Behavior Prediction Through Handwriting Analysis

[1]**Parmeet Kaur Grewal,** [2]**Deepak Prashar**

[1,2]Dept. of CSE, Lovely Professional University, Phagwara, Punjab, India

Abstract

Handwriting Analysis is described as a scientific study and analysis of handwriting. It is a way of interpreting behavior from peculiarities in handwriting. The scientific name for handwriting analysis is Graphology. Handwriting is often called mind writing or brain writing. All that is part of the mind is reflected by an individual in many ways, writing being one. Professional handwriting examiners called graphologists predict the personality of the writer with a piece of handwriting. Accuracy of handwriting analysis depends on the skills of the graphologists. But manual process of handwriting analysis is costly and prone to fatigue. Hence the proposed methodology focuses on developing a tool for behavior analysis which can predict the personality traits automatically with the help of a computer. In this paper a method has been proposed to predict the behavior of a person from the baseline, the letter slant, pen pressure, letter 'i' and letter 'f'. These parameters are input to the Artificial Neural Network which predicts the behavior of the writer.

Keywords

Graphology, Handwriting Analysis, Behavior Analysis, Artificial Neural Network, Behavior Prediction

I. Introduction

Handwriting Analysis or graphology is a scientific method of identifying, evaluating and understanding personality through the strokes and patterns revealed by handwriting. Handwriting reveals the true personality including emotional outlay, fears, honesty, defenses and many others. Handwriting is the written trace of each individual's preferred rhythm, style and habitual manner of moving. Handwriting analysis is an effective and reliable indicator of personality and behavior. Handwriting represents the mental status of a person and handwriting analysis is s projection technique as the body language that profiles the human behavior in areas of social skills, achievements, thinking styles, or work habits. Handwriting also depicts the possible ways of a person's transactions with stress. Handwriting analysis is a study of frozen graphic structures which are being generated in the author's brain and are placed on the paper in a cursive or printed handwriting style which is different from other authors comparing the personalities and their potential for problem solving.

Professional handwriting examiners called graphologists often predict the personality of a person with a piece of handwriting. The graphologist provides a window to personality structure. By examining all elements of handwriting and interpreting them separately and together the graphologists generates a thumbnail sketch of the writer's character traits. With the help of graphology, handwriting analysts predict the attitudes, qualities, sentiments or postures.

In this paper, a method has been proposed to predict the behavior of a person from the features extracted from his handwriting. The personality traits revealed by baseline, letter slant, pen pressure, letter 'i' and letter 'f' as found in individual's handwriting are explored in this paper. Five parameters, baseline, slant, pen pressure, letter 'i' and letter 'f' are input to the ANN which outputs the personality trait of the writer. The evaluation of the baseline and letter slant is using the polygonization method, the evaluation of pen pressure utilizes grey-level threshold value, and evaluations of letter 'i' and letter 'f' use template matching. MATLAB is the tool used for this purpose. The performance is measured by examining multiple samples.

II. System Overview

Professional handwriting examiners called graphologists often predict the personality of a person with the help of a piece of paper. But the accuracy of the results depend on the skills of the analyst. This manual process of handwriting analysis is very costly and time consuming. Hence the proposed methodology focuses on developing a tool for behavior analysis which can predict the personality traits automatically with the help of a computer. The various features in handwiting through which behvaior can be predicted are pen pressure, baseline, slant, width of margins, spacing between letters, spacing between words, size of writing, height of bar on letter 't', letter 'g', etc.

In this paper a method has been proposed to predict the behavior of a person from five parameters- baseline, slant, pen pressure, letter 'i' and letter 'f'.

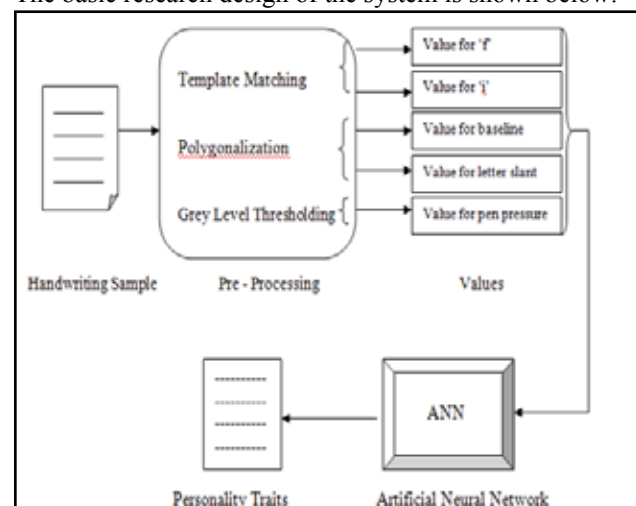The basic research design of the system is shown below:

Fig. 1: Research Design

The baseline in an individual's handwriting—the imaginary line on which the bottoms of the middle zone letters align--reveals a lot of information about the writer. The direction of the baseline may be dependent on a temporary condition, such as mental state or physical condition. The three most common baselines found in writing are- slanting downwards, rising upwards and balanced. Each type reveals a particular personality trait of writer.

Table 1: Baseline and Personality Traits

Baselines		Personality Traits
	Rising upwards	Optimism, faith in future, feeling of being loved, excitement, joy
	Slanting downwards	Pessimism, fatigue, discouragement, depression, illness
	Straight	Reliability, even temper, control of emotions, reason rules, unwavering resolution

Another feature is letter slant. It is related to writer's emotional direction and degree of emotional control. About 77 percent of writers write with a right slant, 15 percent with left slant and rest 8 percent write vertically. The slant of the letters indicates the connection between the writer's inner and outer world. It is the writer's reaction to environmental factors. Table 2 indicates the types of slants as found in writer's handwriting and the corresponding personality traits.

The third parameter considered in this paper, is pen pressure. Pen pressure is the measure of the writer's vitality, intensity or determination. The amount of pressure used is not a conscious habit and usually not done with the writer's awareness. Pressure shows the force or lack of force of the writer's personality. Generally feeling of dominance will produce heavier pressure.

Table 2: Letter Slants and Personality Traits

Letter Slant	Personality Traits
Vertical	Head controls over heart, independent emotional nature, oriented to work well alone, ability to control emotions in crises
Moderate Right	Ability to express opinions, confidence in convictions, freedom of thought, extroverted, future orientation, expressive
Extreme Right	Lack of self-control, impulsive, unrestrained, intense, very expressive, low frustration tolerance
Moderate Left	Reflective, independent, objective, nonsympathetic, difficulty in expressing emotions, difficulty in adapting
Extreme Left	Repressed childhood, early rejection, fear of the future, defensive

A writer with heavier pressure indicates a deeply intense personality. Table 3, shows the interpretation of amount of pressure.

Table 3: Pen Pressure and Personality Traits

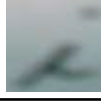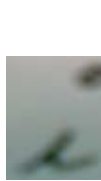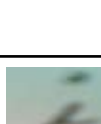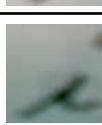| Amount of Pressure	Personality Trait
Heavy	Very deep and enduring feelings, may forgive but will never forget, feels situations intensely
Light	Endure traumatic experiences without being seriously affected, emotional experiences do not make a lasting impression

Fourth important parameter considered in this paper is formation of letter 'f'. The letter 'f' describes the organization and planning ability. Table 4, shows the various formations and corresponding personality traits.

Table 4: Formations of 'f' and Personality Traits

Formation of 'f'		Personality Traits
	Narrow upper loop	Narrow-minded
	Angular Point	Resentful, uncompromising
	Angular Loop	Strong reaction against interference
	Cross Form	Concentration
	Balanced	Well-organized, managerial ability

Fifth parameter- the formation of letter 'i' provides a lot of accurate information about the writer. The 'i' is the only letter in English language that refers solely to the writer. Table 5 shows the common formations of 'i' and the corresponding personality traits.

Table 5: Formations of 'i' and Personality Traits

Letter 'i'		Interpretation
	High, Flying dot	Curiosity seeker, impatience and enthusiasm
	Round, justly placed dot	Detail conscious, accurate, precise and concentration
	Absence of dot	Careless, absent minded
	Circle	Frustrated, attention demanding, imaginative, Artistic, dislikes routine work, loyal to ideas and standards
	Left-faced dot	Neurotic
	Right-faced dot	Observant

III. Implementation and Result

The values calculated for the baseline(3 different values), slant(5 different values), pen pressure(2 different values for heavy and light writing), letter 'f'(5 values) and letter 'i'(6 different values for different types of formations) are taken as inputs to the ANN. The outputs of the ANN are the different personality traits of the writer.

The learning algorithm used is standard back propagation algorithm. The back propagation neural network is a multilayer network that comprises of input, hidden and output layers. The number of nodes in input layer is equal to number of features used for class representation. The number of nodes in hidden layer represents the refinement to the inputs such that the output is reached in shortest duration of training period. The number of nodes in the output layer is equal to number of classes needed. Basic steps of the algorithm are as follows:

• Initialize the weights and threshold levels.
• Input the training example to the network and for each example(x(n),d(n)); perform the forward and backward computations as described in points 3 and 4.
• Forward Computation: Compute induced local fields and function signals as follows:

$$v_j^{(l)}(n) = w_{ji}^{(l)}(n)y_i^{(l-1)}(n) \qquad (1)$$
$$y_j^{(l)} = \phi_j(v_j(n)) \qquad (2)$$

And error signal is computed as:

$$e_j(n) = d_j(n) - o_j(n) \qquad (3)$$

Backward Computation: Compute the local gradients (δs) and adjust the synaptic weights.

• Iterate the forward and backward computations under points 3 and 4 by presenting new examples to the network until stopping criteria is met.

The neural network used is Feed Forward Network. It is an artificial neural network where connections between the units do not form a directed cycle. Here, information moves only in one direction i.e. forward from input nodes, through the hidden nodes (if any) to the output nodes.

Firstly values of the five parameters were collected from scanned copies of handwriting samples using methods such as polygonalization, grey level thresholding and template matching. Then a feed forward neural network was created in MATLAB and values were input to the ANN. As the network utilizes supervised learning, desired output was known. Error was calculated by comparing actual and desired outputs. Handwriting of 50 persons was used to train the network. At the end it was tested by presenting it an unknown sample.

The performance of the ANN was plotted as a graph. Performance was plotted as a graph with x-axis as number of epochs and y-axis as Mean Squared Error (MSE). MSE is one of many ways to quantify the difference between values implied by an estimator and the true values of the quantity being estimated. MSE measures the average of the squares of the "errors." The error is the amount by which the value implied by the estimator differs from the quantity to be estimated. The difference occurs because of randomness or because the estimator doesn't account for information that could produce a more accurate estimate. An epoch is the presentation of entire training set to the neural network. It can be easily seen in the graph below that MSE reduces as number of epochs are increased. Fig. 2, shows the performance plot.
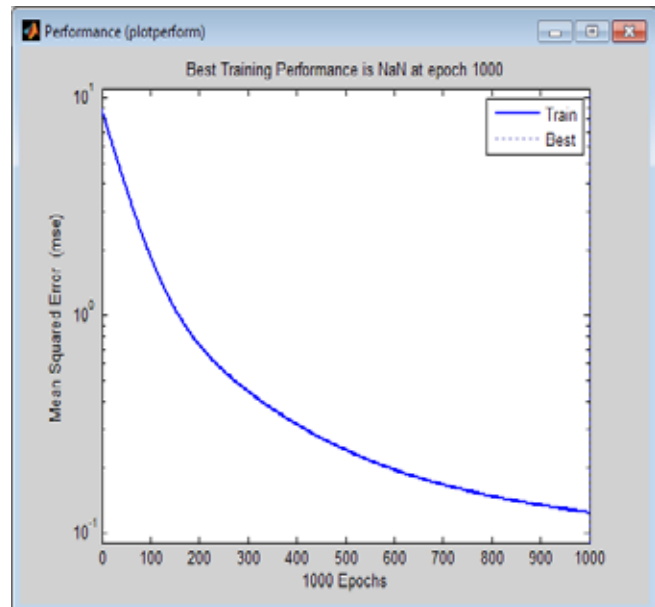

Fig. 2: Performance Plot

In the next step, a graph has been plotted between actual output and desired output.

(Desired output) – (Actual output) = Error

Error is calculated from the above equation. Regression line is plotted in MATLAB. A dotted line is drawn where the actual output is exactly equal to the desired output. The following figure shows a snapshot of regression plot.
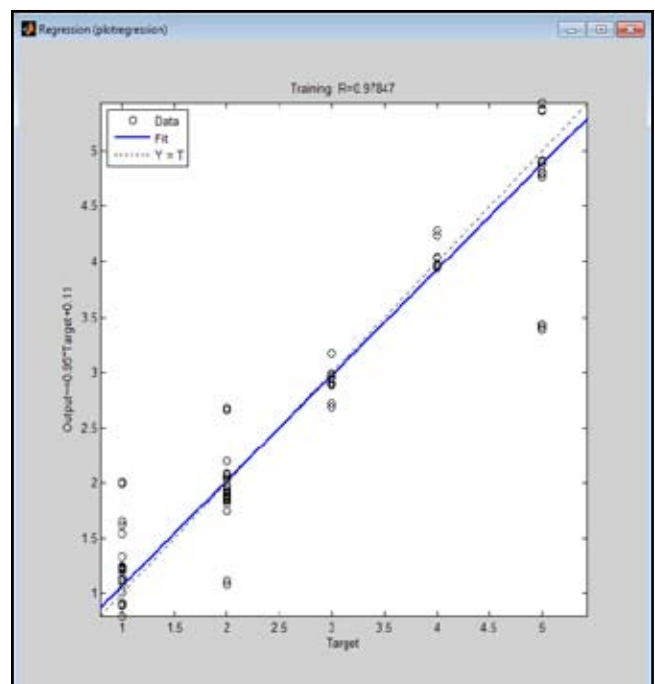

Fig. 3: Regression Plot

IV. Conclusion

A method has been developed to predict the behavior of a person from the features extracted from his handwriting. The personality traits revealed by baseline, letter slant, pen pressure, letter 'i' and letter 'f' as found in individual's handwriting are explored in this paper. Five parameters, baseline, slant, pen pressure, letter 'i' and letter 'f' are input to the ANN which outputs the personality trait of the writer. The evaluation of the baseline and letter slant is using the polygonization method, the evaluation of pen pressure utilizes grey-level threshold value, and evaluations of letter 'i'

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