HANDWRITING ANALYSIS BASED HUMAN PERSONALITY PREDICTION USING SUGENO FUZZY MODEL

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Abstract

Handwriting analysis is an important research area in graphology. In this study it is proposed to predict human writer's personality, based on handwriting features, using adaptive neuro fuzzy inference system. The proposed work intends to predict the personality traits using Sugeno based fuzzy inference model which is designed for predicting writer behavior. The input parameters are spacing, size, slant, shape, loop, dot, pressure, signature, zones and page margin. The fuzzy system is designed using MATLAB 7.1 toolbox. Performance of the model has been evaluated using mean square error (MSE) and root mean square error (RMSE). The simulation results obtained shows the effectiveness and accuracy of the proposed model.

Keywords—fuzzy logic, Artificial neural network, handwriting analysis, personality traits.

I. INTRODUCTION

Each and every individual in this world is born with unique features. This uniqueness can be revealed in various ways such as their retinal pattern, finger prints, palm pattern, voice, DNA and handwriting etc. The very minute patterns produced in handwriting can reveal a person's personality traits [1] [2]. Since handwriting is produced by neuromuscular movements generated by brain, it is also called as 'Brain Writing'. This neurological pattern is similar for the persons having same personality traits. Hence, we can easily predict a person's attitude, social behavior, intellect, imaginative power, defenses etc., by using his handwriting. Earlier, this personality analysis had been done manually. In this paper, a method has been proposed to analyze the personality traits by using fuzzy logic. The attributes which we take for analyzing handwriting includes, 1) size 2)Base line 3) Pressure 4) space between words 5) Margin 6) Speed 7) Slant 8) Looping in the letter 9) Margin . This concept mainly focuses on Particle Swarm Optimization (PSO) based image preprocessing technique using which the image is segmented and the features are extracted for classification [3]. PSO is less expensive, decreases computational time and improve the performance efficiency that it can overcome the existing problems in classifications such as Stagnation and high computational cost. The analysis of handwriting has a vital role in various fields such as Medicine (for identifying Alzheimer's disease, Parkinson's disease, detecting high blood pressure and Cancer) and used in forensic investigations etc.

A. Handwriting and Personality

Table 1 illustrates prediction of traits based on various attributes [4][5].

TABLE I. PERSONALITY TRAITS

Attribute	Type	Personality Traits
Spacing	Wide	Loves to live in independent, have strong belief in themselves
	Narrow	Inablity to live alone,always be in overwhelmed or crowded
Size	Small	Meticulous, shy, loves to work behind the scenes
	Average	Well –adoptable, can

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	large	easily manage situations Loves to be the center of attraction, outspoken, pretends to be self-confident
Slant	No slant Right slant Left slant	Logical thinking, expects discipline in all works Loves learning new things, futuristic Always tends to live in the past, slightly afraid of future
Shape	Rounded Pointed Connected	Artistic personality, good at maintaining relationships Highly intelligent, curious, logical thinking Tends to be systematic, simultaneous thinking
Looping	Narrow Wide	Tends to bottle up feeling Relaxed and spontaneous
Dotting	High Right Left	Highly positive, self-confident Tends to be organized, enthusistic Does not have patience to learn from mistakes
Page Margin	Left No margin Right	Shows eagerness in knowing new things Does not take time to relax, believes more in hardwork rather than smartwork Fear towards unknown things, may have depression
Pressure	Heavy Light	Take things seriously, passionate, very-determined and self-motivated Lack of vitality, in deterministic and tends to be relaxed
Signature	Not Legible Legible	Private, hard to read their emotions Self Confident and comfortable
Zones	Upper Middle Lower	Imaginative and philosophical Egoistic persons, aggressive at times Tends to have unfulfilled emotions, depressed feelings

The rest of the paper is organized as follows. Section II reviews multiple literatures on handwriting analysis. The proposed fuzzy inference system for personality prediction is discussed in section III. Results and conclusion are given in section IV and section V.

II. LITERATURE SURVERY

Various on line tools are available for handwriting analysis such as: NEURO SCRIPT, WANDA, CEDAR-FOX, and Gaussian Mixture Model. Accuracy obtained was 80% [6]. The research for developing computer software that can recognize the Thai handwritten characters by using the genetic algorithm technique (THCRGA). The precision of the system obtained is 88.24%, with recognition speed of 0.42 second per character [7]. An improved HMM based recognition model is proposed for online English and Korean handwritten characters. The recognition of handwritten characters is implemented by a modified level building algorithm, which incorporates the Korean character combination rules within the efficient network search procedure. A modified Hierarchical Clustering approach is

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introduced to partition different writing styles into several classes. Accuracy was 90% [8]. Character recognition is the mechanical or electronic translation of scanned images of handwritten, typewritten or printed text into machine encoded text.

The work discussed in [9] follows a fuzzy approach to recognize characters. Fuzzy sets and fuzzy logic are used as basis for representation of fuzzy logic system for recognition. The fuzzy based algorithm involves segmentation using fuzzy system. This gives possible characters that match the given input and the de-fuzzification involves final recognition of character. Accuracy obtained is 80%. Segmentation is the method used in calculating the features of digital handwriting and the SVM is trained from which the behavior of the writer is predicted and outputted. In this method, 100 different writers were tested with different writing samples. And this method gave about 94% accuracy rate with RBF kernel [10]. A method had been proposed in developing a system using

Artificial Neural Network (ANN) which outputs the personality traits of a writer. The performance is measured by using multiple samples [11]. A method proposed for a system to predict the behavior of a person in which handwriting is analyzed through image processing in MATLAB. The accuracy obtained with this is more than 80% [12]. A proposed method for handwriting analysis using verification by clustering technique has resulted in accuracy over 80% [13]. A method proposed on Feed Forward Back Propagation Neural Networks and accuracy achieved is 97% from untrained writers and 99.1% from trained writers [14].The design of fuzzy system using fuzzy logic editor having the inputs and 1 output with 57 rules. The average result obtained after membership functions tuning is 80% [15].

III. METHODOLOGY

In this section, we present the details of proposed system design. First we start with overall framework of the handwritten character recognition system. Then, we give each component detail. Finally, we present the user interface. First, the system captures the human handwritten character images and stores them in a computer system. The block diagram of Personality Identification System is shown in Fig. 1.

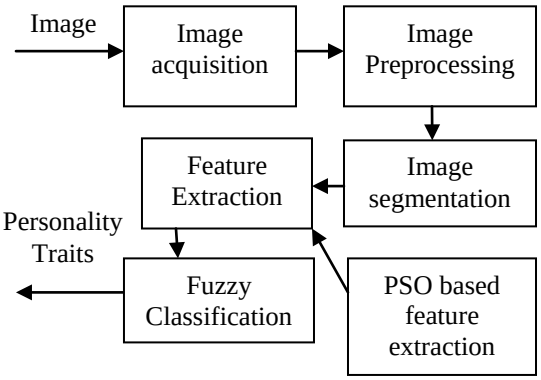

Fig. 1 Personality Identification System.

These steps are explained below.

Scanning: It is the first step in analysis process. The handwriting sample is taken as input which is taken on a plain A4 sheet. There are two approaches in scanning process – (i) offline scanning (ii) online scanning. In offline approach, the image is scanned using a scanner in JPEG or BMP format or photo of the sample which is taken by camera. In Online approach, the user can directly write on the scratch pad or other specially designed instruments for getting text inputs. The obtained input is given to the preprocessing step.

Preprocessing: Preprocessing involves segmentation which includes normalization, binarization, noise removal and slant removal. This image is then segmented which involves portioning the digital image into multiple segments. This results in getting relevant information by removing all unwanted information. This next step after segmentation is feature extraction step.

Feature Extraction: The features are extracted from handwriting which helps in identifying the writer's characters. The features that are extracted are slant, size, pen pressure, spaces between the words etc. From the extracted features, we can classify the writer's characteristics based on the results of three methods,

1) Statistical Method:

It involves the style of character letters. It calculates the upper zone, middle zone, lower zone, shape of the character, projections of the letters, distances between the words etc.

2) Structural Method:

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This method calculates the loops of the character, cross points, strokes and directions of the words.

3) Global Transformation:

It helps in calculating the contour of the character image.

Classification: To identify different personality traits, the writing features extracted from the feature extraction phase are classified using the classifier built using ANN where the network is pre trained to identify the personality traits from the strokes of the handwriting sample.

The fuzzy system shown in Fig. 2 is Sugeno based system with 10 inputs and 1 output. This section describes the development of fuzzy logic controller for predicting personality traits. The Sugeno based fuzzy system accepts ten inputs: spacing, size, slant, shape, loop, dot, pressure, signature, zones and page margin. The output of the sugeno based fuzzy controller is personality traits, which is a constant (fuzzy singleton). The output uses nine membership functions. Table 2 show the fuzzy sets for all linguistic variables used in the research work. The membership functions are depicted in Fig. 3. Some of the fuzzy rules used for personality prediction are shown in Fig. 4.

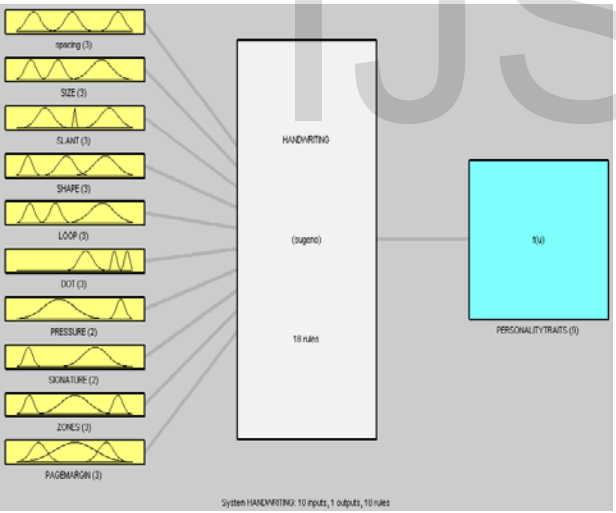

Fig.2 Sugeno fuzzy model.

TABLE II. PERSONALITY TRAITS

Linguistic value	**Numerical range**
Linguistic variable: spacing input	
NORMAL	5/10
NARROW	3/10
WIDE	7-8/10
Linguistic variable: size input	
SMALL	< 2mm
AVG	2-3mm
LARGE	>5mm
Linguistic variable: slant input	
SLANT RIGHT	90-180
NO SLANT	60-120
SLANT LEFT	0-90
Linguistic variable: shape input	
POINTED	
ROUNDED	
CONNECTED	
Linguistic variable: loops input	
LARGE	(rounded shape)
SHORT	(lower zone>normal)
LONG	(lower zone<normal)
Linguistic variable: dot input	
HIGH	90
RIGHT	45-90
LEFT	90-120
Linguistic variable: pressure input	
LIGHT	(above 5 on 1-7 scale)
HEAVY	(below 5 on 1-7 scale)
Linguistic variable: signature input	
LEGIBLE	(80% clarity)
NOT LEGIBLE	(20% clarity)
Linguistic variable: zones input	
UPPER	
MIDDLE	
LOWER	
Linguistic variable: page margin input	
LEFT MARGIN	
NO MARGIN	
RIGHT MARGIN	
Linguistic variable: personality traits output	
ENJOY FREEDOM	
SHY LIKE TO WORK BEHIND SCENE	
ADAPTABLE	
PRACTICAL	

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OUTGOING LOVE ATTENTION
CREATIVE
AGGRESSIVE
INTELLIGENT
CURIOUS
LOGICAL CAREFUL
CONFIDENT
COMFORTABLE
CONSTANT
CONTACT WITH PEOPLE

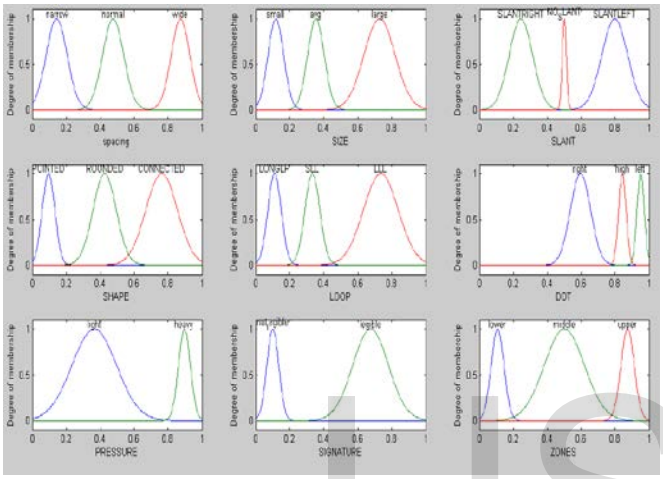

Fig. 3 Membership functions of spacing, size, slant, shape, loop, dot, pressure, signature, and zones.

1. If (spacing is wide) and (SIZE is small) and (SLANT is SLANTLEFT) and (SHAPE is POINTED) and (LOOP is LONGLP) and (DOT is right) and (PRESSURE is light) and (SIGNATURE is not_legible) and (ZONES is lower) and (PAGEMARGIN is LM) then (PERSONALITY)
2. If (spacing is narrow) and (SIZE is small) and (SLANT is SLANTLEFT) and (SHAPE is POINTED) and (LOOP is LONGLP) and (DOT is right) and (PRESSURE is light) and (SIGNATURE is not_legible) and (ZONES is lower) and (PAGEMARGIN is LM) then (PERSONALIT
3. If (spacing is normal) and (SIZE is small) and (SLANT is SLANTLEFT) and (SHAPE is POINTED) and (LOOP is SLL) and (DOT is left) and (PRESSURE is light) and (SIGNATURE is not_legible) and (ZONES is lower) and (PAGEMARGIN is LM) then (PERSONALITYTRAI
4. If (spacing is normal) and (SIZE is avg) and (SLANT is NO_SLANT) and (SHAPE is POINTED) and (LOOP is LLL) and (DOT is left) and (PRESSURE is light) and (SIGNATURE is not_legible) and (ZONES is lower) and (PAGEMARGIN is LM) then (PERSONALITYTRAITS
5. If (spacing is narrow) and (SIZE is large) and (SLANT is SLANTRIGHT) and (SHAPE is POINTED) and (LOOP is LLL) and (DOT is left) and (PRESSURE is light) and (SIGNATURE is not_legible) and (ZONES is lower) and (PAGEMARGIN is LM) then (PERSONALITYTR
6. If (spacing is wide) and (SIZE is avg) and (SLANT is SLANTRIGHT) and (SHAPE is ROUNDED) and (LOOP is LLL) and (DOT is high) and (PRESSURE is light) and (SIGNATURE is not_legible) and (ZONES is upper) and (PAGEMARGIN is LM) then (PERSONALITYTRA
7. If (spacing is normal) and (SIZE is avg) and (SLANT is NO_SLANT) and (SHAPE is POINTED) and (LOOP is LONGLP) and (DOT is high) and (PRESSURE is light) and (SIGNATURE is legible) and (ZONES is upper) and (PAGEMARGIN is MM) then (PERSONALITYTRAT
8. If (spacing is normal) and (SIZE is avg) and (SLANT is NO_SLANT) and (SHAPE is CONNECTED) and (LOOP is LLL) and (DOT is right) and (PRESSURE is light) and (SIGNATURE is legible) and (ZONES is upper) and (PAGEMARGIN is MM) then (PERSONALITYTRAT
9. If (spacing is normal) and (SIZE is avg) and (SLANT is SLANTRIGHT) and (SHAPE is CONNECTED) and (LOOP is LLL) and (DOT is right) and (PRESSURE is heavy) and (SIGNATURE is legible) and (ZONES is upper) and (PAGEMARGIN is MM) then (PERSONALITYTF
10. If (spacing is wide) and (SIGNATURE is not_legible) then (PERSONALITYTRAITS is EnjoyFreedom) (1)
11. If (spacing is narrow) then (PERSONALITYTRAITS is ConstantContactwithPeople) (1)
12. If (spacing is narrow) and (SIZE is small) and (SLANT is SLANTLEFT) and (LOOP is SLL) and (DOT is left) then (PERSONALITYTRAITS is Shylikestoworkalonissosane) (1)
13. If (spacing is narrow) and (SIZE is large) and (SLANT is SLANTRIGHT) then (PERSONALITYTRAITS is OutgoingLoveAttention) (1)
14. If (SIZE is avg) and (SLANT is NO_SLANT) and (LOOP is LLL) then (PERSONALITYTRAITS is AdaptablePractical) (1)
15. If (spacing is normal) and (SHAPE is ROUNDED) and (DOT is high) and (ZONES is upper) then (PERSONALITYTRAITS is CreativeAggressive) (1)
16. If (SHAPE is POINTED) and (SIGNATURE is not_legible) and (ZONES is upper) then (PERSONALITYTRAITS is IntelligentCurious) (1)
17. If (SHAPE is CONNECTED) and (DOT is right) then (PERSONALITYTRAITS is LogicalCareful) (1)

Fig.4 Fuzzy rules.

Invariant moment features and words' measurements features are computed based on Eq. 4-16 and Eq. 17-22 discussed in [16]. Handwriting features are selected using swarm based feature selection method presented in [16].

IV. EXPERIMENTAL RESULTS

This paper proposes a new technique of predicting personality traits based on handwriting by via Sugeno based fuzzy system designed using MATLAB. The sugeno based fuzzy system is trained using 250 data sets and it is shown in Fig. 2. The sample rule base of the fuzzy system is shown in Fig. 5. Fig. 6 shows the surface view of the fuzzy system.

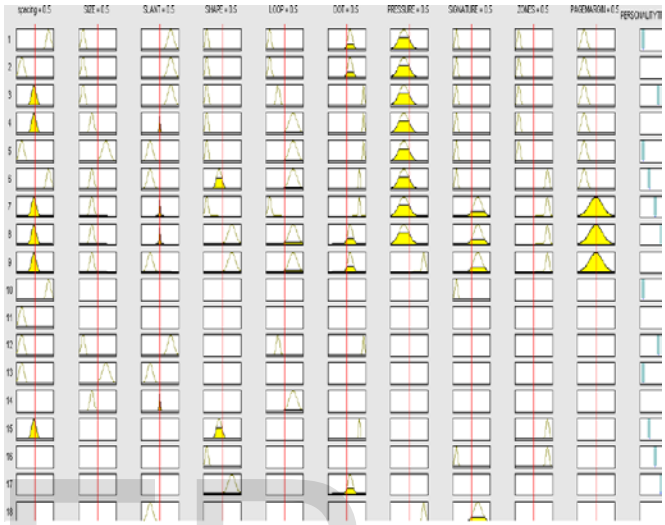

Fig. 5. Rule viewer.

V. CONCLUSION

This paper presents a fuzzy associated human personality prediction system using Sugeno model. It computes personality traits with fuzzy system using image features such as spacing, size, slant, shape, loop, dot, pressure, signature, zones and page margin. The primary focus of future work includes analyzing handwriting features through big data approach and application of data mining to extract knowledge about human behaviors.

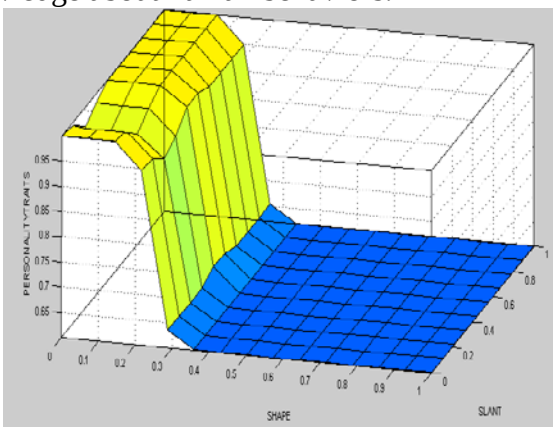

Fig.6. Surface view of fuzzy system.

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