci of the ellipse and its major axis of length. Kurtosis is a measure of flatness of distribution. It gives an idea of whether the data are peaked or flat relative to a normal distribution. Skewness is a measure of asymmetry of distribution.

$$\text{Kurtosis} = \frac{n \cdot \sum (Y - \bar{Y})^4}{(\sum (Y - \bar{Y})^2)^2} \quad (1)$$

Here, Y_i is the i^{th} Variable of the Distribution, $\bar{Y}$ is the Mean of the Distribution, n is No. of Variables in the Distribution.

$$\text{Skew} = \frac{n}{(n-1)(n-2)} \sum \left(\frac{x_j - \bar{x}}{s} \right)^3 \quad (2)$$

Here, n represents number of variables in the distribution, x_j is random variable, s represents mean of distribution, and $\bar{x}$ represents mean of distribution. operation 2 and stored in Result 2. We will print the result based on threshold value or accuracy value of operation 1. We will set threshold value based on trail and error method. If we get same result on operation 1 and operation 2 we will print that result, if operation 1 and operation 2 have different result we will print the result based on accuracy value of operation 1. Example, if threshold value is set to 70 if accuracy of operation 1 is less than 70 then operation 2 result will be printed or operation 1 result will be printed. In second operation we are using ANN. Artificial Neural Network or ANN resembles the human brain in learning through training and data storage. Then the result from operation is stored in variable called Result 2. Later we will classify the result based on threshold value what we get from operation 1.

VII. WORKING METHODOLOGY

Initially we will take some signatures of users and placed into separate folder, each users are given with the unique ID. We will take more images for training it will obvious increase the accuracy. The image that we want to check whether it genuine or forged we will be giving that image path, after submit background processing will start i.e. operation 1 and operation 2.

In operation 1 CNN is used data acquisition where it will digitalize the data in next step. In next step preprocessing of image has to be done. Since we are using less dataset in CNN we are using data augmentation. The aim of pre-

processing is to improve the quality of the image so that we can analyze it in a better way. Then training of image is done that what we saved in folder after training image that we want to test is classified and saved in Result 1 variable. Next operation 2 starts executing, it is based on ANN where we approach the problem in two steps. Initially, the scanned signature images are preprocessed to make it suitable for extracting features. Then, the preprocessed images are used to extract relevant geometric parameters that can distinguish forged signatures from exact ones using the Artificial neural network technology. The signature is first captured and transformed into a format that can be processed by a computer i.e. RGB to grayscale [1]. Now it's ready for preprocessing. In preprocessing stage, the RGB image signatures are converted into grayscale one and then to binary image. The purpose of this phase is to make signature ready for feature extraction. The preprocessing stage includes two steps: Color inversion [6] i.e. RGB image to grayscale image, Filtering and Binarization [5][7][8]. The colored image RGB is converted to the grayscale intensity image by eliminating the hue and saturation information and retaining the luminance. Any image when resampled is filtered by a low passing FIR filter. This is done to avoid aliasing. This aliasing occurs because sampling the data at a rate lower than twice the largest frequency component of the data is occurred. And for this purpose the filter is used. Now the grayscale image is segmented to get a binary image. In a binary image, each pixel assumes to be one of only two discrete values: 1 or 0. A binary image is stored as a logical array. Extracting a feature is the key to develop an offline signature recognition system. We use five global features that cannot be affected by temporal shift. These features are geometrical features which are based on the shape and dimensions of a signature image. The various shape features that we use are: Area, Centroid Coordinates, Eccentricity, Kurtosis and Skewness as we discussed above [9][10]. After extracting the features of training set and test image we will get result of operation 2 and stored in Result 2. We will print the result based on threshold value or accuracy value of operation 1. We will set threshold value based on trial and error method. If we get same result on operation 1 and operation 2 we will print that result, if operation 1 and operation 2 have different result we will print the result based on accuracy value of operation 1. Example, if threshold value is set to 70 if accuracy of operation 1 is less than 70 then operation 2 result will be printed or operation 1 result will be printed.

VIII. RESULTS

The dataset was split into training set and a validation set accuracy of the model has been reported on the validation. The performance of the model is evaluated using the following metrics.

Precision (P): This gives a measure of the proportion of positive identifications that were actually correct for each of the given classes [1].

$$P = \frac{\text{True_Positives}}{\text{True_Positives} + \text{False_Positives}} \quad (1)$$

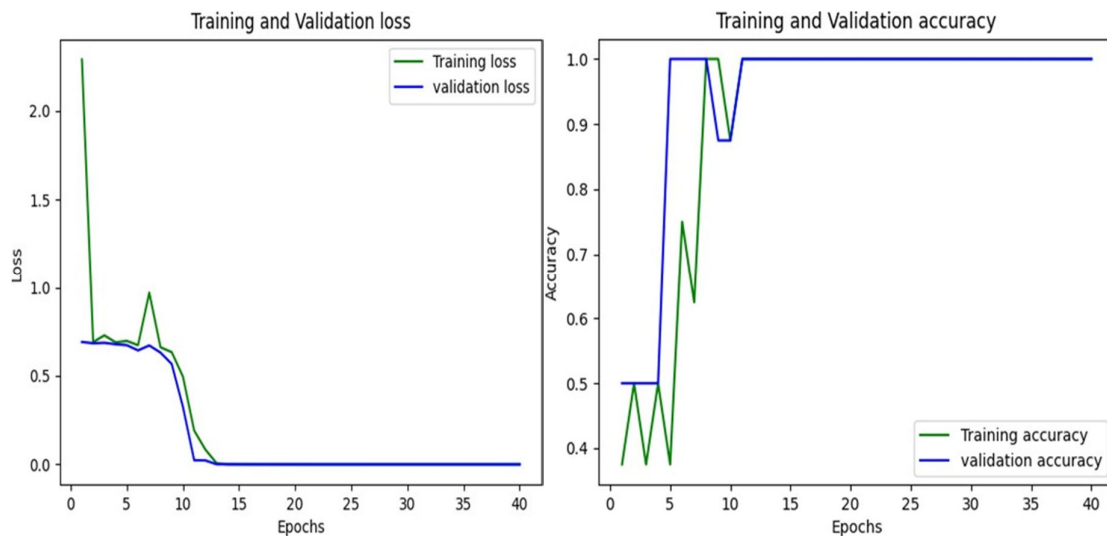


Figure3: Validation accuracy and loss graph

Above figure shows the validation accuracy and validation loss for our model. When we compare our model with previous model we are getting good accuracy i.e. 91% even we are using less dataset we can see that accuracy is increasing in epoch and losses are decreasing. We are getting same accuracy as existing model with less dataset.

IX. CONCLUSION

CNN is the best neural network approach, it is used for modeling of image but it is not limited to just modelling of the image but also out of many of its applications, and an artificial neural network is an algorithm that simulates the fast learning performance of large number of biological neuron cells. The node is the most basic function using, in the ANN, simulating the behavior of a neuron cell by using these two algorithms we can get more efficient results. Throughout the most recent decade, there are many strategies for Offline Signature Verification. While recognizing genuine signatures and forged signatures remains a difficult task, false acceptance rates have dropped fundamentally in the most recent couple of years because of progressions in Deep Learning. For existing model we were using large number of dataset but we are verifying signature with new method by combining both ANN and CNN which is efficient than existing model.

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