Analysis of Signature for the Prediction of Personality Traits

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Abstract— **The richest information about different emotional states and thinking styles of the person is carried by signature The signature analysis is one of the most effective and reliable indicator for prediction of personality. As it reveals the true personality which includes fears, honesty and many other individual personality traits. This can happen with the help of few features like underscores below signature, appearance of dot on the letter, curved start, ending stroke, and streaks disconnected. This paper is focused on above mentioned features. The database has 60 signatures of 10 different persons with 6 samples of each and is properly scanned at 500dpi resolution scanner. The performance is evaluated by splitting a signature into five categories-left, right, upper, middle and bottom. An artificial neural network and structural identification algorithm is used for the prediction of personality and the obtained accuracy rate is 100%, 95%, 94%, 96% and 92% respectively The significance of work is to reveal personality traits in criminology, medical science and counseling.**

Keywords—Artificial Neural Network, Projection, Connected Components

I. INTRODUCTION

Signature is sometimes referred to as token of personality trait evolved with neurological model in the brain. Signature is brain writing which represents the mental category of the person. Signature analysis is a projection technique as the body language that summarizes the human personality in different areas which includes social skills, achievements, thinking styles, or work habits. In graphology theory, graphologists identify the qualities, traits, attitudes, sentiments or postures point out in the handwriting and signature; further graphologist seek insight into how these parameters justify the personality of the writer[1]. Signature analysis is renowned part of Graphology, it judge graphical analysis of the structural type of writing, such as appearance of dots on letter as in i, j, dots below line, curved start, single line or single underscore, double line or double underscore and many more.

Image processing and pattern recognition provides direction to analyze the signature and handwriting based on graphology. In image processing the signature is consider as an image, the prediction can be performed through different stages such as gray level conversion, calculating threshold value, binary conversion and many more for quality improvement followed by feature extraction and pattern recognition. There are enormous research has been done for predicting the personality of a person using one of the most well known technique called as Artificial Neural Network(ANN).

II. WORK DONE SO FAR

Firstly, there are various ways to describe personality such as handwriting, signature, sleeping movement, palm length and width and many more. Among the entire most researchers focused on handwriting and signature

According to [1] the analysis of graphology divided into two approaches digits of each character and signature using multi-structure algorithms and neural networks. The image split into two areas: signature based on nine features, and application form of letters digit area. Each area had preprocessing performed to improve the recognition accuracy. [2] defined a method which provides training time for a neural network. It applies the image acquisition and preprocessing steps for better results. [3], [4] based on skills of signature of people which describe different types of behavior which includes orientation, letter spacing, streaks, thickness and apply Back Propagation Network Learning Algorithm which gives MSE (Mean Square Error). An automated handwriting analysis concept is described in [5] which identifies the psychological traits in the writing such as size, slant, pressure, baseline, margins and many more and is calibrated with manual analysis. [6], [7] proposed for prediction of personality traits from the features extracted from handwriting using artificial neural network. [6] mentioned the result based on Mean Square Error and [7] has evaluated the result by considering number of hidden layers and epochs. The [8] discussed an approach of machine learning technique and implements the automated handwriting analysis tool and uses an approach called Polygonalization and Template matching for the prediction of behavior.

The Table I describe different approaches used by most of the researcher using Multi structural algorithm, Artificial Neural Network using Back propagation based on various features like baseline, extreme margin, and streak disconnected, dot structure, orientation, thickness, letter spacing of signature.

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Similarly the handwriting features which include size, baseline, pen pressure, slant, breaks, word spacing, margins, speed to analyze the personality of a person.

TABLE I. BEHAVIOR PREDICTION ALONG WITH APPROACHES USED

References	Based on	Approaches used	Features	Behavior Analysis/ Personality	Accuracy Rate (Result)
[1]	Signature and Digit of Character	Multi Structural Algorithm	Extreme Margin	Careless, inattentive, fear of failure, fear or others, lack of confidence, pessimistic, respect yourself, reflect personal happy, depressed, shy, feel foreign	100%
			Dot Structure	Establishment of stable, has a suspicion, not always easy to keep believing	100%
			Separate	Had a less pleasant experience in the past	100%
			Streaks Disconnected	Limiting desires, not taking any risks, often discouraged and hesitated to take decisions	87%
		Artificial Neural Network (ANN) using Back-propagation	Curve Starts	Comfortable going past, To formulate a sharp mind, Be careful, friendly, diplomatic	63%
			End Streaks	Open, foresight, desires ahead, confident, Lacking spirit, realistic thinking, lack of confidence, easily discouraged, Excessive fear, introvert, do not care are approximately, not sociable and do not like to work together	58%
			Middle Streaks	Possessive	75%
			Underline	Unique ideas and thinking power, requires support to make decisions	70%
			Shell	Excessive fear, introvert, do not care are approximately, not sociable and do not like to work together	56%
[2]	Signature	Back propagation Neural Network (BPNN)	Full Signature	Good (0.6691), Normal(0.7155), Aggressive (0.7563), Poor (0.7912), Emotional (0.8206)	Based on Mean square Error
[3]	Signature	Back propagation Network (BPN)	Streaks, Orientation, Thickness, Letter Spacing	Polite, Sincere, Kind, Introvert, Hardworking, Excitable, Fun loving, Charming, Loyal	Based on Mean square Error (MSE)
[4]	Signature	Back propagation Network (BPN)	Streaks, Orientation, Thickness, Letter Spacing	Polite, Sincere, Kind, Introvert, Hardworking, Excitable, Fun loving, Charming, Loyal	Based on Mean square Error (MSE)
[5]	Handwriting	AHWAS (Automated Handwriting Analysis System)	Size, Baseline, Pressure, Slant, Breaks, Word Spacing, Margins, Speed	Concentration, ability to express opinion, pessimistic, optimistic, narrow minded etc.	More than 80%
[6]	Handwriting	Artificial Neural Network (ANN)-feed forward neural network	Letter Slants, Base Line, Pen Pressure, Formation of letter such as f, i	Head control over heart, ability to express opinions, lack of self control, reflective, independent by considering letter slant and narrow minded, strong reaction, concentration, absent minded, frustrated, observant etc.	Based on Mean square Error
[7]	Handwriting	Artificial Neural Network (ANN)	Baseline, Writing Pressure and Height of the t-bar on the stem of the letter 't'	Pessimistic, optimistic, level, deep feeling, low – high or moderate self esteem, dreamer	---
[8]	Handwriting	Polygonalization and Template matching	Baseline, Margin, Slant of the words and Height of t-bar	High-moderate-low self esteem, dreamer, defensive, impulsive, expressive, optimistic, pessimistic, balance etc.	---

III. COMPUTATIONAL TECHNIQUES

A. *Artificial Neural Network (ANN)*

Artificial neural network are parameterized computational nonlinear signal processing devices, which are composed from highly interconnected elementary processing devices called neurons working together to solve particular problems. An ANN is configured for a particular application such as pattern recognition or a classification, sequence recognition, data compression, function modeling through learning process. A neural network works by creating connections between processing elements, determining weights on the connections and activation function rather than using a digital model. There are various advantages of Artificial Neural Network, which includes; Adaptive Learning, Self Organization, Real time operation and Fault tolerance via redundant information coding. There are various formats for representing Artificial Neural Network, among all two is described below;

B. *Back propagation Neural Network (BPNN) format:*

BPNN is well known for its back propagation learning algorithm, which is actually a tutor learning algorithm of gradient descent, or its alteration. The figure 1 below describes the general form of BPNN:

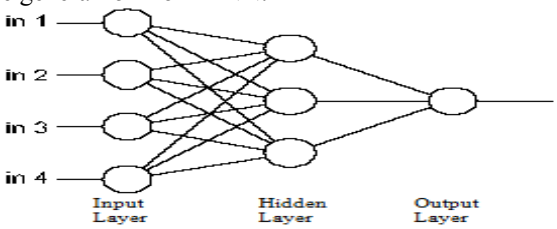


Fig. 1: Structure of Back Propagation Neural Network

In BPNN format firstly, the connections weights and thresholds of a network are initialized randomly. Then considering the training sample, the connection weights and values of threshold for the network are adjusted to minimize the mean square error (MSE) of the network output value and actual value through gradient descent. Lastly, after achieving the goal, the connection weights and thresholds are determined, and the training process of the network completed. This format provides training time for a neural network and thus helpful for prediction of human behavior.

C. *Multilayer Perceptron Neural Network (MLPNN) format:*

The Multilayer Perceptron is well known and most frequently used type of neural network. They actually belong to a general class of structures called feed forward neural network. Generally the signals are transmitted within the network in one direction where each neuron is connected with the other neurons via a weighted communication line where weights are adjusted while training. As it does not consist of any loop, the output of each neuron does not affect the neuron itself. Three well known layers of neural network are input layer, one or more hidden layer and an output layer. They all propose different roles at every layer of neural network.

[1] considered the Multilayer Perceptron for recognizing personality using signature based on five features and four features using multi- algorithm structure and got accuracy rate of 56-78% and 87-100% respectively.

IV. IMPLEMENTATION OF TECHNIQUES

The database creation has been done by taking 6 samples of signature of 10 different people belonging to different age groups in the specified rectangular area on a white paper. Thus there are 60 samples of signatures in the database. These samples are obtained by scanning at 500dpi resolution and resized with dimensions of 200*100 pixels long.
The block diagram shows different steps to be followed while identifying the personality of the person.

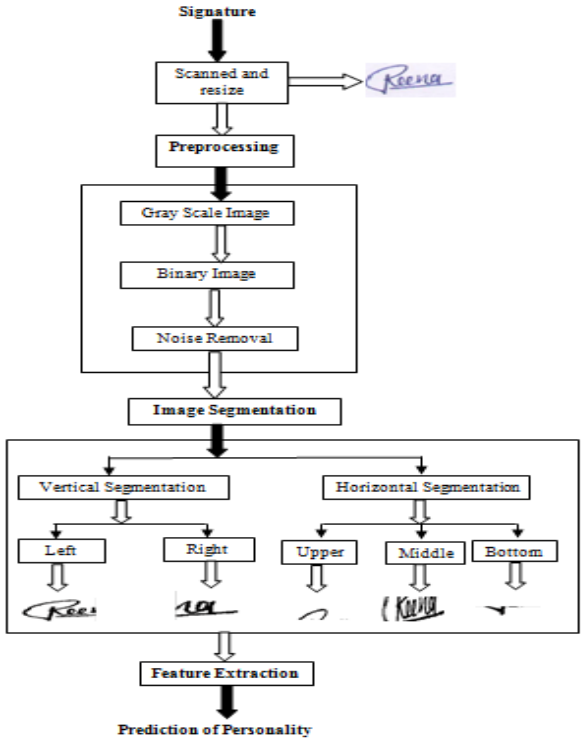


Fig.2 Block Diagram for Prediction of Personality

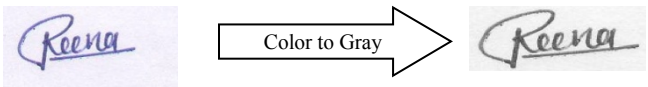
A. *Image Acquisition*

Images have been acquired from the database for the further processing.

B. *Preprocessing Stage*

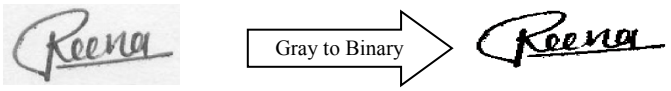
This stage consists of various steps. They are described as follows: color to gray scale, gray to binary, removal of noise.

Step1: Conversion from color to gray scale
Mostly the signature is done with blue or black point pen. These colors must be converted into gray scale, which can becomes easier and helpful for further processing.



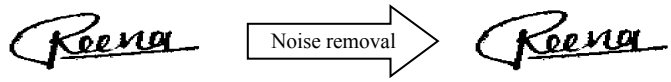
Step2: Binarization

In this technique the gray scale images are converted to binary images. Thus aim of this technique is to remove only the surroundings by setting it to white and by keeping the foreground image unchanged. Thus binarization distributes the foreground and background information.



Step3: Removal of Noise

Before going for further processing, the noise reduction filter is applied to the binary scanned image. This process is important for processing because it eliminates single white pixels on black background and single black pixel on white background.



C. Segmentation

In segmentation technique the image is segmented into two kinds of segments: Vertical Segmentation and Horizontal Segmentation. The vertical segment is again sub-divided into left half and right half. The horizontal segment is also sub-divided into upper, middle and bottom part. These sub-divided parts have unique features and they plays vital role for identifying the personality.

i. Left half - curved start (curved smoothly or illegible stroke), angular strokes.
ii. Right half – ending stroke (increasing or decreasing), dot follows signature.
iii. Upper part - appearance of dots on letter
iv. Middle part- length of signature (small, large), streaks (connected or disconnected).
v. Bottom part- baseline going upside (ascending), dot structure below underline, single or double baseline.

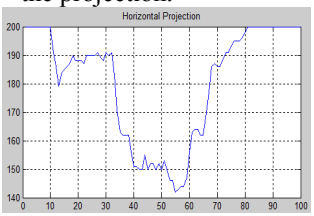
D. Feature Extraction

Feature extraction describes the significant shape information in order to provide pattern so that the task of classifying the pattern is made easy by a formal procedure. Feature extraction is mostly used to reduce dimensionality in image processing and pattern recognition. The main goal of feature extraction is to obtain the most relevant information from the unique data and embody that information in a lower dimensionality space. A term Feature Extraction transforms the input data into the group of features. The features set will be used to take out the significant information from the input data in order to perform the preferred task [9].

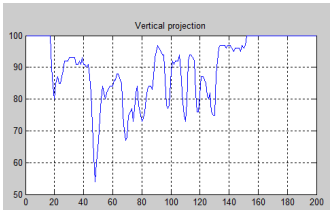
In this proposed methodology feature are extracted and are based on projection.

a) Projection based feature extraction

It consists of two type namely horizontal and vertical projection. Horizontal and vertical projection is an array contains sum of pixels present in each column and in each row respectively. The size of horizontal and vertical projection is equal to the number of rows and columns in the signature. Both are the kind of histogram, as histogram indicates the intensities around which the image pixels are concentrated, similarly projection histograms count the number of background and/or foreground pixels in a precise path. Fig 3 below, describes both the projection.



Horizontal Projection



Vertical Projection

Fig3. Horizontal and Vertical Projection of the image

In horizontal and vertical projection, we count number of black pixels present in each column of the signature line by line, if the numbers of black pixels are not equal to zero, it indicates connected part of the signature. The interpretation of the personality has been defined by assuming signature as a one image. The Table II describes the interpretation of the features for the prediction of personality traits:

TABLE II. INTERPRETATION OF THE FEATURES USED FOR THE PERSONALTIY TRAITS THROUGH SIGNATURE

Sr.No.	Sign	Feature	Interpretation
i.		Curved Start	Segmented left half vector values in between 66 to 192 present on each column are passed through neural network.
ii.		Ending Stroke	Segmented right half vector values in between 66 to 192 present on each column are passed through neural network.
iii.		Ascending Bottom underline	Segmented bottom part vector values of each column are passed through neural network.
iv.		Streaks disconnected	Segmented middle part with large column difference through structural identification algorithm
v.		Appearance of dot on the letter	Segmented upper part interprets dot, and is considered as a separate element by using structural identification algorithm.

Considering above features, Table II illustrates the prediction of personality traits, which has been characterized according to Big Five Personality Traits also called as Five Factor Model. This model describes the person's personality through five factors namely Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism or OCEAN. All these can be described as follows:

Openness: People who enjoy new experiences and like to learn new things usually high scored in openness. It includes some traits such as imaginative, insightful, curiosity and has wide interests.

Conscientiousness: People's are self-discipline, thoughtfulness, reliable and prompt. It includes traits like organized, methodic.

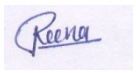
Extraversion: People get their energy from sharing thoughts and interacting with others. It includes talkative, energetic, sociability, positive emotions and assertive.

Agreeableness: Such kinds of people are friendly, cooperate and compassionate. It includes traits sympathetic, affectionate and kind.

Neuroticism: This relates with emotional stability, degree of negative emotions and impulse control. Moody, anxiety, jealousy and tense are included as traits.

TABLE II. PREDICTION OF PERSONALITY TRAITS

Sr. No	Signature	Feature	Type of Signature	Personality	Category of Personality according to Five Factor Model	References
1.		Curved start	Curved smoothly	Person is gentle, charming, flexible, outgoing and sociable.	Extraversion	[1][10]
		Ending Stroke	Backwards	Need sincere efforts for achievement but may fail to have it.		[12]
		Appearance of dots on letter	Jab like i-dot	Anger, easily disturbed by minor or momentary disturbances		[14]
2.		Simple	Only first name	Has mission/vision, depends on their own strength	Conscientiousness	[10]
		Dot structure below underline	Two dots	Has confident		[10]
		Appearance of dots on letter	i-dot to right of i stem	Restlessness, want to act without any delay, Observant		[6],[14]
		Underline	Single Underline	Fulfilled with particular ideas and thinking, Have a confident and healthy ego.		[1],[10]
		Ascending	Base line going upside	Optimism, ambition, active. Feels good about his/her public character,		[10]
3.		Interconnected	First name and second name	Richness in character, sociability, strong parental association	Extraversion	[10]
		Appearance of letter	Very long and big loops in the lower zones of letter j and g	Demand variety in their physical activities.		[12]
		Appearance of dots	Dot follows signature	Talking in a shrill voice that also implies that end or word stops here, doubts own actions.		[11]
4.		Full surname	First letter limited to initials, surname with full details	Over dependence on their parents and gives less priority to their own goals.	Agreeableness	[10]
		Underline	Single Underline	Fulfilled with particular ideas and thinking, Have a confident and healthy ego.		[1],[10]
		Ascending	Base line going upside	Optimism, ambition, active. Feels good about his/her public character,		[10]
5.		Illegible Signature	Illegible/unreadable Signature	The person may be apprehensive and want to mask his true personality and feelings.	Neuroticism	[11]
		Appearance of dots on letter	Jab like i-dot	Irritability, easily annoyed by minor or momentary disturbances		[13]
6.		Angular Strokes	Angular strokes/connections	Competitive, aggressive and has a strong will.	Extraversion	[10]
		Small Signature	Small signature	Reserved and humble and timid. Could be in depression or other emotional problems		[12]
		Underline	Single Underline	Fulfilled with particular ideas and thinking, Have a confident and healthy ego.		[1],[10]
		Ascending	Base line going upside	Optimism, ambition, active. Feels good about his/her public character,		[10]

7.		Curved Start	Curved backwards	Comfortable going past	Openness	[1]
		Underline	Single Underline	Fulfilled with particular ideas and thinking, Have a confident and healthy ego.		[1],[10]
		Ascending	Base line going upside	Optimism, ambition, active. Feels good about his/her public character,		[10]
8.		Streaks disconnected	Break just after first letter	Limiting desires, not taking any risks, often discouraged and hesitated to take decisions.	Agreeableness	[1],[10]
		Underline	Single Underline	Fulfilled with particular ideas and thinking, Have a confident and healthy ego.		[1],[10]
		Ascending	Base line going upside	Optimism, ambition, active. Feels good about his/her public character,		[10]
9.		Ending Stroke	Increasing	Open, foresight, desires ahead, confident	Agreeableness	[1]
		Underline	Single Underline	Fulfilled with particular ideas and thinking, Have a confident and healthy ego.		[1],[10]
		Ascending	Base line going upside	Optimism, ambition, active. Feels good about his/her public character,		[10]
10.		Curved Start	Curved backwards	Comfortable going past	Openness	[1]
		Underline	Single Underline	Fulfilled with particular ideas and thinking, Have a confident and healthy ego.		[1],[10]
		Ascending	Base line going upside	Optimism, ambition, active. Feels good about his/her public character,		[1],[10]
			Only first name	Has mission/vision, depends on their own strength		[10]

V. RESULT ANALYSIS

The output of the system is tested on 60 signatures of 10 different peoples with 6 samples each. It is observed that the prediction of personality is 94% accurate for the curved start, 96% for ending stroke and 100% accurately detect the single ascending underline using back propagation neural network. The accuracy rate for the streaks disconnected is 92% and 95% for appearance of dot on the letter using structural identification algorithm.

VI. CONCLUSION

This research paper depicts the prediction of personality traits of a person based on segmentation which actually focused on vertical and horizontal segmentation and also highlights the features based on curved start, ending stroke, single ascending underline, streaks disconnected and appearance of the dot on the letter of signature. The relevant area of this paper is Human Resource (HR) which concerns with good communication skills, objectivity and leadership with respect to personality type and traits and have authority to recruit the employee. Human personality recognition solves most of the important and intricate tasks and thus helps in simplification in jobs or in other significant opportunities. It can also be used in designing expert system for computerized astrological systems.

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