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Automatic Emotion Recognition through Handwriting Analysis

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Abstract - Handwriting assessment is a method for better understanding a person through his or her handwriting. We can make a sketch that portrays the writer's emotional outpourings, worries, honesty, mental condition, and a range of other emotion features by focusing on the handwriting. Emotions are how you understand, perceive, and react to the feelings you're experiencing in this moment. They're the ones who connect thoughts, feelings, and actions. The main purpose of this study is to use handwritten qualities including baseline, slant, pen-pressure, size, margin, or area to determine a person's emotional levels. This can help identify people who are emotionally disturbed or depressed and need psychological help to overcome their negative feelings.

Key Words: handwriting, recognition, emotions, image,

1.INTRODUCTION

The importance of wellness to a human being cannot be overstated. Many factors can contribute to sickness, including high levels of tension, stress, and despair. It is critical to determine whether a person is experiencing depression or stress, both of which are negative emotions. Emotions are a type of physiological condition that is formed subconsciously. Joy, happiness, and excitement are examples of good emotions, whereas sadness, anger, disgust, fear, depression, anxiety, and stress are examples of negative emotions. Handwriting analysis, psychological assessment, speech analysis, and video review are some of the numerous approaches for recognizing emotions. Emotion recognition has a wide range of uses, including schooling, games, colleges, and offices. It is helpful to monitor the motions of a eye or body so relation to potential of attention of the learner, just as it is in the field of education. Capturing player emotions through social activities could be utilized for a variety of applications in the gaming industry. While emotion recognition in universities and offices can assist understand a person's unpleasant feelings and determine whether or not they require psychiatric treatment. Regarding emotion recognition [1, 6, 7] or human behavior predictions machines learning algorithms like random forests, neural networks, Bayesian networks, k-NN, or Support vector machine are used. The properties of behavioral signals like voice, body motions, and facial expressions are retrieved and used as input to a classifier. The machine learning approach was used for the problem of character recognition. The authors conducted studies employing audio, video, or body motions to recognize emotions.

Related work

Using diverse modalities, writing has demonstrated numerous techniques for acknowledging sentiments. A combination of modalities, such as looks and sound signs, motions and sound, handwriting assessment, and mental testing, produces superior results. Some authors of a paper studied gesture recognition, specifically facial articulations and hand gestures, whereas Sebe et al. present studies on feeling recognition based on looks, sound indicators, and physiological signs They have given these techniques unrestricted treatment. The article introduces a combination of mental evaluation and handwriting examination. Handwriting or sketching were related to emotional states in such an enhanced the capacity by Likforman-Sulem et al. The 129 customers who participated in the DASS survey were given handwriting and sketching tests. The DASS exam is used to assess emotional states such as unease, sadness, and tension. During extracting features, an arbitrary woodlands classifier is used. Cross-approval tests were used to obtain the unique assessment metrics, such as precision. Tension and stress are more precisely recognized than doom. The study introduces creators' investigation of penmanship highlights for experiencing acknowledgment. It is stated that different aspects of personality could be recognized by handwriting research. One of them is the ability to control one's emotions. Recognizing the feelings of their counselee is beneficial to the advocates. They used the fluffy technique to extract information from handwriting. Using Membership functions surmising, the degree of sensation is determined by the design and slant of the calligraphy. John & Julie present a research of mental assessment using DASS scale; the claim that the DASS was developed using reasonable and trial considerations. The DASS is evaluated via corroborative factor investigation. For suggested reasons, it was determined also that DASS scale display's reliability & validity. Apart from these, there have been a lot of other studies on handwriting, such as tying penmanship to depression or anxiousness, and connecting handwriting to a character blend of sound video-body motions. To the best of our knowledge, this is the first method for recognizing feelings that combines mental appraisal with handwriting analysis using profound learning.

2. Methodology

EMOTION RECOGITION THROUGH HANDWRITING ANALYSIS Automated emotion recognition based on handwriting analysis is a multi-stage procedure. It all starts with gathering handwritten examples on plain white A4 paper. Following that, the samples are scanned and converted to JPEG images, which are then processed for handwriting analysis. The analysis and classification based on these processed images results into the recognition of corresponding emotions. The system architecture is depicted in Fig 1. The entire processing includes the following steps:

- **Image Pre-processing Image pre-processing** is the process of converting a handwriting sample into a format that can be processed effectively and quickly in subsequent phases. Thresholding, noise removal, and skew correction are all part of this process. Thresholding is the process of converting a grayscale image to a binary image. Using background subtraction techniques, the clarity of the transformed image is increased. Before processing, A picture is aligned with skew correction. Following that, the segmentation process begins, which divides the digital image into numerous sets, or segments. Because the picture has its own limitations and concerns, such as ambiguous image data and informational noise, the lines, curves, and borders of the objects are defined in this step to make it easier to analysis. This method obtains only the useful and significant information, i.e., text, while all other irrelevant data is removed. The generated image is fed into the feature extraction process.

- **Feature Extraction Feature Extraction** is a critical task that must be completed by professionals. Features are divided into macro and micro categories, with macro features defining gray-scale and micro features defining structural view, respectively. The writing properties such as baseline, slant, pen-pressure, Size, Margin, Zone, and so on are all set in this phase. Handwriting samples are used to determine Feature extraction is a dimensional character decreasing method that analyses data from such a person's handwriting, and is used in database and processing.

- **Classification** the Automated Emotion Detection system is built around in this approach. After the image has been processed and sanitized, it is subjected to feature extraction, which extracts the unique qualities of the handwriting. The classifier uses these extracted features as input. The classifier recognizes the writer's emotions and internal mental state using those same characteristics. The classifier categorizes these characteristics and displays the output of the emotions that are the most similar.

System Architecture:

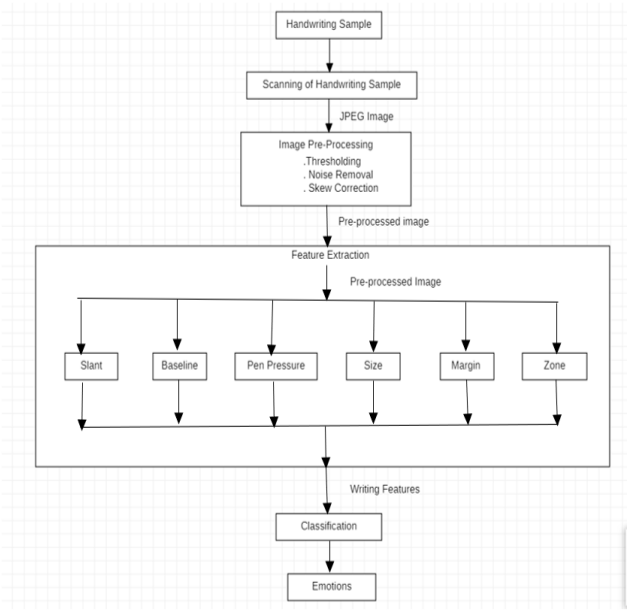


Fig 1: System Architecture

Support Vector Machines

The seven raw handwritten features are normalized into discrete values using an experimentally determined threshold value.

SVM Algorithm steps:

- Collect datasets
- Plot train data into graph
- Apply linear or nonlinear separable
- Calculate Hyperplane
- Classify two class

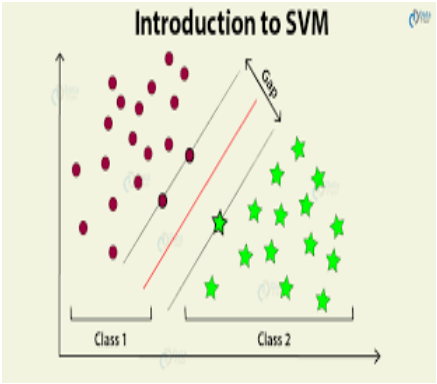


Figure: SVM algorithm

K- Nearest Neighbor

KNN Algorithm Pseudo code:

1. Calculate "d (x, xi)," with I =1, 2, n and d signify the Euclidean distance between the positions.
2. Def Euclidean _ Distance (x, y):
3. Return sqrt(sum(pow(a-b,2) for a, b in zip (x, y)))
4. Arrange the calculated n Euclidean distances in non-decreasing order.
5. Let K be a +ve integer, take the first K distances from this sorted list.
6. Find those K-points corresponding to these K-distances.
7. Let Ki denotes the number of points belonging to the it class among k points i.e., k ≥ 0
8. If Ki >Kj ∀ i ≠ j then put x in class i.

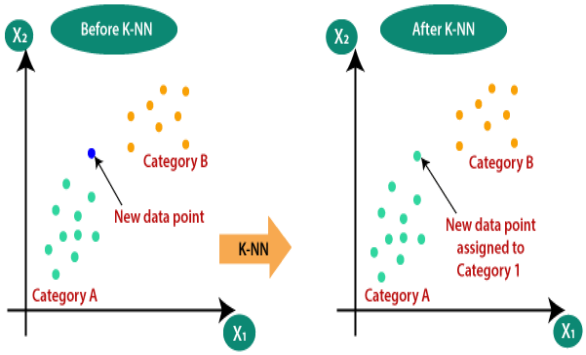


Figure: K-nearest Neighbor

Normalization and Features

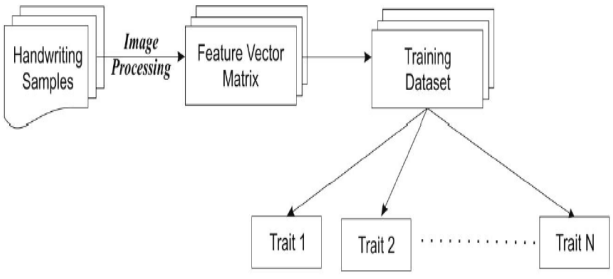
Table 3.1: Normalization and Features.

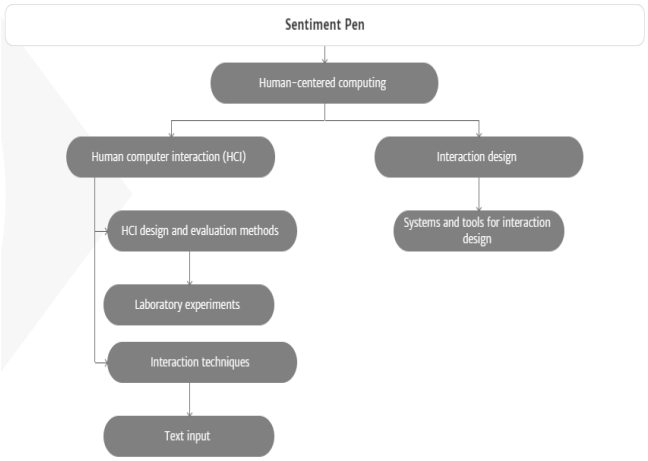
Feature	Normalized Value
Baseline	0 = descending 1 = ascending 2 = straight
Top Margin	0 = medium or bigger 1 = narrow
Letter Size	0 = big 1 = small 2 = medium
Line Spacing	0 = big 1 = small 2 = medium
Word Spacing	0 = big 1 = small 2 = medium
Pen Pressure	0 = heavy 1 = light 2 = medium
Slant Angle	0 = very reclined 1 = a little of moderately reclined 2 = a little inclined 3 = moderately inclined 4 = extremely inclined 5 = straight 6 = irregular

These combination of these seven features would predict the eight emotion qualities. As a result, every other emotional attribute will have eight labels and eight SVM classifiers. Each handwriting sample and its accompanying normalized features are studied to label the photos.

The eight classifiers are trained using the radial basis function (RBF) kernels and the SVM version of the Sci-kit Learn Library. Two-thirds of the photos are picked at random for training, while the rest are utilized to determine accuracy.

Process Flow Diagram for Generation of Training Dataset





3. Discussion

Handwriting Analysis based on Segmentation Method for Prediction of Human Emotion Using Support Vector Machine is a comparable effort. The project's work derives seven handwriting traits from an input image including a person's handwriting. Then, depending on certain combinations of those handwriting features retrieved utilizing support vector, 8 emotions of a author will be predicted.

Table 5.4.2 on the following page contains a comparison of all of the works discussed below.

Table: Comparison and Similar work

No.	Researchers	Methodology	Result
1	Shitala Prasad, Vivek Kumar Singh, Akshay Sapre, Dept. of Information Technology, IIIT Allahabad, India	Support Vector Machine	90.3%
2	Navin Karanth, Vijay Desai, S. M. Kulkarni, Dept. of Mechanical Engineering, NIT Karnataka, India [5]	No machine Learning	80 to 100%
3	Champa H N, Dept. of CSE, University Visveswaraya College of Engineering, Karnataka, India, Dr. K R Ananda Kumar, Dept. of CSE, SJB Institute of Technology, Karnataka, India [6]	Artificial Neural Network	99%
4	The proposed system	Support Vector Machines	100%

The suggested system's classifiers predict every character feature with a 100% accuracy rate, which is excellent.

All of the projects listed here have the same end goal in mind: to create a system for computer-assisted graphology. Nonetheless, there are significant discrepancies inside the selection of several handwriting elements among the many outlined in psychology, extraction techniques, segmentation into emotions, and presentation of the end result in these researches.

4. Conclusions

A method for predicting a individual's emotions has also been proposed using machine learning to analyze his and her handwriting patterns. We considered extracting seven handwriting traits and predicting emotion using different combinations of them. Every SVM classifier is trained for every emotion. We can predict emotion on new handwriting image samples with remarkable accuracy and efficiency after a reasonable amount of training.

Apart from slanted removal, the system uses a variety of image processing approaches and algorithms that were created independently. Regarding image processing, we were using the OpenCV Library and now the Sci-kit Learn

Library, as well as the conventional implementation of support vector machines with RBF kernel. It would be quite difficult to obtain the desired result without these libraries.

The created system's prediction of emotion produces satisfactory results in a short amount of time. However, feature extraction approaches may not be able to handle all examples of unusual handwriting styles, or such situations may result in erroneous results. The input handwriting image should be specifically prepared for usage with the system, according to the recommendations.

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