A Review of Human Graphology Analysis and Brainwaves

N F Akila¹, E M N E M Nasir¹, N Fuad1², Mohd Helmy Abd Wahab¹², Syed Zulkarnain Syed Idrus³

¹Faculty of Electrical & Electronic Engineering, University Tun Hussein Onn Malaysia (UTHM), 86400 Parit Raja, Batu Pahat, Johor, Malaysia.
²Computational Signal, Imaging and Intelligence (CSII) Focus Group, Universiti Tun Hussein Onn Malaysia 86400 Batu Pahat, Johor, Malaysia.
³Faculty of Applied and Human Sciences, Universiti Malaysia Perlis, 01000 Kangar, Perlis, Malaysia.

*Corresponding author’s e-mail: norfaiza@uthm.edu.my

Abstract. This paper will do a study about brain, electroencephalograph (EEG) and also brainwriting. There are four types of frequency bands produces by human brain like delta, alpha, beta and theta. Every bands have their own spectrum of frequency where it be used for analysing brain activities. Electroencephalogram (EEG) is a method to measure signal by studying and evaluating the pattern of the brainwaves. The neuron will transfer the signals in the brain and the populations of neurons form pattern of network that form a brainwaves detectable in EEG. While graphology analysis is about the handwriting pattern that will illustrate the personality traits of the person. Everything that is written by the hand is processed from brain where is can give certain frequency bands or waveform for the personality.

1. Introduction
Brain is the most influential structure that is responsible to control the human body activities in their daily life. This is where all the activities such as processing, integrating, coordinating information they receive from senses organ and making decision from the signal that they received. Brain also an electromechanical organ that contains about 100 billion neurons and these neurons are linked to another two hundred and fifty thousands of other neurons [1-3], [5], [6]. Human brain have two different halves which are left frontal and right frontal [1-2], [5]. Human brain is capable to generate brainwaves that the data can be measured and collected by using the EMOTIV Insight equipment. There are five brain waves produced by a brain which are Theta, Delta, Alpha, Beta and Gamma. Each brainwave has distinctive frequency and amplitude because of it depends on the different signal or situation that happen in the brain. The brain waves pattern is normally in sinusoidal form that are measured from peak to peak and usually range from 0.5 to 100 uV in amplitude that is 100 times lower than ECG signal. Beta brainwave also called as high frequency low amplitude brainwaves and frequency range is between 14 Hz to 40 Hz that are detected when we are awake. Alpha band range is between 9 Hz to 12 Hz while theta band range is between 4 Hz to 8 Hz that is normally found when we in deep relaxation or sleep. The slowest brainwave is Delta wave where the range is between 1 Hz to 3 Hz that is usually detected in infants and young children.
Graphology analysis is the analysis of the pattern handwriting of the person where the personalities and characteristics of the person can be identified or also can be known as the study of the handwriting. Handwriting is brain writing, showing the mental condition of the person [4]. Handwriting of the person is unique to themselves. The fundamental of individuality, also recognized as the basis of uniqueness, forms the standard for handwriting analysis [7]. The fingers have chosen biggest space in the brain than others, so it is easy to detect personality traits from handwriting. The chemical reaction will happen when the brain is thinking, therefore the fingers will move in distinct direction where the loops, line and arcades will be formed. This is how thoughts transformed into words, words turn to actions and actions grow into the character of the person. What is written at that time is an instant photo of how the person thinks, feels and behaves. Each trait of identity is shown by a neurological brain pattern. Expert handwriting examiners who recognize the personality traits through the handwriting samples are called graphologist [8]. Others than manual handwriting analysis and automated system analysis, rule-based approached also can be applied in handwriting analysis and also predicting the human behaviour or characteristics [9].

2. Electroencephalograph (EEG)
The EEG pattern that is formed from the brainwaves activity have different characteristics that depends on the activity of the brain. For obtaining basic brain pattern of the person, the person is advised to close their eyes and relax. EEG signals have stochastic waveforms with various frequency and amplitude [10]. EEG spectral pattern was distinguished by certain spectral elements were these spectral powers acknowledge internationally to be recognized as frequency bands. These spectral component shows EEG oscillations and were speculated to express cyclical divergence in the excitability of neuronal assemblies [18]. The EEG measurement has been used widely in medical and neuroscience research areas [10,19-21]. The brain waves pattern is normally in sinusoidal form where they are usually determined from peak to peak and commonly range from 0.5 to 100 uV in amplitude which is 100 times lower than ECG signal. Brain waves is classified into four basic group which are Beta, Alpha, Theta and Delta [11].

| Band  | Frequency (Hz) | Location | Normal functional correlation |
|-------|----------------|----------|-----------------------------|
| Delta | < 4            | Frontally for adults, posteriorly for children; have high amplitude of waves. | Continuous attention tasks. Adult slow-wave sleep. |
| Theta | ≥ 4 and < 8    | Found in locations where the task not related to hand. | Higher in young children Drowsiness in adults and teens. motivation to alert goals and new behaviour patterns |

Table 1. Types of brainwaves and characteristics.
Alpha $\leq 8$ and $< 14$
Posterior region of head,
Both sides, higher in amplitude
on dominant side.
Central sites (c3-c4) at rest.

Beta $\geq 14$
Both sides, well-proportioned
distribution, visible frontally and
low amplitude waves.

Relaxed/reflecting
Closing the eyes,
mentally alert,
energy healing,
daydreaming and
happy

Active thinking,
focus, high alert,
anxious.

3. Graphology analysis (brainwriting)
Abb Jean-Hippolyte Michon is the person that create a phrase of graphology by joining two words from Greek which are ‘graphein’ that is mean to write and logos that is mean science [12]. Graphology is about studying the pattern handwriting of the person while graphologist is the professional handwriting examiners that will identify the personality through the pattern of handwriting samples. Every person in this world has a unique characteristic, which include the style of thinking, skill of speaking or presenting individuality [13]. The graphology also will bring us to our subconscious mind. The process of handwriting often takes place in the subconscious mind where it can influence the actions and feelings of the person. The accuracy of the graphology analysis is about 85-95% [14]. Bart Baggett is the one of the America’s top marketing consultant, forensic handwriting expert and professional speaker. He involved in graphology analysis more than 20 years. Different specificatio of the handwriting samples such as margin, baseline, T-bar and slant will be taken into consideration to decide equivalent characteristics [15-16]. There are a lot of features in handwriting such as baseline, slant, pressure, letter, size, letter spacing, word spacing or margin that is beneficial to expose the character of a person [17].

Figure 1. The process of handwriting

3.1. Baseline
The baseline is the direction of the imaginary line on which letter reside. The baseline will help to find the motivational level in the person and it also will illustrate how determine they are to achieve their target or goal in life. The baseline shows the changes in motivation within yourself including emotion
and how the person pursue the life goals. There are several types of baseline where each type of these baselines will have their own characteristics that will be explained more detailed in the table below.

| Types of baseline | Personality traits |
|-------------------|--------------------|
| Straight          | Able to control and manage their own heart, very well discipline, focus and organized. |
| Ascending         | Cheerful, ambitious and optimistic person |
| Descending        | Pessimistic person where lack of confident, depressed, easy to give up. |
| Concave           | Easy to lose their confident and motivation in their life |
| Convex            | Easy to give up |
| Erratic           | Easily distracted by emotions and thought |

### Table 2. Types of baseline and personality traits.

3.2. Slant
The handedness or domination of right handed and left handed is not affecting the slanting of words when writing. The slanting will convey the emotions of the person. Normally, the slant will be focused on letter b, d, h, k, l, p and t [14]. The slanting can identify by using imaginary lines where the letters can be at 90 degrees, below 90 degrees and above 90 degrees [17]. The types of slanting and their respective personality traits is explained in the table 4 below.

| Types of slant | Characteristics | Personality traits |
|----------------|-----------------|--------------------|
| Vertical       | The letter is at 90 degree | Rational and have positive qualities of independence |
| Rightward      | The letter below 90 degree | Initiative character, social performance, and extreme bonding of emotion |
| Leftward       | The letter above 90 degree | Selfish, introversion and inexpressive emotion character of person |
| Variant        | Combination of slant | They have doubtful and changeable nature |

### Table 3. Types of slant and personality traits

3.3. Size
The size of the handwriting will illustrate how the person appreciate themselves and also how they can concentrate on the situation of problem. It will portray the self-confidence and the interaction between the person and people around them. The size of handwriting can be big, medium, small where each size of handwriting has different personality traits.

Table 4. Types of size and personality traits.

| Types of size | Personality traits                                                                                     |
|---------------|--------------------------------------------------------------------------------------------------------|
| Big           | have an open personality, sense of humour and also friendly with the surrounding.                       |
| Medium        | characteristics is more simple and calm. They can give a good attention and trust people very well.    |
| Small         | have an extreme ability to concentrate for a long period. They also can be called as detail oriented person because they are more cautious or careful in doing their job |

3.4. Margin
Margin is the blank space on the right, left, top and bottom of the blank paper [7]. These margin will portray the past and future of the person where the margin normally related with time and relationship. The left margin will illustrate about past and right margin will illustrate the future.

Table 5. Types of margin and personality traits.

| Types of margin | Personality traits                                                                                     |
|----------------|--------------------------------------------------------------------------------------------------------|
| Left           | can accept the past very well, have a clear objective for their future and using past experienced as a lesson for them in the future. |
| Right          | Have a clear plan for future, open to others opinions                                                   |
| No margin      | Very busy person and work hard but the ego is high                                                     |

3.5. Pressure
The quantity of force that is used when writing is known as pressure of pen [7]. The pressure can illustrate the energy and health of the person [14]. The pressure will convey the spirit and mental energy of the person when socializing and do their work.

Table 6. Types of pressure and personality traits.

| Types of pressure | Personality traits |
|--------------------|--------------------|
Heavy  
highly motivated but can be stubborn and arrogant.

Medium  
Capable in managing the pressure and emotions,

Light  
Have a brilliant idea but lack of motivation, romantic and sensitive person

Irregular  
Unstable mood and bad in managing pressure

3.6. Speed  
The speed when writing will convey the thinking ability and action of the person [14,17]. The speed can be measured by the time taken for the person to write each sentence when writing.

| Types of speed | Personality traits |
|----------------|--------------------|
| Fast           | Intelligent, fast in making decision and thinking but also impatient. |
| Medium         | Intelligent, great in planning, rational and good in emotion control. |
| Slow           | Slow thinking and action, tend to be pressure and less active. |

3.7. Spacing  
The distance from the ending of the first word and starting of the second word is referred as word space or spacing [7]. Word spacing will show the closeness of the person with the surrounding and show way of communication with others.

| Types of spacing | Personality traits |
|------------------|--------------------|
| Wide             | Flexible, easy to adapt with situation and tend to be alone. |
| Narrow           | Good in socializing, can give good responds to others and cannot be alone. |

3.8. Zones  
Zones of handwriting can be categorized in three types which are lower zone, middle zone and upper zone. Each of these zones have their own characteristics.

| Types of zones | Personality traits |
|----------------|--------------------|

6
Lower
Calm, good in planning, workaholic and very caring in terms of finance, family and health.

Middle
Enjoy the life, take care of appearances, easy to get bored in planning the future and impatient.

Upper
Tend to focus in spiritual, like to think and planning.

3.9. Connecting strokes
Connecting strokes is defined when the letter is linked or connected to other letters. The letter that is not connected each other is known as printed letter [14]. There are four type of connecting strokes which are garland, arcade, angular and thread. The connecting strokes will illustrate the way of thinking of the person.

Table 10. Types of connecting and personality traits.

| Types of connecting strokes | Personality traits                              |
|-----------------------------|------------------------------------------------|
| Garland                     | Sociable, easy to adapt in new situation, easily influenced and discouraged. |
| Arcade                      | Creative and using creativity to finish the job, arrogant. |
| Angular                     | Firm and aggressive, egoistic and have a high target. |
| Thread                      | Easy to adapt but very sensitive and good at taking chances. |

4. Methodology
Graphologists normally will examine the handwriting manually which is written on the paper. The skill of the graphologist depends on their psychological art of interpreting the particular blend of handwriting features. But the time taken to analyse the handwriting will be expensive and take a long time. The proposed methodology focuses on developing a system with the minimum aid of human intervention. There are several step in determining the personality traits using handwriting which are data acquisition, scanning, pre-processing, segmentation, feature extraction and classification.

4.1. Data acquisition
The data of handwriting will be obtained from the samples which is written on the blank A4 paper by using ballpoint pen to reduce the error.

4.2. Scanning
The A4 paper will be scanned and stored as an image file in JPEG or BMP format before inserted into pre-processing step.

4.3. Pre-processing
Pre-processing is important in improving the quality of the image in order to reduce error in determining personality traits. This process includes normalization of the intensity, binarization, and noise removal.

4.4. Segmentation
The image will be segmented into several parts in order to enhance the analysis efficiency which are line, word and letter segmentation. Segmentation is accomplished to get merely the important information and extract out all lousy and unnecessary information where the image will be used as an input in the feature extraction step.

4.5. Feature extraction
In feature extraction process, the important and related information about the sample will be analysed. The feature extraction process is done base on the handwriting features of the handwriting that is explain in section 3 above.

4.6. Classification
To recognize various personality traits, the handwriting characteristics obtained from the feature extraction step are analyse by applying some classifier such as Anti Neural Network (ANN), Support Vector Machine (SVM) and Back Propagation Network (BPN). According to the feature values from the classifier, the personality of person is identified.

| Work/Year                                    | Classifier/Method                      | Accuracy % |
|----------------------------------------------|----------------------------------------|------------|
| Manimala, Meghasree G, Poornima G Gokhale and Sindhu Chandrashekar [2016] [22]. | Simple n-class classifier(n > 1). | 93.77      |
| Shitala Prasad, Vivek Kumar Singh, Akshay Sapre [2010] [4]. | Support vector machine/ RBF kernel | 93.86      |
| Vaishali Sharma and Er. Depti [2017] [23]. | Back propagation network (BPN) | 90.00      |
| Syeda Asra and et al [2017] [24]. | Support vector machine | 90.00      |

5. Conclusion
Handwriting analysis is developing capacity for personality identification. There are various system or method for personality analysis that can be achieved for getting high accuracy of correct personality trait information for the person. Automated personality recognition by handwriting analysis will appear to be a pleasant and beneficial practice for personality traits identification. A relatively simpler technique has been recommended to predict the character of a person by exploring various handwriting features. The recommended method can be applied as a device by graphologist to enhance the accuracy and anticipate the behaviour of a person faster. These applications can be discovered especially in the fields of personnel recruitment, marketing, medicine, counselling, biometrics and forensics studies [8].
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