Graphology Analysis for Handwritten Latin and Arabic

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Abstract

Graphology is a scientific method of analyzing, identifying, evaluating and understanding personality through strokes and patterns revealed by handwriting. Personality that can be revealed through handwriting includes emotional outlay, fear, honesty, defense and many other individual personality traits. Graphology analysis is normally been used by teachers, lecturers, business people, company owners, police, forensic investigators, forensic psychologist, parents, spouse and many others. Numerous researches had been done on Latin handwritten script. Among the variants in Arabic handwritten script that are mostly been researched and receive considerable attention in recent years are Farsi (Persian) and Urdu. However, not much highlight had been given to Arabic script. This paper highlights the current research on graphology and the purpose of researching graphology towards Arabic handwritten scripts.

*Keywords***:** *Graphology, Personality traits, Latin scripts, Farsi scripts, Arabic scripts.*

1. Introduction

One of the methods to get to know a person's personality is through his or her handwriting whereby their personality can be guessed even though the person would try to hide their feelings or introduce themselves otherwise (Karami, 2017). Personality traits can be determined through handwriting analysis. Handwriting patterns can reveal personality characteristics features such as mental and emotional instability. The branch of study that examines the characteristics of a person through handwriting patterns is called graphology, or in other words handwriting analysis. Psychometric graphology or graphometry is the branch of the graphology. For almost 400 years people have been studying handwriting (Oliveira et al., 2005). However, the term graphology was established in the year of 1897 by Abb Jean-Hippolyte Michon in Paris (Crepieux-Jamin, 1951).

Numerous researches had been done on Latin handwritten script. Among the variants in Arabic handwritten script that are mostly been researched and receive considerable attention in recent years are Farsi (Persian) and Urdu. However, not much highlight had been given to Arabic script. This paper highlights the current research on graphology and the purpose of researching graphology towards Arabic handwritten scripts. Apart from that, feasible computationally personality characteristics features, script features or context parameters, and the types of image classifiers that have been used in previous researches will be revealed.

2. Background

Health issues, morality and past experiences to hidden talents, and mental problems could be prevailed studying the person's handwriting (Oliveira et al., 2005). Champa and AnandaKumar (2010) mentioned that graphology is claimed to be useful for everything from understanding emotional outlay, fear, honesty, and even being defensive whereby the person may have issues on being very anxious to challenges or used to avoid criticism. Pratiwi et al. (2016) concluded that handwriting analysis can provide information on a person's strengths and weaknesses, behavior in a given situation, mental and psychology health condition, and the ability of a person to interact with a current situation.

Graphologists are the professionals who are expert in the field of graphology. They are the handwriting examiners who will scrutinize the handwritten scripts and make measurements of various characteristics of handwriting so as to make deductions about the writer. The skill level of the analyst will determine the accuracy of the handwriting analysis (Champa and AnandaKumar, 2010 and 2011).

The Latin or Roman alphabet consists of 26 individual alphabets. The alphabet characters are A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, and Z in upper case and a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, and z in lower case. A mix of these alphabets characters will form meaningful text word or sentence, paragraph and so on which is also called as script.

Handwritten scripts are individually unique from one writer to another. Childhood is when a person's handwriting starts to develop. When the person writes, the pen is under the control of the muscles of the fingers, hands and arm of that person. The mind is the controller of all of these body parts (Hashemi et al., 2015). Champa and AnandaKumar (2010 and 2011) referred brain writing as another term given to handwriting as for handwriting analysis is not a type of document examination. This is because each of the neural brain patterns of a person who has a certain personality feature produces a small subconscious movement that is led by a unique neural and muscular movement.

In order to perform personality elicitation, samples of different individuals' handwritings are been used by these professional handwriting researchers to investigate and analyze the handwritten sample. Distinguishing the personality of a human being through his or her handwriting is an old technique. Previously, it was done manually and consumes lots of time, costly and prone to fatigue (Fallah and Khotanlou, 2015, and Champa and AnandaKumar, 2010 and 2011).

With the power of exponentially growing computers, graphology has now become an interesting subject in psychology, forensic, job recruitment and others. People that might be interested in graphology studies or make use of graphology analytics are teachers, lecturers, business people, company owners, police, forensic investigators, forensic psychologist, parents, spouse and many others. For instance, researchers have tried to utilize modern scientific equipment by combining the ideas of graphology and the expertise of Forensic Document Examiners (FDE) to automatically analyze and verify the handwritten scripts.

3. Researched Parameters

Handwriting has many aspects that can be researched. These aspects can serve as a scheme to help in projecting the personality traits of a person. Among the aspects that have been researched are baseline that consists of up, flat and down, size of letters or font size that comprises of large, medium and small size, writing pressure, connecting strokes, spacing between letters, words and lines, starting strokes, end-strokes, word-slant or tilt writing which involves leaning to the left, leaning to the right and vertical, speed of handwriting or in other words writing speed, width of margins, and others (Champa and AnandaKumar, 2010 and 2011, Fallah and Khotanlou, 2015, Hashemi et al., 2015, Pratiwi et al., 2016, and Wijaya et al., 2018). On top of the aspects that had been stated, Fallah and Khotanlou (2015) adds a couple more of handwriting aspects which are curves and figures, line tilts, sharpness of edges, text

density, and order point. Pratiwi et al. (2016) add breaks which consist of dashed and connected. Besides that, Wijaya et al. (2018) include three zones which incorporate of superior zone, middle zone and inferior zone, capital letter, signature, and special letter.
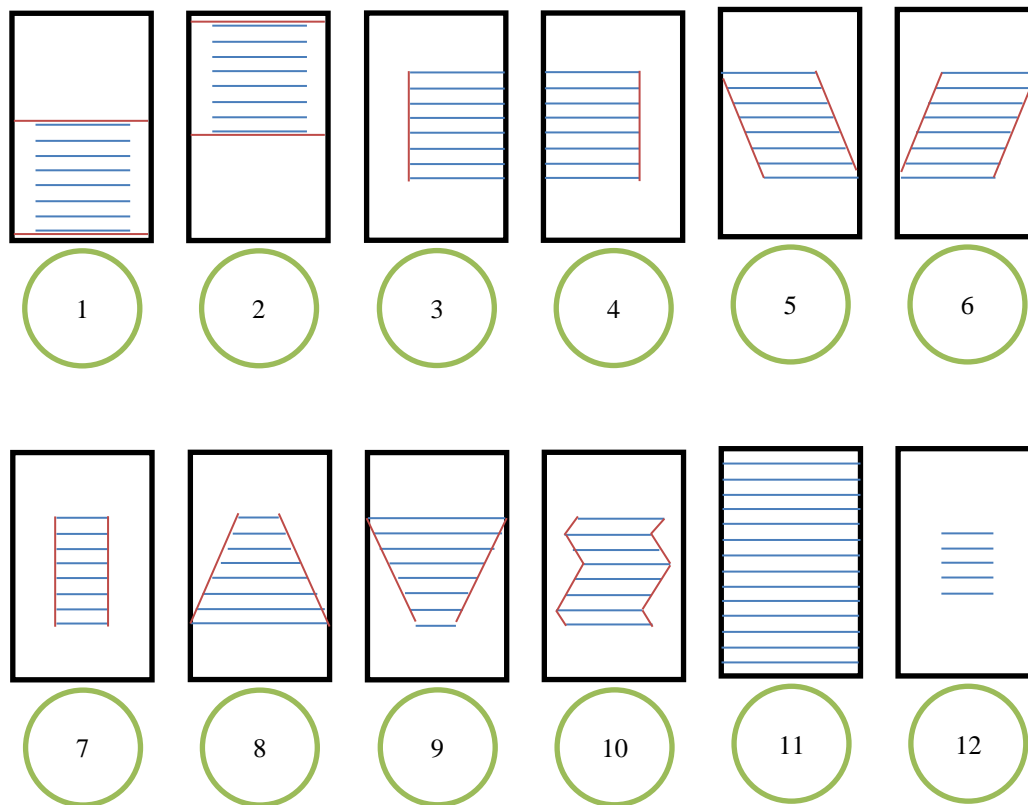

Figure 1: Graphology analysis on margin script handwriting aspect.

Table 1: Type of margin and the personality trait description towards the particular type of margin applied in Figure 1.

No.	Margin Type	Personality Trait Description
1.	Large superior (small inferior).	Distance with the receptor. Prioritizes the practical before the esthetic.
2.	Small superior (big inferior).	Desire of closeness with the receptor, watches manners, impatience for turning pages.
3.	Big left (no right).	Extroversion, impulsiveness, thoughtlessness.
4.	No left (big right).	Shyness, held back, introversion.
5.	Right diminishes (left increases).	Desire for contact with others, subconscious introversion.
6.	Left diminishes (right increases)	Fears, effort made for communicating with others.
7.	Left and right are both big	Anguish.
8.	Both stretch out	Insecurity.
9.	Both get wider	Search for security.
10.	Irregular	Affective instability. Difficulty in adjusting.
11.	No margins	Presence of psychological defense. Optimum administration of time and space. Possible verbosity.
12.	Excessive margins	Anguish, frustration, inhibitions, tendency to isolation, introversion.

An example that could be taken into account is the meaning of different kinds of margin towards the relationship with a person through graphology analysis. Different people in this world would possibly write in different kinds of margin on a piece of paper. Figure 1 shows a variety kinds of margin that are being researched under the field of graphology. Table 1 reveals the type of margin and the personality trait description (Ibarguren, 2016) towards the particular type of margin applied in Figure 1.

There are many kinds of other handwritten aspects that need to be taken into account of being research and developing the graphology analytic of handwriting interpretation through electronic means. For an example, graphology analysis can display a person's personality traits faster by using android based mobile device (Wijaya et al., 2018). Apart from that, with the aid of a computer, personality traits can be predicted automatically without the need of human intervention. However, much automation researches have been done on Latin scripts, but only few have been done on Arabic scripts and its variants such as Farsi (Persian) and Urdu.

Surprisingly, none had been done on Jawi scripts, which is one of the Arabic's variant. According to Yaacob et al. (2001), Jawi is an endangered written language that must be preserved and should be popularize through automation with the use of Internet applications such as the development of JAWINET, Jawi browser, Jawi word processing software, Jawi character recognition and instructional products and services that are aided by computer for the study of Jawi spelling and writing. Apart from that, Malaysia has implemented Ujian Penilaian Kelas Kafa (UPKK) examinations throughout all Kelas Agama Dan Fardu Ain (KAFA) primary schools whereby it uses Jawi script as the medium language script. Thus, all primary students who enroll into KAFA schools will learn and know how to read and write Jawi scripts. It is important to preserve Jawi scripts as for it symbolizes the Malay heritage through its written script language. Thus, automated graphology analysis could be done as well on Jawi handwritten scripts.

4. Related Researches

The following researches that had been conducted are supported by the hypothesis that consistent handwriting that is distinct from the handwriting of another individual is developed by each individual. However, no rigorous scrutiny has been subjected to the hypothesis with the accompanying experimentation, testing, and peer review (Champa and AnandaKumar, 2010 and 2011, and Toraichi et al., 1995).

In Champa and AnandaKumar (2010) research paper, they conducted a research by using Artificial Neural Networks (ANN) classifier to predict the personality of a person from the features extracted from the writer's handwriting. The tool that was been used was MATLAB. Only one person's handwriting sample was used for the research. They explore the personality traits of the writer which are revealed by the output of ANN. The input of ANN are three parameters which consist of the baseline (3 values for three different slants), pen pressure (2 values for dark and light writing) and the height of the t-bar on the stem of the letter 't' (5 different positions) from the person individual's handwriting.

The analysis of the baseline uses the polygonalization method and the assessment of the pen pressure utilizes the grey-level threshold value. The height of the t-bar on the stem of the letter 't' is calculated by using template matching. The performance is measured by examining multiple samples. There were 30 different outputs of the ANN and there were the 30 different personality traits of the writer depending on the way the writer crosses the letter 't', the pressure with which the writer writes and the baseline of the writer's writing. The huge amount of data amounting from 30 different combinations of traits is then been analyzed to predict the personality traits. The baseline, pen pressure and the letter 't' in the writer's handwriting reveal a lot of accurate information about the writer. The researchers suggested that more features of the handwriting like margins, the size of the letters, and others can be experimented as inputs in future's work for personality trait determination.

In another research paper of Champa and AnandaKumar (2011), they applied a Rule-Base approach which is a set of "if – then" rules that is used for decision making. Only one person's handwriting sample was used for the research. They explore the personality traits of the writer which are revealed by the output of rule-base. The baseline and the pen pressure were the two parameters that became the inputs of the rule-based approach. Polygonalization of the single line in the handwritten text is the main technique for finding the baseline slant. A closed polygon is produced around one of the lines in the scanned image of the handwritten text. The coordinates of the polygon indicates the slant of the baseline's slope. The evaluation of the pen pressure uses the grey-level threshold value.

Table 2: Rules framed for the formation of the rule-based approach.

Rule	Details
Rule 1	If baseline is **level** and pen pressure is **light** then personality trait = level and less emotional
Rule 2	If baseline is **level** and pen pressure is **medium** then personality trait = level and moderately emotional
Rule 3	If baseline is **level** and pen pressure is **heavy** then personality trait = level and highly emotional
Rule 4	If baseline is **ascending** and pen pressure is **light** then personality trait = optimistic and less emotional
Rule 5	If baseline is **ascending** and pen pressure is **medium** then personality trait = optimistic and moderately emotional
Rule 6	If baseline is **ascending** and pen pressure is **heavy** then personality trait = optimistic and highly emotional
Rule 7	If baseline is **descending** and pen pressure is **light** then personality trait = pessimistic and less emotional
Rule 8	If baseline is **descending** and pen pressure is **medium** then personality trait = pessimistic and moderately emotional
Rule 9	If baseline is **descending** and pen pressure is **heavy** then personality trait = pessimistic and highly emotional

Table 3: List of Personality Traits.

Baseline	Light Writer	Medium Writer	Heavy Writer
Level	Level, Less emotional	Level, Moderately emotional	Level, Highly emotional
Ascending	Optimistic, Less emotional	Optimistic, Moderately emotional	Optimistic, Highly emotional
Descending	Pessimistic, Less emotional	Pessimistic, Moderately emotional	Pessimistic, Highly emotional

Level, ascending and descending are the three most common baselines found in any handwriting. Whereas the most important feature in handwriting is the writing pressure. Depth of feeling or emotional intensity is the term applied on the amount of pressure exerted while writing on a paper. Writing pressure can be classified into light writer, medium writer and heavy writer. By using the rule-based approach, the researchers managed to identify nine personality traits and formulate sets of rule. Table 2 shows the sets of rules framed for the formation of the rule-based approach, whereas Table 3 displays the predicted contrary personality traits that were derived from using the two features which are the baseline and the pen pressure. The researchers again suggested that more features of the handwriting like margins, the letters' size, and others can be experimented as inputs in future's work for personality trait determination.

From the research paper of Fallah and Khotanlou (2015), automated graphology analysis was conducted on 70 individuals with different educations, ages, and genders who were selected from ordinary people like college students, employees, and others. The tool that was been used for all simulation were MATLAB and DRTools (Dimensionality Reduction) toolbox for the Gaussian Discriminant Analysis (GDA) algorithm application. The Multilayer Perceptron (MLP) Neural Network was used for

classification. Independent text features that were experimented include the margin value from the beginning of the page, word expansion, characters sizes, line spaces, word spaces, word tilts, vertical to horizontal ratio of characters, and line tilts.

Each writer took the Minnesota Multiphasic Personality Inventory (MMPI) personality test. MMPI was developed by two researchers of the University of Minnesota, United States in 1940s. It consists of 71 fundamental true or false option questions that the writer should choose from. A score will be given to the test that is in fact the character profile based on eleven clinical scales. The results were stored together with the ID that was assigned to each writer before the writers start to write the corresponding paragraphs in the given forms. The writers were asked to fill the forms in a specific time of duration with patience and tranquility and write by using their ordinary handwriting without trying to alter or improve it. There was no limitation regarding the type of handwriting. The forms do not have lines and only the paragraph area is specified.

In the experiments, 50 were selected for training and the rest was used for tests from the total amount of 70 samples. The highest recognition rate resulted from the experiment was when the number of neurons in the input layer was 18 and the number of neurons in the hidden layer was 10. The proposed system create feature vector using Higher Order Local Auto-Correlation (HLAC) independent feature, context features such as value of margin from the top, word extension, character sizes, line space, word space, word tilts, vertical to horizontal ratio of characters, and line tilts. The result of the experimented algorithm was compared with other conventional methods using one database and the results are shown in Table 4.

Table 4: Evaluation of the proposed algorithm.

Test	Efficiency	Measure
13%	20%	K-Means
46%	58%	Fuzzy C means
61%	76%	Proposed method

The researchers suggested the following advantages from the proposed algorithm and results (Fallah and Khotanlou, 2015):
1. Using dependent and Independent features of text in the process of feature extraction.
2. The proposed personality recognition system is automated, particularly in the process of feature extraction (none automated systems are very unendurable and time-consuming).
3. Enhance accuracy and reliability of the personality recognition system due to the use of MMPI test on training step.
4. No need to segmentation on feature extraction phase.
5. Using GDA to increase the space between classes.

Another research paper by Hashemi et al. (2015) proposed graphology for Farsi handwriting. A total of 120 handwriting samples were collected from 120 different writers who consist of the students from Islamic Azad University of Abhar. 30 samples were used to train the experiment's classifier named Support Vector Machine (SVM) and the remaining 90 samples were used in the test set. The parameter features that were been analyzed were left and right page margins, word expansion, letter size, line and word spacing, line skew, ratio of vertical to horizontal elongation of words, and slant.

The results of automatic analysis and comparison with the graphologist's opinion for 30 training samples and 118 test samples are presented in Table 5 whereby Table 5 displays the graphology analysis output obtained from the proposed system experimented on an input of handwriting sample shown in Figure 2. Feature extraction from handwriting is difficult and entails a high degree of uncertainty. This research showed that a number of graphology features for Farsi script could be automatically extracted and analyzed by the implementation of SVM classifier. An exact and precise extraction of features and their analysis can help and be very useful for graphologists and any other users of this system. The system showed promising results. The researchers also suggested that the only difference between Farsi

and Arabic scripts is that Farsi script has four more characters than Arabic in its character set. Therefore, graphology for Farsi handwriting can also be used for Arabic handwriting graphology.
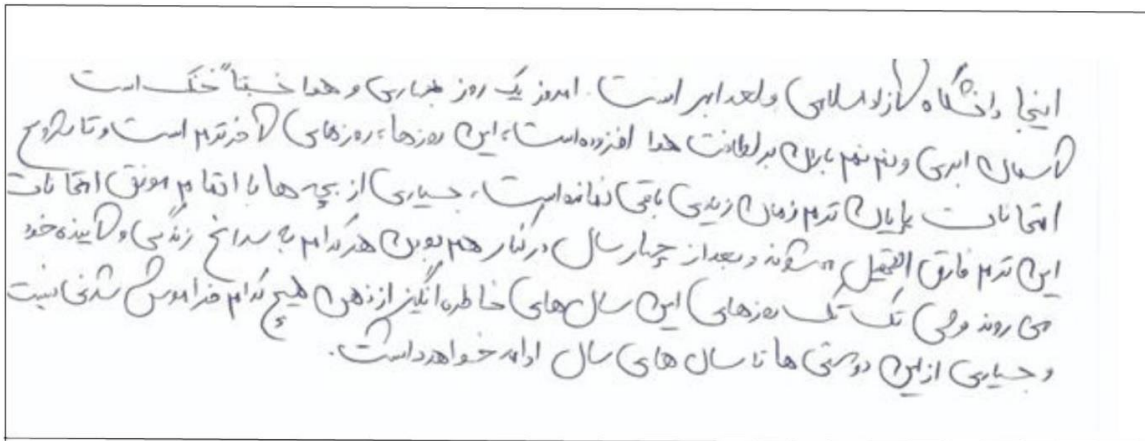

Figure 2: A sample input of the proposed system.

Table 5: The output of the proposed system to Figure 2.

No.	Feature	Personality Review
1	Page margins	Law-abiding personality and good management characteristics.
2	Word expansion	Honest and trustworthy personality.
3	Letter size	Extrovert personality.
4	Line and word spacing	Narrow-minded individual or a "collector".
5	Line skew	Optimistic character.
6	Slant	Warm and friendly disposition.

Last but not least is a research paper by Pratiwi et al. (2016) whereby the aim of their research is to apply one method of psychological tests commonly used by psychologists to recognize human's personality that is Enneagram towards previous studies that have been successfully applied the science of graphology towards analyzing digital handwriting and characteristics of a person's personality through shape based feature extraction. The handwriting samples were collected through a distribution of questionnaires directly to the various 50 people. The questionnaire contains 90 questions and an empty column whereby the writer will fill their handwriting in the respective columns. The forms will be processed by using software to produce in accordance with the type of personality psychology and graphology. The classifier that was been used for the experiment was Fuzzy C-Means. The parameter features that were been examined were baseline that consists of 'up', 'flat' and 'down', slant that consists of 'leaning to the left', 'leaning to the right' and 'vertical', size which consists of 'large', 'small' and 'medium', and breaks that consists of 'dashed' and 'connected'.

From the 50 data collected, 1 data was considered not valid due to the handwriting was unfitting the questionnaire. From the 49 tested data, the study shows a matching rate of 81.6% between the personality analysis of psychology towards science graphology. The percentage was obtained from 40 data that were tested with similar results, and 9 data were with different results for the personality type.

Therefore, the study was able to prove that there is a correlation between a human's personalities by the shape of their handwriting. Analyzing the behavior, characteristics, psychological condition of someone can be done through handwriting and not necessarily through psychological tests. Science of graphology has been scientifically proven its validity through this research whereby implementation of graphology method in analyzing someone's personality type of handwriting can have the same results with the analysis using enneagram method in psychology. It is also faster than the application of the enneagram, because graphology analysis only requires handwriting samples with simple sentences and without going through a series of questions and taking as many psychological tests with enneagram (Pratiwi et al., 2016).

5. Conclusion and Future Work

In a nutshell, based on previous experiments, results and suggestions proposed, it is highly recommended that the research towards automating faster and reliable graphology analysis should be carried on not only in Latin script, but also in Arabic script. As it had been proven that graphology towards Farsi script could also be implemented on Arabic script. More comparison and contrast could be derived from future experiments towards Arabic script. Apart from that, various machine learning algorithms can be researched in order to find or predict the most appropriate one in researching other parameter features of handwriting. Along with that, the performance of image classification can be evaluated and documented.

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