Prediction of Human Behavior from Handwriting

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***Abstract*- Graphology is a method for identifying, evaluating personality traits by handwriting. Professional Handwriting analysts are called Graphologists. Handwriting is often called as Mind Writing or Brain Writing. It reflects human's thought-process through his handwriting Accuracy of Handwriting depends upon intellectual of the Graphologists. The proposed System focuses on developing a software for predicting human behavior. In this paper a method has been proposed from baseline, slanting of letters, looping of letters, pen pressure and height of the letters. The system uses Convolutional Neural Network (CNN) for prediction of human nature.**

Index Terms- Behavior detection, Image Processing, feature extraction, CNN.

INTRODUCTION

Throughout history, scientists, philosophers, artists and others have been interested in the relationship between the handwriting and the writer. This attempted to relate specific handwriting elements to specific human traits. It took a while. In 1910, Milton Newman Bunker, a shorthand teacher, in Kansas, let his curiosity get the better of him. He wanted to know why, as a penmanship student, he had put wide spaces between his letters and long finals on his words. He began to study the graphology. In 1915, Bunker made his unique discovery. He recognized that each of his students formed shorthand strokes in a unique manner. He suddenly and clearly realized that it was not the letter which had a trait meaning but the strokes – the shape of the formations within the letter. Graphology suggested that an O with an open top – that is a space opening, indicated a person who would speak very openly and often. He checked and found this to be true. He thought, however, that logically, other letters with the same circle formation (a,g,d & q) should have the same meaning and after checking carefully he found that he did. After traveling thousands of miles, and interviewing thousands of people and examining more than half a million handwriting specimens in his lifetime, the copyrighted American System of handwriting analysis – Graphoanalysis was born.

OBJECTIVES

This paper aims to predict human behavior through handwriting analysis. Convolutional layers apply a convolution operation to the input, passing the result to the next layer. The convolution emulates the response of an individual neuron to visual stimuli.

LITERATURE REVIEW

[1] Esmeralda C. Djamal projected Autography movement emulate the written element of each individual's periodicity and design. By analyzing all fundamentals of handwriting and interpreting them, using typical of graphology author could initiate a chart of the writer's character attribute, sentimental constitution and gracious design. In graphological analysis, an image is separated into two accession that graphics attributes and partition digit each character. In this research, author employ graphical accession based on signature and digit of character of consumption scheme using many-frame algorithms and artificial neural networks (ANN). The image crack into two space: the signature occupied on nine appearance and consumption scheme of letters digit space. On each space preprocessing is performed to improve the recognition accuracy. ANN classifier is applied on five features of impression which outcome has exactness of 56-78% and four appearance of the impression that disclosure using many frame algorithms result 87-100% exactness.

[2] Sandeep dhang on Handwriting Analysis of Human Behavior Based on Neural Network, Graphology or Handwriting analysis is a scientific method of identifying, evaluating and understanding of anyone personality through the stroke and pattern revealed by handwriting. Handwriting reveals the true personality including emotional outlay, honesty, fears and defenses and etc. Handwriting stroke reflects the on-paper draw of each individual's rhythm and Style. The image split into two areas: the signature based on three features and application form of letters digit area. In this research performance evaluation is done by calculating mean square error using Back Propagation Neural Network (BPNN). Human behavior is analyzed on the basis of signature by using neural network

[3] Javier Galbally, Julian Fierrez, Marcos Martinez-Diaz, R´ejean Plamondon E´cole Polytechnique de Montre´al focus on "Quality Analysis of Dynamic Signature Based on the Sigma- Lognormal Model". In this paper author distinct that various personal ethics can be precisely illuminate as a set of influential describe sequenced together by a Markov chain. To diagnose personal ethics from sensible data and to deduce personal ethics over a few seconds time, author then use these influential Markov layouts. To ensure the virtue of this designing avenue, creator report an experiment in which, author was able to achieve 95precision at predicting automobile drivers‟ subsequent actions from their starting preparatory movements.

[4] In this author distinguish a new behavioral biometric technique based on human computer communication. Author urbanized a system that captures the user communication via a lighten, and uses this observable information to verify the individuality of an individual. Using analytical pattern credit techniques, author developed a sequential classifier that processes user interaction, as reported by the user identity is considered real if a predefined accuracy level produced, and the user is classified as a pretender otherwise. Two statistical models for the features were tested, namely Parsing density opinion and a unimodal disposal. The system was checked with different numbers of users in order to assess the scalability of the proposal. Experimental results show that the normal user communication with the computer via a pointing device entails behavioral information with particular power.

[5] Proposed a paper addressing problem of personal authentication through the use of autograph recognition is described in this paper. There are two method of verification: online and offline signature verification. The dynamic methods covered the analysis of the shape, speed, stroke, pen pressure and timing information. While the stationary methods involve general shape recognition techniques. The paper inclined a sharp historical outline of the extant methods and it presents some of the recent research in the field. In this paper the problem of exclusive testimonial through the use of signature perception is considered. Twain on-line and offline methods have been described.

PROPOSED METHODOLOGY

Graphologist identify human nature with a piece of handwritten handwriting. The accuracy of handwriting analysis depends on how skilled the graphologist is. Even though manual handwriting has been effective it is costly and prone to fatigue, hence the proposed methodology focuses on developing a software for behavior analysis which can predict personality traits with the help of computer without human interference. The mostly used features of handwriting for prediction of personality traits are baseline, thickness, pen pressure, height etc. In this paper, the baseline, pen pressure, letter height and slant of letters has been considered for predicting personality.

Baseline: It is the line along which the writing flows

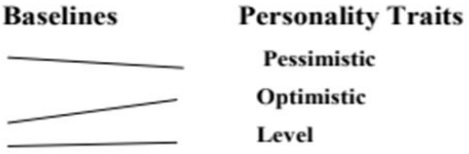
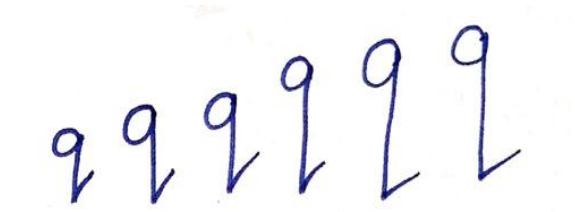


Figure.1: The baselines representing different personality traits of the writer

Pen Pressure: Amount of intensity applied while writing.

Height: It is the total vertical length of letters.



Slant: It is the inclination of letters.

Below are the implementation steps involved in Handwriting analysis..

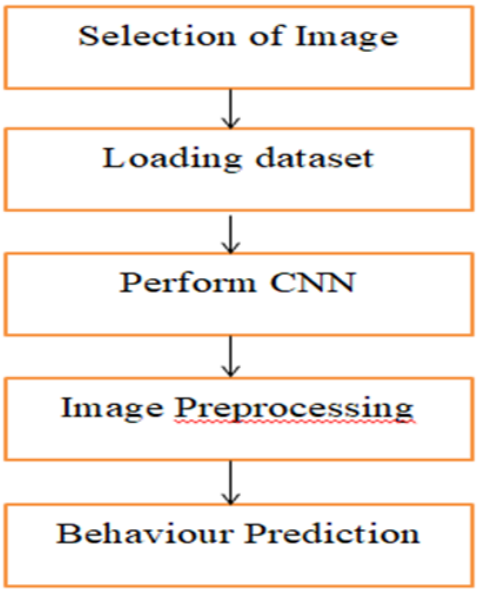


Fig1. Overall Architecture

1. Image Pre-processing

Image processing is done with an aim to improve the image data that suppresses unwanted distortions or enhances some image features important for further processing.

Image processing task is divided into 5 groups. They are:

1. Visualization - It observe the objects that are not visible.
2. Image sharpening and restoration - It is used to create a better image.
3. Image retrieval - It seek for the image of interest.
4. Measurement of pattern - It measures various objects in an image.
5. Image Recognition - It distinguish the objects in an image

a. Gray Scale

Grayscale image also known as black-and-white image is the one in which each pixel of the image carries intensity information. Gray scale image has only two colors: Black and white. The converted grayscale image might lose contrasts, sharpness, shadow, and structure of the color image. Also the luminance of a pixel value of a grayscale image ranges from 0 to 255

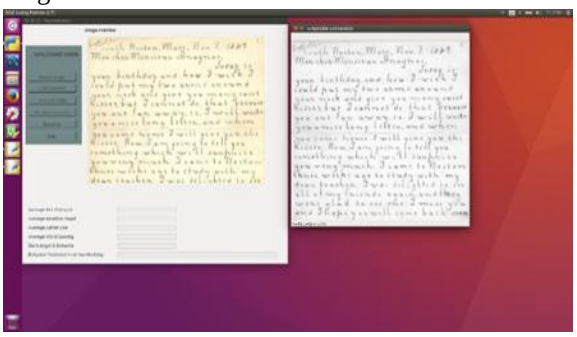


Fig2. Gray Scale

b. Bilateral Filter

A bilateral filter is non-linear, edge-preserving, and noise-reducing smoothing filter for images. It also replaces the intensity of each pixel with a weighted average of intensity values from nearby pixels. This weight is based on a Gaussian distribution. Typically, the weights depend not only on Euclidean distance of pixels, but also on the radiometric differences (e.g., range differences, such as color intensity, depth distance, etc.). This preserves sharp edges.

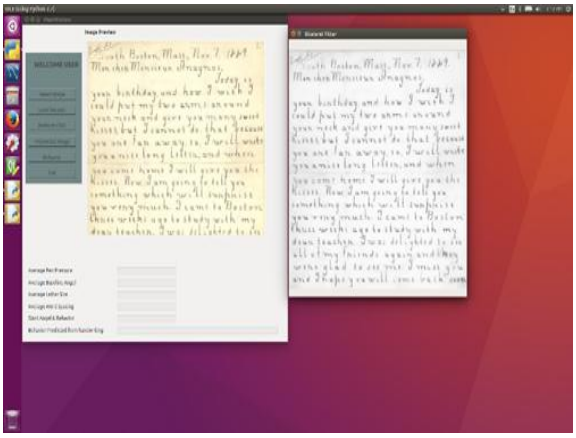


Fig3.Bilateral Filter

C. Canny Edges

Canny edge detection is a used to extract important structural information from different objects and also reduce the amount of data to be processed. The general criteria for edge detection include:-

1. Detecting the edge with low error rate, this means that the detection should accurately catch as many edges shown in the image as possible.
2. The edge point detected from the operator should accurately localize on the center of the edge.
3. A given edge in the image should be marked once, and wherever possible, image noise should not create false edges.

To satisfy these requirements Canny used the calculus of variations - a technique which finds the function which optimizes a given functional. The optimal function in Canny's detector is described by the sum of four exponential terms, but it can be approximated by the first derivative of a Gaussian.

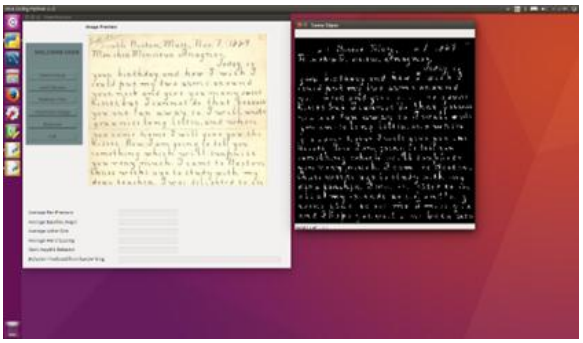


Fig4. Canny edges

2. Convolutional neural network(CNN)

Convolutional neural network (CNN or ConvNet) is a form deep learning and it is most commonly applied to analyze visual imagery. It use a variation of multilayer perceptron's designed to require minimal preprocessing. It is also called as shift invariant or space invariant artificial neural networks (SIANN), based on their shared-weights architecture and translation invariance characteristics. Convolutional network was inspired by biological processes in which the connectivity pattern between neurons is similar to the organization of the animal visual cortex. Individual cortical neurons respond to stimuli only in restricted region of the visual field known as the receptive field. The receptive fields of different neurons partially overlap such that they can cover the entire visual field. CNNs use little pre-processing compared to other image classification algorithms which means that the network learns the filters that in traditional algorithms were hand-engineered. This independence for prior knowledge and human effort in feature design is a major advantage. They have applications in image and video recognition, recommender systems, image classification, medical image analysis and natural language processing. A CNN consists of an input and an output layer and multiple hidden layers. The hidden layers of CNN typically consist of convolutional layers, pooling layers, fully connected layers and normalization layers

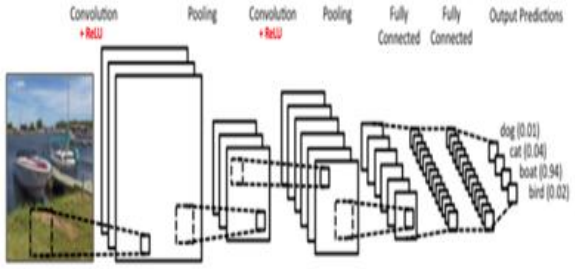


Fig6. Simple ConvNet

The Convolutional Neural Network in Fig. is similar to the original LeNet and classifies an input image into four categories: dog, cat, boat or bird.

There are four main operations in the ConvNet shown in fig. above:

1. Convolution
2. Non Linearity (ReLU)
3. Pooling or Sub Sampling
4. Classification (Fully Connected Layer)

An Image is a matrix of pixel values.

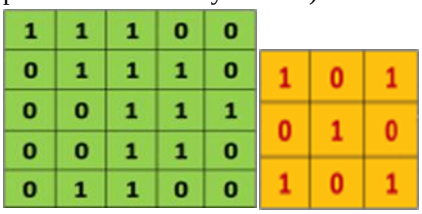
Typically, every image can be represented as a matrix of pixel values. Channel is conventional term used to refer to a certain component of an image. An image from a standard digital camera will have three channels – red, green and blue – you can imagine these channels as three 2d-matrices stacked over each other (one for each color) and each having pixel values ranging in 0 to 255.

The Convolution Step

ConvNets derive their name from “convolution” operator. The primary purpose of Convolution in case of ConvNet is to extract features from the input image. Convolution refers to the spatial relationship between pixels by learning image features using

small squares of input data. We will not try going into the mathematical details of Convolution here, but will try to understand how it works over images.

As we discussed above, every image can be considered as matrix of pixel values. Consider a 5 x 5 image whose pixel values are only 0 and 1 (note that for a grayscale image pixel values range from 0 to 255 and the green matrix is a special case in which pixel values are only 0 and 1):



Also, consider another 3 x 3 matrix as shown. Then, the Convolution of the 5 x 5 image and the 3 x 3 matrix can be computed as shown in the animation

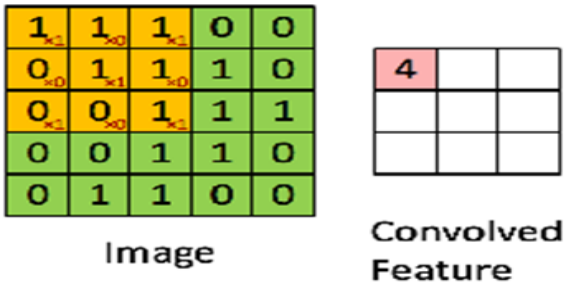


Fig7. The Convolution operation. The output matrix is called Convolved Feature or Feature Map.

Let's take a moment to understand how the computation for the above one is being done. We slide the orange matrix over the original image (green) by 1 pixel (also called 'stride') and for every position, we compute element wise multiplication (between the two matrices) and add those multiplication outputs to get final integer which forms single element of the output matrix (pink). Note that 3×3 matrix "sees" only a part of the input image in each stride.

In CNN terminology, 3×3 matrix is called 'filter' or 'kernel' or 'feature detector' and the matrix formed by sliding the filter over image and computing the dot product is called the 'Convolved Feature' or 'Activation Map' or 'Feature Map'. It is important to note that the filters acts as feature detectors from the original input image.

It is evident from the animation above that the different values of filter matrix will produce different Feature Maps for same input image. For example, consider the input image.

Introducing Non-Linearity (ReLU)

An additional operation called ReLU has been used after every Convolution operation in Figure above. ReLU stands for Rectified Linear Unit and is a non-linear operation and the output is given by:

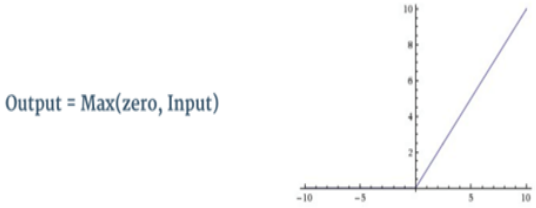


Fig8. The ReLU operation

ReLU is an element wise operation (applied per pixel) which replaces all negative pixel values in the feature map by zero. The purpose of ReLU is to introduce non-linearity in our ConvNet, since most of the real-world data would want our ConvNet to learn that would be non-linear (Convolution is a linear operation –element wise matrix multiplication and addition, so that we account for non-linearity by introducing a non-linear function like ReLU).

The Pooling Step

Spatial Pooling (also called subsampling or down sampling) reduces dimensionality of each feature map and retains the most crucial information. Spatial Pooling has various types: Max, Average, Sum etc.

In Max Pooling, we define spatial neighborhood (for example, a 2×2 window) where we take the largest element from the rectified feature map within the window. In average pooling, we take the average (Average Pooling) or sum of all elements in that window. In reality, Max Pooling has been shown to work better.

The image shows an example of Max Pooling operation on a Rectified Feature map (obtained after convolution + ReLU operation) using a 2×2 window.

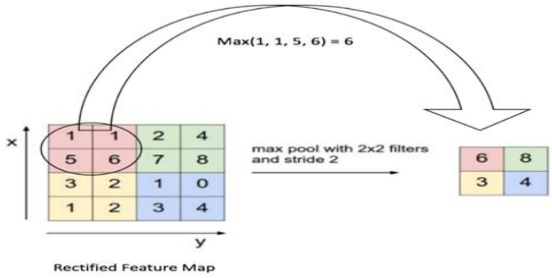


Fig 9. Max Pooling

We can slide our 2 x 2 window by 2 cells (also called 'stride') and take the maximum value in each region.

As shown in Figure, this reduces the dimensionality of our feature map.

CONCLUSION

A simpler method has been proposed to predict the personality of a person by exploring his handwriting. The system extracts features from breaks, size, space between words, baseline, loop of 'e' and few other features like pressure, margin, slant and dot distance in 'i'. The proposed system can be used as a twin tool by graphologist to improve the accuracy and anticipate the behavior s of a person faster. The estimated weighted accuracy of 93.77 % is achieved

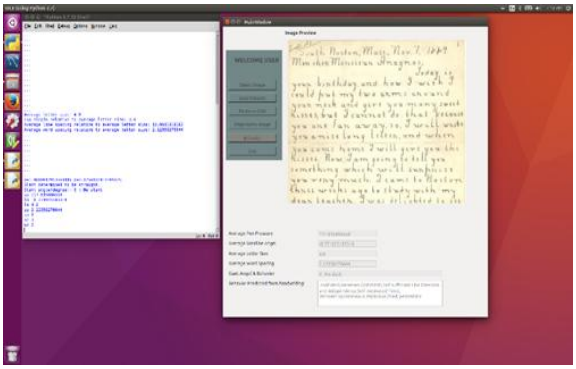


Fig10. Prediction

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