



Automatic Identification Of Personality Using Writing Behavior

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Certificate

It is to certify that the final year project of BS (CS) Final year project & Automatic Personality Identification using Writing Behaviors is developed by Usman Khalid and Sadaqat Ali under the supervision of Mr. Imran Siddiqi and that in his opinion, it is fully functional, in scope and quality for the degree of Bachelors of Science in Computer Sciences.

Head of Department

Supervisor

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External Examiner

Dedication

Dedicated to our parents whose utmost love, care and struggle against all odds brought us to this height of knowledge with the blessings of Allah Almighty. I would like to thanks my friends, class mates to help me at every weak point to accomplish this goal.

Acknowledgement

All praises to Almighty Allah Who provided us not only this golden opportunity to enhance our skills, but also gave us power and wisdom to work and plan with full devotion to our beloved country.

We pay gratitude and thanks to our supervisor **Mr. Imran Siddiqi** for guidance, support, patience and understanding throughout the research period. He is an inspiration for us and we are honored to be in his supervision may Almighty Allah bless him with perfect health and potential to carry on him valuable work. Ameen!

No words in any dictionary can acknowledge the sacrifices, love and moral support given to us by our beloved families. Their prayers had never leave us alone in any good & worst circumstances. May they be included among whom Allah loves. Ameen!

Road is long, life is short and we have to learn more, may Allah give me the valor and opportunity to discover and face the truth. Ameen!

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Chapter 1

Introduction

1.1 Introduction

Handwriting is one of the most common and oldest expressions of human behaviors. We learn to write by copying shapes from a standard set of prototype alphabets the copy book. With time, every individual deviates from the scholarly writing style as a function of personal preferences. These preferences include shapes of drawing the letters (allographs), presence or absence of connection between two letters, word and line spacing etc. This allows handwriting to be used as a biometric modality to identify the author of a questioned document or verify the authenticity of a document or a signature [11]. Moreover, studies have shown that handwriting can be effectively employed to predict a number of demographic attributes of writers including age group, gender, race and handedness etc. [12]. Handwriting can also be used as a non-invasive diagnostic tool for prediction of a number of neurological disorders including Parkinson [10] and Alzheimer [13]. In addition, psychologists and graphologists exploit handwriting and hand-drawn shapes to identify the personal attributes of an individual [1, 2].

Analysis of handwriting by human experts is recently being complemented by computerized analysis using image processing and pattern recognition techniques. Mature computerized systems have been developed for analysis of handwriting targeting a number of applications including forensic analysis, signature verification, handwriting recognition, key-word spotting and classification of ancient manuscripts. Personality profiling from handwriting (Graphology) cite1,2,3,4,5,6, though a mature area of research in psychological studies, has been relatively less explored by the computer scientists and makes the subject of our study.

Graphology is a scientific method of identifying the personal attributes of an individual by analyzing the strokes and patterns in the handwriting. Handwriting is a complex fine motor skill that involves coordination of brain and muscles hence often termed as ‘brain writing’. Studies have shown the existence of correlation between small neuro-muscular movements and personality traits of a person . A unique neuro-muscular movement is produced by a neurological brain pattern resulting in a specific stroke in handwriting and such strokes are found to be common across persons sharing certain personality attributes [5].

Interest in graphology dates back to more than 400 years back. Camilo Baldi, known as the father of graphology, carried out systematic observations of the way handwriting is produced and published the first graphological essay in 1622. In the year 1897, it was Abb Jean-Hippolyta Michon who coined the term ‘graphology’ by merging two Greek words ‘graphein’ (to write), and ‘logos’ (science) [9]. These initial and later studies concluded that handwriting can reveal a number of attributes of an individual’s behavior, character or personality. In addition, handwriting also provides an insight into an individuals intellect, emotional responsiveness and energy, defenses and fears, motivation, integrity and imaginative power and, aptitude. Graphologists claim that over 100 individual traits of personality can be revealed through analysis of handwriting. Exploiting computer algorithms to extract personality traits from writing behaviors can facilitate the task of graphologists and is the subject of our study.

1.2 Objectives

The key objectives of this study include the following.

- To study the correlation between different writing strokes and personality traits
- To design and implement algorithms to extract useful features from handwriting which are correlated with personality attributes
- To train classifiers on extracted features making them learn to recognize different personalities from writing features
- Collect and label a database of writing samples and establish the personality profile of the contributors using known methods (questionnaire)

- Compare the results of personality prediction through writing behaviors with those realized using established methods
- Conclude the validity of the hypotheses that writing behaviors are indicative of personality traits

1.3 Problem Description

Automated analysis of handwriting enjoys a renewed research interest during the last few years and offers a wide variety of applications as discussed earlier. This project aims at a relatively less explored application of handwriting analysis prediction of personality traits. The proposed system intends to algorithmically compute a subset of features employed by psychologists for personality analysis through handwriting.

1.4 Methodology

Differences in personality traits lead to diverse writing styles and features of handwriting like the baseline, slant, pressure, letter, size, letter spacing, word spacing, margin etc. can be computed to reveal the personality of an individual [9]. The unsupervised approaches [1] for personality profiling from handwriting typically categorize each writing attribute into predefined classes. For instance, the baseline is categorized as straight, ascending or descending, the slant is identified as vertical, left or right, pen pressure is quantified as heavy, medium or light, letter size is considered to be either small, medium or large and so on. Depending upon the combination of attribute values for each feature of handwriting, a personality profile of the individual is predicted. Supervised approaches [2, 3], on the other hand, use a learning algorithm that is fed with different writing features and corresponding personality labels. The algorithm learns to discriminate between different personality classes and classifies a given writing sample into one of the learned classes. We intend to follow a supervised approach in our study. We extract the textural information in handwriting by computing the Local Binary Patterns (LBP) and Histogram of Oriented Gradients (HOG). The extracted features are then classified into different personality classes using nearest neighbor classifier.

A key challenge in developing such a system is to experimentally validate the proposed ideas. The personality class predicted through handwriting needs to be validated. For this purpose we employed the well established

Five-Factor Model (FFM) that is based on the hypothesis that by sampling language it is possible to derive a comprehensive taxonomy human personality traits [9]. These five factors include the following.

- Neuroticism
- Extraversion
- Openness
- Agreeableness
- Conscientiousness.

Using the FFM questionnaire, a personality class is identified for each individual in our study. Writing sample of the individual is also collected. The developed computerized system is then used to predict the personality class and the predicted class is compared with the one obtained using the questionnaire allowing quantitative analysis of results.

1.5 Project Scope

The project considers only the offline (scanned) images of handwriting. Consequently, online features like writing speed and pressure are not considered in our study. An individuals personality is categorized according to the aforementioned FFM model and the evaluations are carried out by comparing the results of the automated analysis with the manual interpretation of the personal traits.

1.6 Solution Application Areas

The proposed automated handwriting analysis system offers interesting applications in a number of areas. Computerized personality profiling can be employed by psychologists and graphologists to efficiently profile their subjects. The system can also be employed for recruitment purposes where the personality of candidates can be evaluated through their writing samples.

1.7 Tools/Technology

1. Hardware

- Optical scanner for digitization of handwriting samples.
- Desktop machine for algorithmic development.

2. Software

- Development Platform: CSharp
- Libraries: Accord.NET, Emgu CV

1.8 Organization of Report

This report is organized as follows. In the next chapter, we present an overview of the notable contributions to computerized prediction of personality from handwriting and related areas. Chapter 3 details the requirement specifications while Chapter 4 presents the design details of the project. Implementation and algorithmic details are presented in Chapter 5. Chapter 6 presents system testing and evaluation while Chapter 7 concludes this document.

Chapter 2

Literature Review

This chapter presents an overview of significant contributions to computerized analysis of handwriting in general and prediction of personality attributes in particular. Among well-known contributions, Kacker et al. [1] extract features like page margins, baseline and spacing etc. to predict personal attributes from images of handwriting. Writing samples were collected on an A4 page in black ink. The images are digitized and binarized prior to feature extraction. Image analysis techniques are then employed to extract the writing attributes. The baseline is computed by calculating the angle between the page borders and the written lines as illustrated in Figure 2.1. Authors also compute the ratio of three zones of writing (upper, middle and lower) as indicated in Figure 2.2.

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In another work [2], Kedar et al. carry out a comprehensive review of personality profiling from handwriting. Impact of writing attributes like

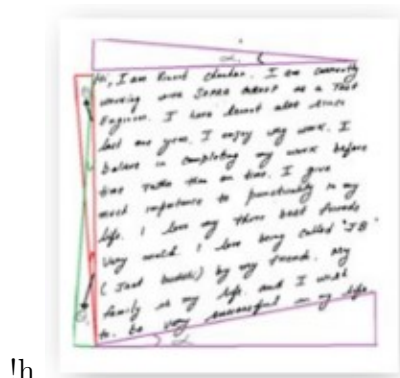


Figure 2.1: Computation of baseline angle



Figure 2.2: Three zones in handwriting

baseline, slant, letter size, word spacing and margins etc. on different aspects of personality is studied. Authors identify different types of baseline including straight, ascending, true ascending, descending, concave, suicidal or erratic. The interpretations of these different types is summarized in Figure 2.3. Likewise, the authors identify four classes of slant along with their interpretations as presented in Figure 2.4. Similarly, different interpretations of margins and sizes are summarized in Figure 2.5 and Figure 2.6 respectively. Authors discuss the different techniques employed for extracting these features and categorize them into statistical, structural and global transformation approaches. The study concludes that in most cases near to 90% predictions are reported. It is, however, important to note that most studies simply compute the writing attributes and group writers into personalities without actually predicting the personality through other mechanisms (questionnaires, interviews, psychological tests etc.).

In another work by Prasad et al. [3], six attributes of handwriting including letter size, slant of letters and words, baseline, pen pressure, letter spacing and word spacing are exploited to predict personality. Classification is carried out using SVM with Radial basis kernel function. Authors report experiments on writing samples of 100 different individuals with a correct classification rate of 94%. Authors in [4] extract a number of writing attributes and employ a machine learning based technique to identify the personality of writer. Authors use the Five-Factor model of personality profiling which considers personality attributes like Neuroticism, Extraversion, Openness, Agreeableness and Conscientiousness. While many studies rely on text-dependent writing samples, authors in [4] presented a text-independent approach where writing samples of different writers contain arbitrary textual content.

In another work [5], Champa et al. present a computerized system to classify the personal behaviors using baseline, letter slant, pen pressure and features extracted from the letter 'i' and the letter 'f'. Extracted features








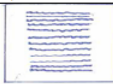


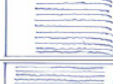



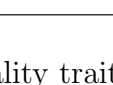
Sr. No.	Type	Personality Traits	Writing Sample
1	 Straight Baseline	Stable outward behavior, disciplined, realism and straightness.	<i>Straight lines extend outward</i>
2	 True Ascending Baseline	Healthy mental energy, Stay busy and Active. Hopefulness & Cheerfulness. Excitability, euphoria, and choleric behavior.	<i>I am an extrovert character</i>
3	 False Ascending Baseline	Quitter, Enthusiastic about his/her goal.	<i>One children will come to</i>
4	 Descending Baseline	Sinking feeling, Purely physical weakness or physical or mental tiredness of a temporary nature. Depression & Melancholy. Pessimistic, Digestive trouble.	<i>I am not keeping myself</i>
5	 Suicidal Baseline	Suicidal feeling	<i>that my America</i>
6	 Concave Baseline	Enthusiastic at start of the work, depressive at the middle and reach to goal at the end.	<i>Our college reports</i>
7	 Erratic Baseline	Unstable, Moody, can easily cry and laugh.	<i>very very emotion out of control</i>

Figure 2.3: Different Baselines and their interpretations [2]

Sr. No.	Type	Personality Traits	Sample
1	Vertical Slant	Real feelings, Positive qualities of independence, Living in the present, Cool judgment, Discrimination and Controlled emotions. Apathy, coldness, laziness.	<i>For him light labor spread her</i>
2	Rightward slant	Demonstrative, Affectionate, Passionate, Speaks of future, Compliance, Vision, and Expressiveness.	<i>am not what it is, do I hope</i>
3	Leftward Slant	Avoid emotional involvement in a situation. Materialistic, Oriented towards the past, Negative, past, fear, resistance, doubt and repression.	<i>I'm constantly being told</i>
4	Variant Slant	Unstable nature, can not take decision correctly.	<i>I'm all mixed up I don't know what to do.</i>

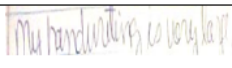

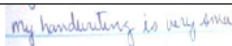
Figure 2.4: Different slants and their interpretations [2]

are fed to an artificial neural network that learns the recognize different personalities. Kathait & Singh [6] exploit the analysis of handwriting for career counseling. The features considered in this study include size, slant, word spacing, pen pressure, line spacing, upper zone loops, lower zone loops and page margins. Based on a set of heuristic a personality profile and a career are suggested for against a query handwriting image.

Sr. No.	Type	Personality Traits	Sample
1	Even Margin all around	Naturally appearance-conscious, Interest in beauty, design, symmetry, order, and balance.	
2	Overly wide left margin	Imaginary barrier between himself/herself and the past. Feels the past.	
3	Overly wide right margin	Future goals, Imaginary barrier as to how far one can get in life.	
4	Crushed right margin	Dangerous impulsiveness, not conscious, do not plan ahead, do not think.	
5	Narrow margin on left and right	Can't prepare himself to leave room for others.	
6	Wide upper margin	Formal, Respectful. (official letters)	
7	Wide lower margin	Afraid of future and not going ahead.	
8	No margin at all	Fill every waking moment of your life with some activity or other, Have a compulsion to be busy leaving no time for relaxation, Will do everything to get a thing done.	

!h

Figure 2.5: Page margins and related personality traits [2]

Sr. No.	type	Personality Traits	sample
1	Large size	Extroverts, Cannot concentrate on small details, Demand space in life, Lavish, ceremonial, prodigal, and luxurious, big planners and see things in a big way, Boisterous and loud.	
2	Medium size	Social and have an average ability to concentrate on things, Has a need to conform in all areas.	
3	Small Size	Introversion, Sense of economy, Deep concentration	

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Figure 2.6: Letter sizes and related personality traits [2]

Among other well-known contributions, Rahiman et al. [7] consider personality attributes like emotional state, fears, honesty and defenses etc. in the proposed system termed as ‘HABIT’ (Handwriting Analysis Based Individualistic Traits Prediction). Like many other studies, this work also considers the traditional features like slant of baseline, pen pressure, slant of letters and size of writing etc. Fisher et al. [8] present an overview of the state-of-the-art systems for automated analysis of handwriting including forensic applications, prediction of gender and personality.

It is interesting to note that while applications like writer identification, signature verification and prediction of gender from handwriting have been considered in a number of studies, prediction of personal attributes has not been explored to its full potential. In many cases, the features employed in the aforementioned areas [11, 12] can be adapted for prediction of personality attributes.

Chapter 3

Requirement Specifications

3.1 Purpose

The purpose of this chapter is to explain in detail the requirements of the proposed system to predict personality from offline images of handwriting. This document will include the working, functionality and the specification in which the system is intended to work.

3.2 System Overview and Scope

The developed application will rely on offline attributes of handwriting. Personality of an individual will first be determined using the five factor personality model. The personality predicted from handwriting will be compared with the one predicted by the model.

3.3 General Description

3.3.1 Product Functions

The developed application will include modules for preprocessing, feature extraction and classification. Features extracted from images of writing will be employed to train a classifier. In the evaluation phase, a query writing sample will be presented to the system which will predict the personality of the writer in question.

3.3.2 User Characteristics

No specific characteristics are expected from the users of this application.

3.4 Operating Environment

The following features must be installed to execute the developed application.

- Windows
- Visual Studio 2013 or later

3.5 Constraints, Assumptions and Dependencies

- The handwriting sample should contain sufficient text, i.e. 3-5 lines for correct prediction of personality.
- The individuals contributing writing samples must also fill the questionnaire of five factor model.
- The images of handwriting are acquired on plain white papers.

3.6 Functional Requirements

The key functional requirements of the system are listed in the following.

- Binarization of digitized images of writing
- Extraction of textural features from images
- Training of classifier using extracted features
- Prediction of personality of a questioned writing sample

3.7 Non-Functional Requirements

The non-functional features of the system are listed in the following.

- **Importance:** The system will allow automated analysis of handwriting for prediction of personal attributes.

- **Benefits:** The system can be employed in a number of applications including graphology and career counseling.
- **Efficiency:** The system is expected to extract features and recognize personality in an efficient manner.
- **Scalability:** The system can be scaled to larger datasets.
- **Learnability:** The system is easy to learn for new users.

3.8 Risks Involved

- Non-availability of sufficient writing samples and corresponding questionnaires
- Non-availability of sufficient text per writing sample
- Correlation between selected features and personality may not be valid

Chapter 4

System Design

4.1 Purpose

The purpose of this design document is to explore the logical view of architecture design, sequence diagram, block diagram, class diagram and activity diagram of the software for performing the operation such as pre-processing, extraction, features and display the personality of the text image.

4.2 Scope

The purpose of this design document is to explore the logical view of architecture design, sequence diagram, block diagram, class diagram and activity diagram of the software for performing the operation such as pre-processing, extraction, features and display the personality of the text image.

4.3 Diagram and Methodology

The proposed methodology use some technology to pre-process and feature extraction to detect and display personality of the text. The proposed method are of 4 steps:

- Handwriting.
- Pre-processing.
- Feature Extraction
- Learning.

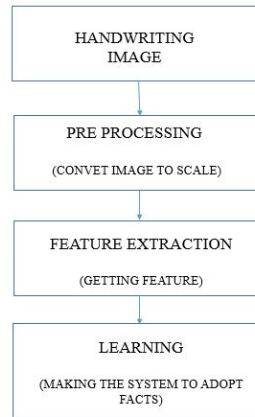


Figure 4.1: System Diagram

4.3.1 Handwritng

In this process the persona insert the image in to the system for knowing there personality.The system will only detect the image if it is in required format.

4.3.2 Pre-Processing

The pre-processing is a series of operation on scanned image. The role of pre-processing is to segment the interesting pattern. The pre-processing also define a compact representation of the pattern. Binarization process convert an image into binary image then dilation.

4.3.3 Feature Extraction

There are two techniques employed based on the efficiencies obtained, while training the neural network. They are as follows:

- Feature Extraction based on character geometry.
- Feature Extraction Using qradient feature.

4.3.4 Result

The result or personality is identified by the feature extracted.

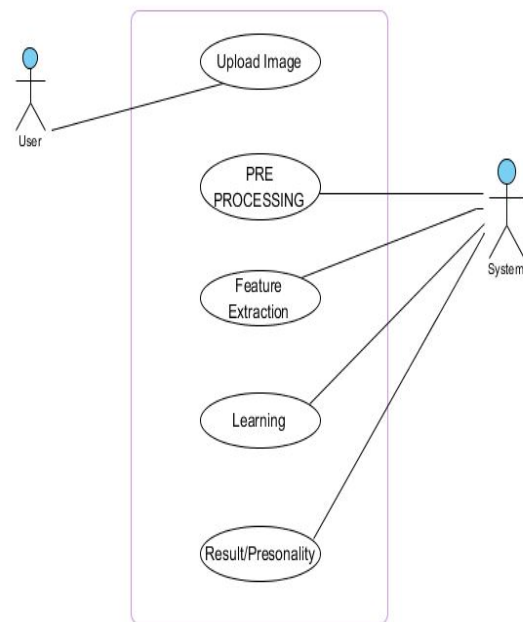


Figure 4.2: Use case

4.4 Use Case

4.5 Actors

- Users
- System

4.6 Use cases

- Upload handwriting image
- Preprocessing of image
- Feature Extraction
- Learning
- Personality/result

Use case ID	1
Title	Upload handwriting image.
Description	User insert the image of the handwriting.
Primary Actor	User
Pre-Condition	Image of handwriting
Post-Condition	Upload image

Table 4.1: Uploading image

Use case ID	2
Title	Preprocessing of image.
Description	In this the system check the level and scale and compute it.
Primary Actor	System.
Pre-Condition	Successfully upload of image.
Post-Condition	Successfully transformed image.

Table 4.2: Pre-Processing

Use case ID	3
Title	Feature Extraction.
Description	In this the system extract feature of handwriting.
Primary Actor	System.
Pre-Condition	Successfully transformation of image.
Post-Condition	Successfully extraction of features.

Table 4.3: Feature Extraction

Use case ID	4
Title	Learning.
Description	In this the system,learn the extract features.
Primary Actor	System.
Pre-Condition	Successfully extraction of features.
Post-Condition	Successfully system learning about the features.

Table 4.4: Learning

Use case ID	5
Title	Personality/result
Description	In this the system,display the respective result of the handwriting.
Primary Actor	System.
Pre-Condition	System must learn the feature .
Post-Condition	Successfully display the result.

Table 4.5: Personality/Result

4.7 Flow Chart**4.8 Component Diagram****4.9 Block Diagram****4.10 Class Diagram****4.11 Activity Diagram****4.12 Sequence Diagram****4.13 Collaboration Diagram**

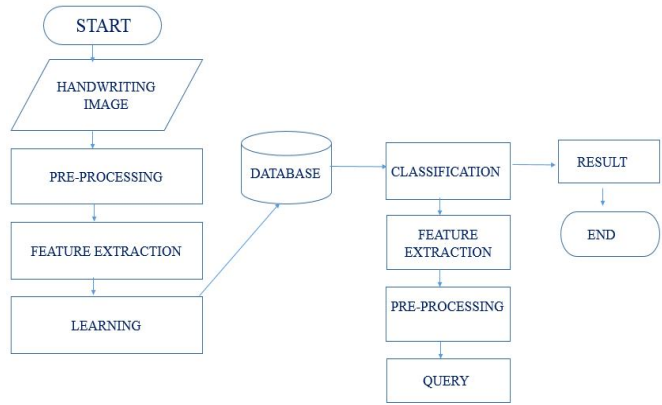


Figure 4.3: FlowChart

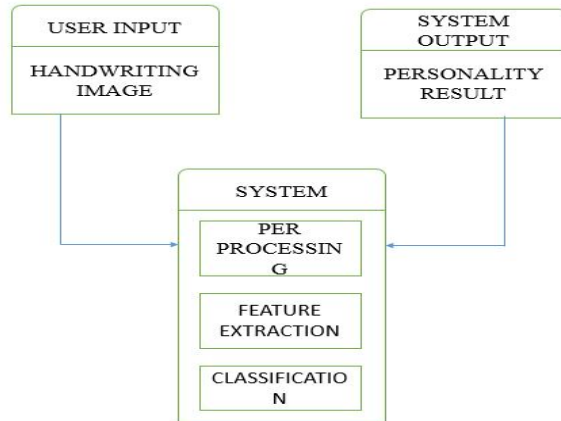


Figure 4.4: Component Diagram

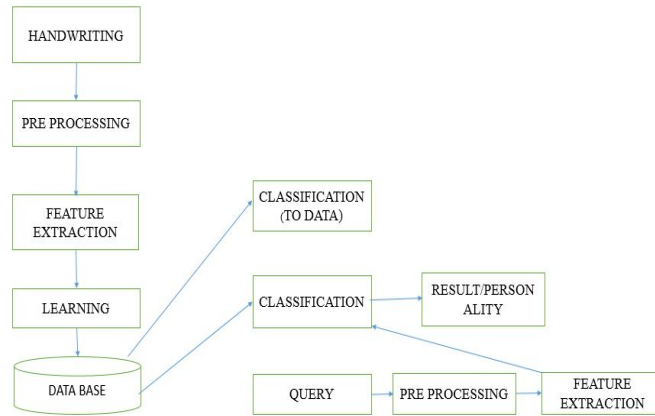


Figure 4.5: Block Diagram

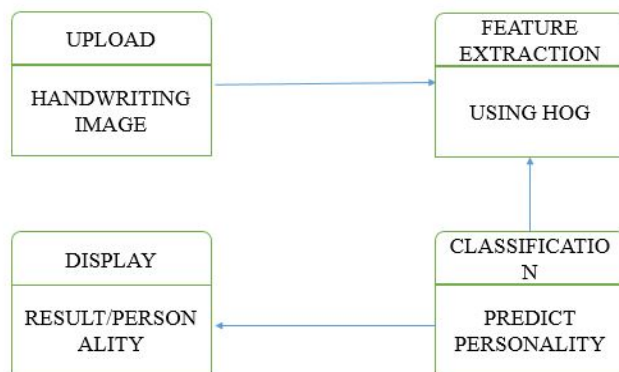


Figure 4.6: Class Diagram

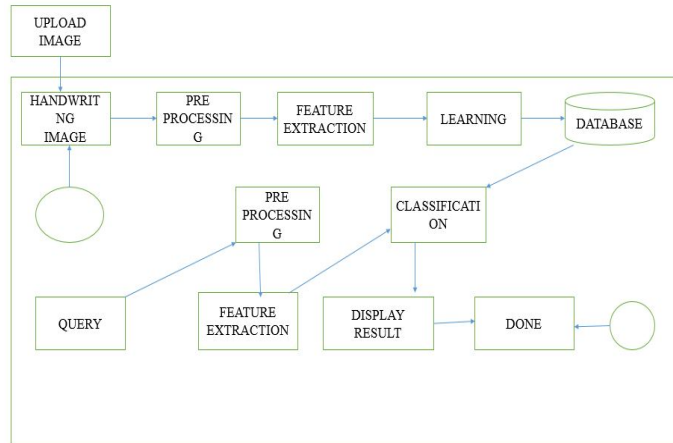


Figure 4.7: Activity Diagram

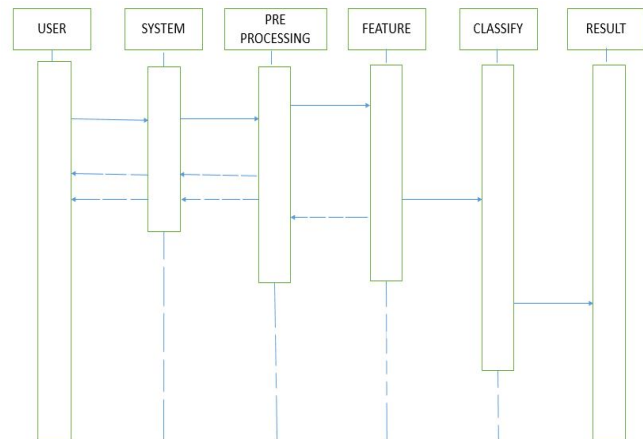


Figure 4.8: Sequence Diagram

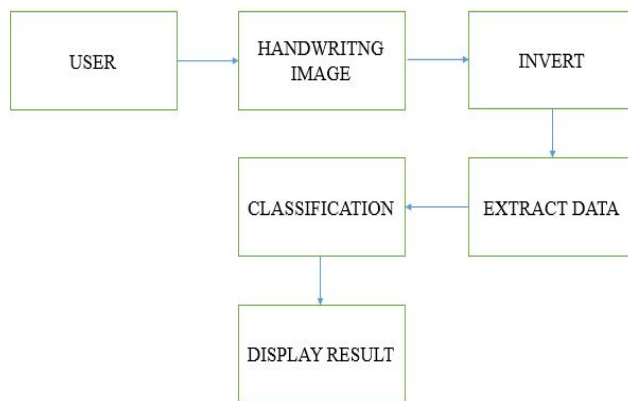


Figure 4.9: Collaboration Diagram

Chapter 5

System Implementation

This chapter presents the algorithmic and implementation details of the application. The key steps involved in processing include preprocessing, feature extraction and training (classification). Feature extraction relies on considering each writing as a unique texture. Features computed include LBP (Local Binary Pattern) and HOG (Histogram of Oriented Gradients). Classification is carried out using nearest neighbor classifier.

5.1 Tools and Technology

The tools and technologies employed in the development of the application are listed in the following.

- Visual Studio 2013
- Emgu CV

5.1.1 Visual studio

Visual studio is a notable IDE (Integrated improvement Environment) provided by Microsoft for developing window based programming application. Visual studio underpins many programming dialects including VB.NET, Visual C# and so forth. In our implementation, we have developed the application in C#.

5.1.2 Emgu CV

To facilitate loading and processing of images, Emgu CV library has been integrated with C#.

5.2 Algorithmic Details

This section presents the algorithmic details of the developed system to predict personality from images of handwriting. Different key steps including preprocessing, feature extraction and classification are discussed in the following.

5.2.1 Pre-Processing

Preprocessing, in general, prepares the image for the subsequent step of feature extraction. In our system, the writing samples are collected on white pages without any graphics or other noisy components. Consequently, the preprocessing in our case comprises thresholding the digitized images to obtain binary images and segment handwriting from the background. Since the images have bi-modal intensity distribution, a global thresholding is applied to all images to convert them to binary.

5.2.2 Feature Extraction

Traditionally, features like slant, margins, baseline and spacing etc. have been employed to predict personal attributes from handwriting. In our study, we consider each writing as a unique texture. To capture the textural information in the writing, two well-known descriptors are employed. These include Local Binary Patterns (LBP) and Histogram of Oriented Gradients (HOG). Each of these are discussed in the following.

Local Binary Patterns

Local Binary Patterns or LBP is an effective textural descriptor that has been applied to a number of recognition problems. The computation of LBP involves comparing a pixel with its neighboring pixels. The central pixel intensity value is considered as a threshold and the neighboring pixels are assigned binary values (1 or 0) as a function of the central pixel. The resulting sequence is considered as a binary number and is termed as LBP. The histogram of these numbers is then employed as a descriptor. Such histogram can be computed globally from the entire image or locally from different regions of the image and later concatenating all histograms. The most common neighborhood in computing the LBP codes is (8,1), i.e. 8 pixels with a radius of 1. This results in 8 bit binary numbers (0 to 255). Figure 5.1 illustrates the different examples of neighborhoods in computation of LBP. In our implementation, we consider 8 neighbors for each pixel.

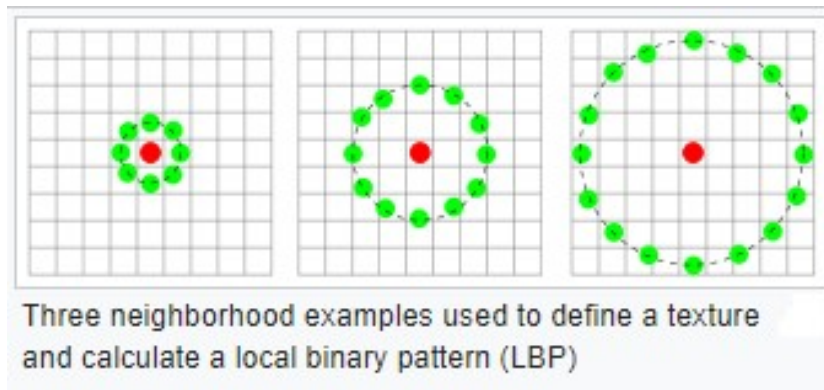


Figure 5.1: Different neighborhoods in LBP computation

Histogram of Oriented Gradients

Histogram of Oriented Gradients or HOG computes image gradients locally using small cells. HOG captures the local gradient information in small regions of the image, generally known as cells which are grouped into blocks. Since the dimensionality of the HOG descriptor is a function of image size, we resize all handwriting images to a fixed size. Figure 5.2 illustrates the computation of HOG descriptor on a sample image.

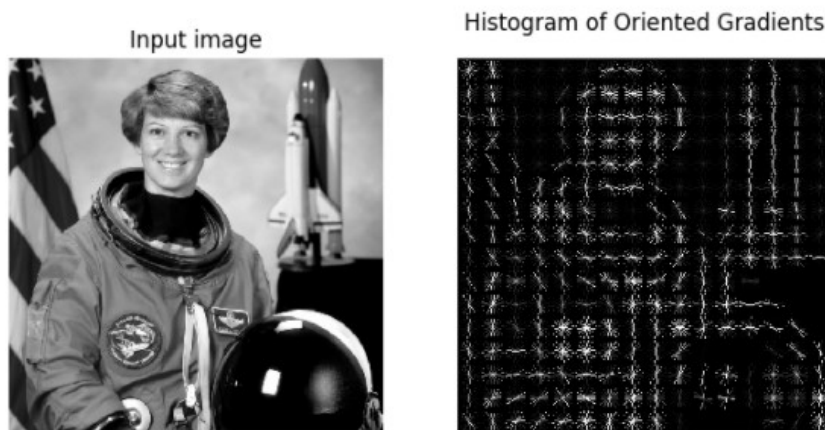


Figure 5.2: Computation of HOG

5.2.3 Classification

Classification is carried out using nearest neighbor classifier. The feature vector of the query handwriting image is compared with all the feature vectors

in the reference base. The feature vector reporting the minimum distance is picked and the personality of the query writer is identified. The personalities of the individuals in the dataset are labeled through the five factor model questionnaire.

Chapter 6

System Testing and Evaluation

6.1 Introduction

This chapter presents the details of the tests carried out on the developed application. The testing is carried out from two perspective. One is the project testing to study if all implemented modules function correctly. The other is to study the effectiveness of the proposed scheme in characterizing the personality attributes from handwriting.

6.2 Testing

Different types of tests are carried out on the system as described in the following.

6.2.1 Usability Testing

To test for usability, different users were asked to use the application. The tasks included uploading an image and predicting the personality. The system is fairly straight forward to use and no issues were reported by the users.

6.2.2 Compatibility Testing

The system was deployed and tested on machiens with different configurations to test for compatibility.

6.3 Test Cases

6.3.1 Verification

A number of test cases were designed to check if the different modules are working properly. These are summarized in Table 6.3.1.

TestID	Test Case	Input Description	Expected Output	Pass/Fail
1	Upload image	User selects and uploads an image of handwriting	Image should be selected and uploaded	Pass
2	Preprocess image	Image is provided for pre-processing	Binarized image	Pass
3	Feature Extraction	Image	LBP and HOG features extracted	Pass
4	Result (Personality)		Respective personality of the person	Pass

Table 6.1: Test Cases

6.4 Experimental Results

This section details the results of experiments carried out to validate the proposed technique. We first introduce the database employed in our study followed by presentation of results.

6.4.1 Database

A major challenge in developing such an application is the collection and labeling of dataset. We collected writing samples from 100 different individuals. Each individual was required to write a paragraph of text. The participants were also required to fill the five factor model questionnaire. The questionnaire was analyzed and scored and each individual was assigned a personality profile on the five parameters already discussed. Writing sam-

ples of 80 individuals were used as training (reference) set while those of 20 individuals were employed in the test set.

6.4.2 Results

The results are presented for the five factors Neuroticism, Extraversion, Openness, Agreeableness, Conscientiousness. Each of these factors is identified as low or high established through the questionnaire. The predicted value (low or high) through handwriting is then compared with the true value. The realized results are summarized in Table 6.2.

Factor	High		Low	
	Actual	Predicted	Actual	Predicted
Neuroticism	15	14	5	5
Extraversion	18	16	2	2
Openness	15	12	5	3
Agreeableness	9	6	11	7
Conscientiousness	10	7	10	8

Table 6.2: Results of personality prediction through handwriting

It can be seen from Table 6.2 that for the five factors considered in our study, the prediction of these attributes from handwriting is indeed very promising.

Chapter 7

Conclusion

We presented a system for prediction of personality through computerized analysis of handwriting. The system relies on a set of image analysis operations to extract textural features from images of handwriting and predict the personality. Unlike most of the similar studies on this problem which carry out a subjective evaluation, we carry out a quantitative evaluation of the system. A database of 100 individuals is collected where each participant filled a standard questionnaire to determine the personality. The handwriting of these individuals are also collected. Later, the personality predicted through handwriting is compared with the one predicted through the established questionnaire. The promising classification rates validate the effectiveness of the developed system.

The system can be further enhanced by enriching the feature set. In addition to textural measures, local features can also be investigated. Likewise, the present system employs a simple nearest neighbor classifier. More sophisticated machine learning based classification techniques can also be employed. Furthermore, the size of the database can be enhanced and additional personality attributes can also be considered.

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Annexure

Automatic Identification Of Personality Using Writing Behavior

Questionnaire & Images of Handwriting

DATE: -----

GENDER: -----

AGE: -----

Traits	Very Acc	Mod Acc	Nei	Mod Inacc	Very Inacc
Easy forming of close attachment to other people (affection and friendly)					
Preference for the company of other (avoidance of being alone)					
Tendency to lead and dominate social situation					
(Energetic disposition) fast paced lifestyle and propensity toward busyness					
Craving for exhilaration and stimulation (preference for noisiness)					
Tendency to experience positive emotions inclination towards optimism					

Traits	Very Acc	Mod Acc	Nei	Mod Inacc	Very Inacc
Active, mental life and strong imagination					
Strong appreciation of art and beauty					
Receptive to ones own feelings and, emotions.					
Willing to explore new places, try new, foods.					
Intellectual curiosity; enjoys, philosophical arguments and brain-teasers					
Ready to explore and evaluate ones own, social, political, and religious values					

Traits	Very Acc	Mod Acc	Nei	Mod Inacc	Very Inacc
Inclined to believe that others are honest					
Sincere, and genuine in expression of opinions and thoughts					
Strongly, moved by and dedicated to the promotion of the well-being of others					
Inhibition, of aggression, deference to others in interpersonal conflict					
Humbleness, in speaking of own accomplishments					
Concerned, about others					

Traits	Very Acc	Mod Acc	Nei	Mod Inacc	Very Inacc
Capability, to deal with life challenges and hardship					
Neatness in living					
Dutifulness					
Willingness, to work hard					
Ability, to follow through with tasks and limit distraction					
Tendency, to carefully contemplate decisions before acting					

Traits	Very Acc	Mod Acc	Nei	Mod Inacc	Very Inacc
Fearfulness, tenseness, restlessness					
Tendency, to experience frustration and bitterness, as well as anger					
Propensity, to experience depressive symptoms, such as loss of energy, diff in sleep					
Frequent experiences of shame and embarrassment					
Inability to control cravings or urges					
Dependence, on others for support					

The elated fan expressed his gratitude at receiving the memento from his favorite cricketer. Pakistan's victory by 180 runs on Sunday has sparked widespread celebration in the country, where cricket is the number one sport. The national heroes are warmly welcomed by the fans all over the country. Hundreds of fans gave Pakistan Captain Sarfraz Ahmed a hero's welcome as he arrived home carrying the Champions Trophy early on Tuesday. Men, women and children packed Karachi airport as Sarfraz returned from England, where Pakistan thrashed arch-rivals India to be crowned surprise winners. Sarfraz held up the trophy to loud cheers and chants of "long live Sarfraz!" as a police band played patriotic song nearby. Ahmad said he jostled his way through the crowd of well-wishers. Sarfraz was showered with bouquets and given a traditional skull cap and 'ajrak' shawl, which is usually presented as a mark of honour.

The elated fan expressed his gratitude at receiving the memento from his favourite cricketer. Pakistan's victory by 180 runs on Sunday has sparked widespread celebrations in the country, where cricket is the number one sport. The national heroes are warmly welcomed by the fans all over the country. Hundreds of fans gave Pakistan captain Saif-uz-Zaman a hero's welcome as he arrived home carrying the Champions Trophy early on Tuesday. Men, women and children packed Karachi airport as Saif-uz-Zaman returned from England, where Pakistan thrashed arch-rivals India to be crowned surprise winners. Saif-uz-Zaman held up the trophy to loud cheers and chants of "Long live Saif-uz-Zaman!" as a police band played patriotic songs nearby. "We won thanks to Allah and the prayers of the whole nation", Saif-uz-Zaman said in brief comments as he jostled his way through the crowd of well-wishers. Saif-uz-Zaman was showered with bouquets and given a traditional skull cap and an 'ajrak' shawl, which is usually presented as a mark of honour.

18-A

Once there was a crow. It was very thirsty. It flew here & there but couldn't find water.

At last, it saw a pitcher, full to the bottom. Its beak could not reach to the bottom. Its beak could not reach to the edge. It hit upon an idea. It brought some pebbles & threw it on to the pitcher. So the water of pitcher raised & it drank it.