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Mental Health Status Detection through Handwriting Analysis

Monica S[1], Khushi Kumar[2], Anaga A[3], Anagha S[4]
[1, 2, 3, 4]*Vidyavardhaka College of Engineering*

Abstract: ***A person's handwriting is thought to reflect his/her mental and physical coordination. Handwriting analysis is used to make inferences about a person's mental health. Emotions are evoked subconsciously and describe a person's mental condition. They inspire, organise, and direct people's perceptions, thoughts, and actions. They may be positive or negative. Depression, anxiety, and stress are all expressions of negative emotions.***
It is vital to recognise negative emotion in a person who may require counselling or psychiatric treatment. The suggested technique aims to create a system that employs machine learning to forecast a person's mental health without the need for human intervention.
The major goal of this study is to extract characteristics from handwritten text, which will subsequently be normalised, scaled, and utilised to make mental health judgments.

I. INTRODUCTION

Mental health is just as important as physical health, as a result of which it is vital to keep a check on a person's mental health which includes depression, anxiety and tension which is commonly occurring among individuals. Recent studies show that by the end of December 2022 20% of Indians are likely to be diagnosed with various mental illnesses in their lifetime.
There are multiple ways in which a person's mental health can be determined by looking at the respective symptoms or by getting it diagnosed by a psychologist.
Various environmental settings in which an individual takes part in also plays a role. For instance, students spend most of their time in classrooms. classrooms are emotional settings. Students' emotional experiences can impact on their ability to learn, their engagement in school, and their career choices all We know that some emotions provide a barrier to students' classroom engagement and test performance.**[1-3]** For example, academic anxieties, have wide-ranging effects, affecting strategy use, test performance, and subject choice which leads to decline in their cognitive capacity**[15].**
Handwritten analysis is used to determine mental illnesses such as depression, anxiety and tension in individuals by using machine learning. Handwritten analysis uses DASS scale and CNN.
The DASS is a 42-item questionnaire primarily used to measure the three related bleak emotional states of depression, anxiety and stress. **[11]** CNN stands for Convolution neural network, it is a powerful tool by deep learning, because of its ability to handle large amounts of data. **[12]**
It's applications go beyond handwriting analysis it is also used in image data, classification prediction problems and regression prediction problems. Recognizing negative emotions is quite important and handwriting analysis serves this purpose which in simple words is the analysis of handwriting with attempt to determine someone's mental health status. Handwriting analysis has existed since the nineteenth century.
Handwriting analysis uses various features to analyse these include baseline, slant, size, margin, pressure, spacing, zones and, loop of 'e' and the distance between title(dot) and stem of 'i' are considered for developing the handwriting analysis system.**[13]** This is what makes each handwriting unique.

II. PROBLEM STATEMENT

Nearly 150 million Indians are in need of active interventions to help with their mental health problems out of which only 41% Indian youth are in favour of seeking support.
Due to the lack of user-friendly methods for analysing an individual's handwriting for psychological and psychiatric evaluation, the proposed system can be used to extract features from handwriting and use it to draw conclusions about a person's mental health status.

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III. LITERATURE SURVEY

The summary of some of the papers we referred to are shown below in tabular format.

PAPER NO.	TITLE	AUTHORS	PUBLICATIONS & YEAR	METHODOLOGY	RESULTS
[1]	Bi-modal emotion recognition from expressive face and body gestures	Hatice, Gunes, Massimo Piccardi	Journal of Network and Computer Applications 30, no. 4 (2007)	Firstly, individual classifiers are trained from individual modalities. Secondly, they merged *facial expression* & *affective body gesture data* at the feature and decision level.	2 modality emotion(6) classification achieved better recognition accuracy outperforming classification using individual facial/bodily modality alone.
[2]	Multimodal emotion recognition from expressive faces, body gestures and speech	Caridakis, George, Ginevra Castellano, Loic Kessous, Amaryllis Raouzaiou, Lori Malatesta, Stelios Asteriadis, and Kostas Karpouzis	In IFIP *International Conference on Artificial Intelligence Applications and Innovations*, pp. 375-388. Springer, Boston,MA(2007)	They trained and tested a model with *a Bayesian classifier*, using a *multimodal* corpus with 8 emotions and 10 subjects. First individual classifiers were trained for each modality. Then, data were fused at the feature and decision level.	It performed well by more than 10% with respect to the most successful unimodal system. Further, the fusion resulted at the feature level showed better results when compared to the decision level.
[3]	Artificial neural network for human behaviour prediction through handwriting analysis	Champa H N , and K R Ananda Kumar	International Journal of Computer Applications (2010)	They have used a method to predict a person's personality from the baseline, pen pressure & the letter as found in an individual's handwriting. Later, for the inputs, these parameters are utilized to the Artificial Neural Network which outputs the personality trait of the writer.	30 different o/p of ANN are 30 different personality traits of writer depending on the way he crosses the pressure with which he writes & baseline of his writing. Huge amount of data amounting from 30 different combinations of traits is analysed to predict personality traits.
[4]	Automatic Emotion Recognition through Handwriting Analysis: A Review	S.V. Kedar, D. S. Bormane, Aaditi Dhadwal, Shiwali Alone, Rashi Agarwal	International Conference on Computing Communication Control and Automation (2015)	Scanned handwritten sample is given as input which undergoes image pre-processing (Thresholding, noise removal, skew correction), then feature extraction takes place (features used are Slant, Baseline, Pen pressure, Size, Margin and Zone) and at last classification takes place to detect emotion.	It detects emotions which determine exact mental state of writer like depression, fear, anxiety, excitement etc. It would be helpful to find out if the writer is nerve-wrecked & if he's found to be so, then psychological treatment or support can be provided with the intention that they overcome it.
[5]	EMOTHAW: A novel database for emotional state recognition from handwriting and drawing	Likforman-Sulem, Laurence, Anna Esposito, Marcos Faundez-Zanuy, St´ephan Cl´emenc¸on and Gennaro Cordasco	IEEE Transactions on Human-Machine Systems 47, no. 2 (2017)	Database includes 129 participants samples whose emotional states, namely anxiety, depression, & stress, are assessed by DASS. 7 tasks are recorded through a digitizing tablet (includes writing & drawing). They first computed measurements related to timing and ductus & separate measurements according to the position of the writing device & analyse and classify this set of	It gave accuracy, sensitivity & specificity evaluation measures obtained from *cross-validation* experiments. The results show that anxiety & stress recognition perform better than depression recognition.

				measurements using a *random forest approach*. At Last, utilized ranking process to get the features which shows a well targeted emotional state.	
[6]	A Survey on Automatic Emotion Recognition Using Audio Big Data & Deep Learning Architectures	Zhao, Huijuan, Ning Ye, and Ruchuan Wang	In 2018 IEEE 4th International Conference on Big Data Security, HPSC & IDS (2018)	Speech Emotion Recognition Using *Neural Network (CNN)*, which uses *End-to-End Conception* to achieve End-to-end Emotion Recognition.	It reduced the feature engineering, especially the speech signal pre-processing, windowing, framing and feature extraction.
[7]	Sentiment Pen: Recognizing Emotional Context Based on Handwriting Features	Jiawen Han, George Chernyshov, Dingding Zheng, Peizhong Gao, Takuji Narumi, Katrin Wolf, Kai Kunze	ACM ISBN (2019)	Handwritten samples are collected from people who are made to watch certain video clips before writing and then Feature extraction is done. Support Vector Classifier is used to test whether there is any relation between the handwriting features and the self-reported emotional state of the participant recorded using the SAM.	For user dependent 4-class classifier, the classification accuracy is up to 70% for certain tasks. For user independent 4-class classifier, the classification accuracy is up to 66% for a certain writing task.
[8]	Handwriting Analysis for Mental Disorder Detection	Shreeyash Magar, Bhumika Marathe,Sunny Khambayat, Prem Mamadge	International Journal of Engineering Research & Technology, IJERT (2021)	The strategy to predict the accurate personality traits of a person from the features extracted from handwriting employing a ML approach (CNN & SVM). The features are going to be extracted from the handwriting samples into feature vectors which might be compared with an initially trained data set; then mapped to category with corresponding personality trait.	Administered to diagnose diseases like Alzheimer, Autism, Mild-Cognitive Impairment, Dysgraphia, Schizophrenia,Parkinson's. Mental disease supported digital handwriting analysis is reviewed. It's found that features associated with motion, time & pressure are helpful for diagnosis of health & mental diseases using handwriting analysis approach.
[9]	Mental Health Analysis Using Handwriting by Generating Writing Prompts	Manogna Pallapothu, Pragati Shinde, Vinish Marito	International Journal of creative research thoughts (IJCRT), (2021)	7 handwriting features are considered to predict if the writer has any of the 3 mental illnesses: Stress, Depression and Anxiety. The extracted features from handwritten text which will be then normalized, scaled and used to draw conclusions about a person's mental health. Further, 4 support vector machines will be used to classify the results derived from the mentioned algorithms.	The accuracy achieved by the SVM model over the test dataset is 98.58%.

Table 2.1: Summary of some related survey papers.

In paper **[10]**, the study is done to see whether graphological analysis is a reliable factor for identifying the symptoms of major depressive diseases. In graphology the handwriting of a person is studied to get some insights from it. According to the methodology used in this paper, 13 handwritten samples of people who are affected by major mental disorders are collected. Few participants are selected and divided into two groups such as: Clinical Sample and Control Group, and evaluation of agreement among graphologists and between the psychological assessment and the judges' ratings is done. Satisfactory results are found.

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In this paper **[11]**, the data collection of DASS is taken from 1771 participants, who are all adults. It involves the process of Statistical analysis to form some competitive models of DASS. These models are later parameterized as model 1a, 2a-2c and 3a-3d. Each of these models measure separate factors like anxiety, stress, etc. The resulting DASS scores are highly influential on Demographic variables. These are used in deriving an optimal DASS model, which is proven to be valid for most of the cases.
In paper **[12]**, the handwritten text is recognized using the concepts of deep learning. It classifies handwritten text to individual words, to convert the text into digital format. It uses two main methods to complete the task. In the first method, CNN training model is used to classify the words which are derived from handwritten text. In the second method Long-Short term memory networks are used with convolution to build boxes for each character present the word. These characters are then passed to the CNN classifier for classification. At last reconstruction and segmentation takes place.
The paper **[13],** gives insights about the outstanding performance of Convolutional Neural Network (CNN) in classification and also explains how they can be improved. Visualization technique is used to analyse the functions of different layers of the CNN classifier.
The paper **[14],** presents some of the best practices that document analysts can use to do research and get better output from neural networks. The approach followed in this paper is - first, the dataset is created by adding some distorted data to increase the size of the dataset. Second, CNN model is used.
In this paper **[15]**, it consists of the researches on 4 fields like software engineering, web customization, gaming and education. The main idea behind this is to collect all the possibilities of getting emotion recognition methodologies in all these fields. It has analysed every possible scenarios in each of these fields and as a result, gave an idea of the various methods of recognising emotions.

IV. METHODOLOGY

In this system, the handwritten text sample and psychological test results will be used to detect the emotional status of a person. There will be the following sections in the system. They are:

1) Emotion status detection using handwritten text input.
2) Emotion detection is done using psychological tests that provide standards of anxiety, stress and depression.

A. System Description

The proposed system's methodology or system flow diagram is shown in figure 1. In the first step, a handwritten sample and DASS scale result of the writer will be provided as input to the system. We are taking DASS, because we are mainly focusing on the negative traits. Emotion database will be formed using the DASS result of the writer. Then the input image will undergo pre-processing which involves resizing of image and normalisation. In the next step, the convolutional neural network will be used to train the dataset and then testing takes place. Lastly, a new input sample will be provided to predict the emotion based on the trained model, which will test this input sample and give the result as depression, anxiety, stress or normal.

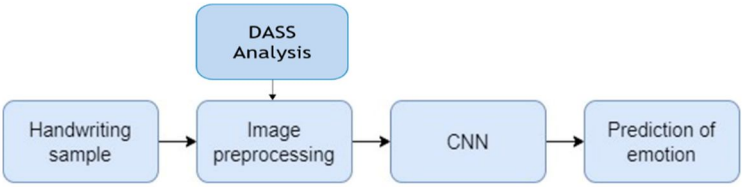


Fig 3.1: System flow diagram

V. CONCLUSION

In this paper, the main focus is the use of CNN algorithm for identifying negative emotional traits of a person using his/her handwritten text sample and psychological test results. Since, this paper uses the CNN model for feature extraction and classification of samples to different classes of emotion, it is expected to reduce the training time of the system compared to the previous methods used.

VI. FUTURE SCOPE

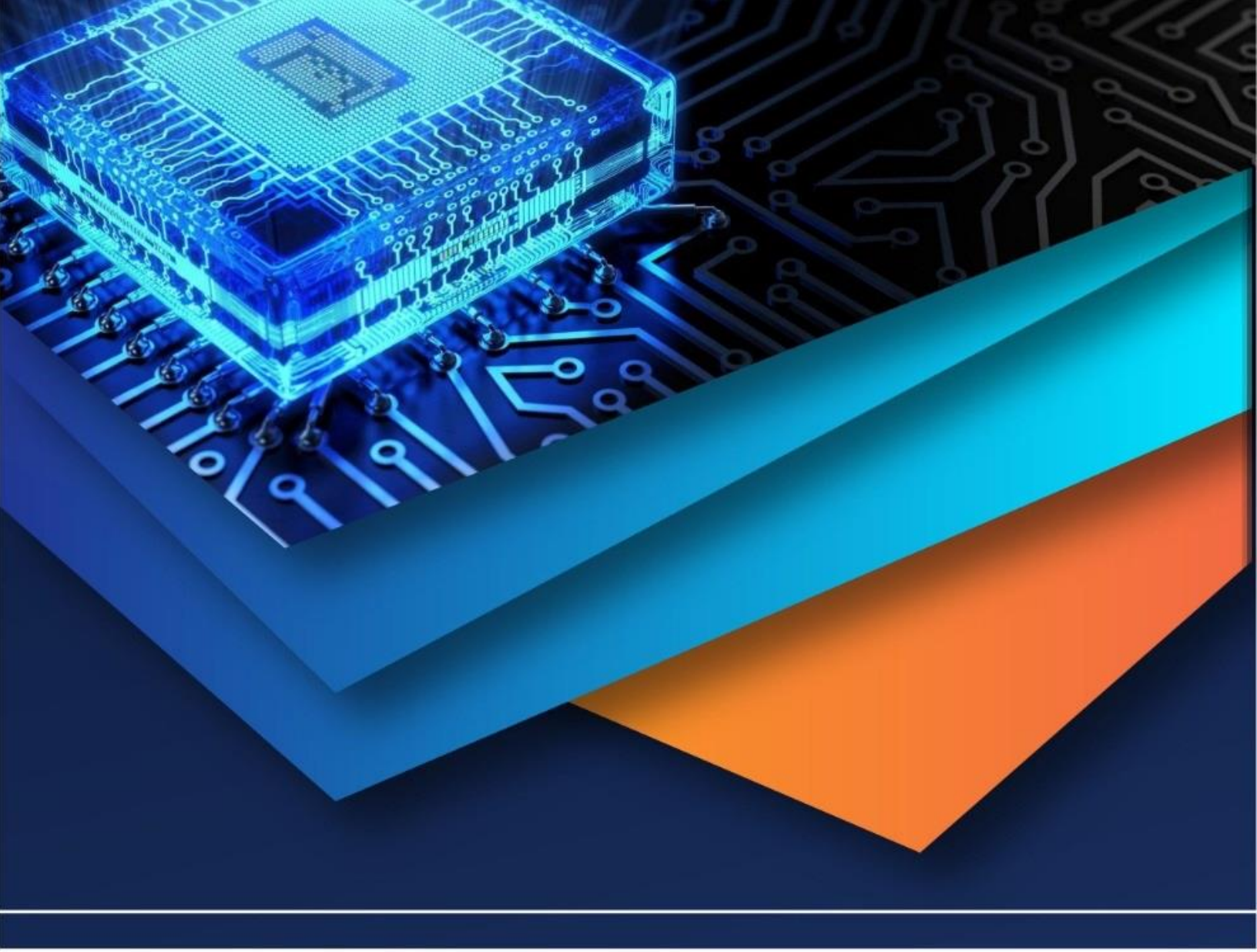
The proposed system:

1) Can be extended to work as a language independent assistance.
2) Can be improved by increasing the accuracy of the system by reducing the possible errors.
3) Can be expanded to work on both online and offline samples.

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