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HANDWRITTEN CHARACTER RECOGNITION IN DEEP LEARNING

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Abstract: *There are many things that humans have in common, yet there are other things that are very unique to every individual and one of them is handwriting. As computerization is becoming more prominent these days, Handwriting Recognition is gaining importance in various fields. The major focus is to make the system understand the handwriting and convert it into readable text format. Deep learning, an ability of Artificial Intelligence (AI), is used for the system to learn the input automatically and convert the handwritten text to printed text. This project proposes a method for Handwritten Character Recognition (HCR) using Convolutional Neural Networks (CNN) with Graphical User Interface (GUI). The Proposed system could have potential applications that can improve efficiency, accuracy and productivity in various domains such as Education, Forms Processing, Banking's, etc.*

Keywords: *Machine Learning, Convolutional Neural Networks, Deep Learning*

I. INTRODUCTION

Handwriting recognition is the ability of a machine to receive and interpret handwritten input from multiple sources like paper documents, photographs, touch screen devices etc. Recognition of handwritten and machine characters is an emerging area of research and finds extensive applications in banks, offices and industries. The main aim of this project is to design expert system for, "HCR using Neural Network" that can effectively recognize a particular character of type format using the Convolutional Neural Network approach. Neural computing Is comparatively new field, and

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design components are therefore less well specified than those of other architectures. Neural computer is trained (not Programmed) so that given a certain starting state (data input); they either classify the input data into one of the number of classes or cause the original data to evolve in such a way that a certain desirable property is optimized [1].

Despite the provision of digital writing instruments, many obligations that include filling out form bank related plates are still preferred as pens paper. This cannot be considered a technical issue but rather the convenience of users on keyboard, mouse and touch screens.

Despite the availability of digital writing tools, many tasks such as filling the form for Bank related work are still preferred as pen paper. Obtaining customer credentials is entirely dependent on paper and pencil, but at the same time, it is very difficult to memorize them and access the actual files properly. In addition, manually accessing a person's credentials to the database presents the risk that sensitive data may not be converted to numeric data or that the manual entry of statistics into the device may be erroneous. Therefore, garage, access and recovery can be made virtual, without having to store the physical copy of the document. This system can find effective answers using deep learning technology. Individual Handwritten Reputation is the technology of recognizing handwritten text and then inserting it onto the male or female Reputation copy as a digital translation of the images [2]. This technique can be demonstrated by using convolutional neural network (CNN) image processing and then storing the image content in the database in a device-editable text-content layout, using Python libraries. Convolutional neural networks are generally used in the field of sample pattern recognition and are similar to ANNs. CNN contains neurons that have the ability to optimize themselves across the domain, that is, they take an initial input vector and perform operations to obtain a final classification result for the class.

Convolutional neural network

Architecture of CNN is well suited for 2D data and it uses 2D convolutional layers to process data such as images. Convolutional layer is the key building block of CNN. According to Alexander Del Toro Barba, the ConvNets are computationally efficient than the machine learning algorithms and have the ability to handle unstructured data, thus have

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successfully evolved in areas such as image recognition.

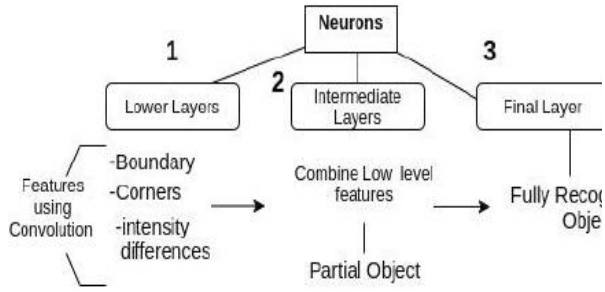

Fig.1 Feature Extraction in Neurons

Matrix multiplication with different sections using randomly generated matrices (Kernels) is done to find a good feature. If good feature is not found, the algorithm backpropagates for improvement. Using this improving algorithm, the machine self-learns[3].

PURPOSE

The purpose of this project is to take handwritten English characters as well as Digits as input, process the character, train the neural network algorithm, to recognize the pattern and modify the character to a beautified version of the input.

This project is aimed at developing software which will be helpful in recognizing characters of English Language and Digits. It can be further developed to recognize the characters of different languages as well as Sentences.

II. LITERATURE SURVEY

Literature was reviewed from various sources, like from research papers, publications books, existing bibliographic information, and recommendations by the project panel. These research papers have provided us sufficient amount of data for the survey.

Introduction of the optical character recognition and knowing the advantages of this technology gave rise to the conduction of experiments with OCR. The second generation of IBM OCR was used to recognize numerals back then in the 1960s. Upgrading the generations, further research was carried out in 1975-1980, for OCR to operate on large hand-written data sets with poor print quality than before. Online character recognition used to put some restrictions on the orders and number of strokes for Japanese characters. This disadvantage was overcome in the offline methodology for Japanese character recognition, which used nonlinear shape normalization. In the year 1999, recognition was performed as a combination of online and offline character recognition where bitmap image was used as an input for offline method thus achieving a 73 percent recognition rate. Further, the use of the Hidden Markov Model (HMM) in the recognition

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systems was encouraged to upgrade the recognition rate for offline character recognition. Algorithms such as image segmentation and recognition in union with the HMM suggested optimization of word recognition problems.

In [4] It is a leading journal in the field of document analysis and recognition. The journal is dedicated to the publication of high-quality research on all aspects of document analysis and recognition, including handwritten character recognition. The journal covers topics such as optical character recognition, handwritten text recognition, handwriting analysis, and document image analysis.

In [5] the authors argue that combining multiple feature extraction techniques can provide more robust and accurate representations of the handwritten characters, which can lead to improved recognition performance. The paper compares the performance of the proposed method with traditional feature extraction methods, such as PCA (Principal Component Analysis), and with state-of-the-art machine learning algorithms, such as SVM (Support Vector Machines). The performance of the proposed method is evaluated on benchmark datasets for HCR, and the results are compared to those of other methods. The paper also provides insights into the factors that affect the performance of the proposed method, such as the number of features extracted and the type of classification algorithm used.

In [6] The paper also discusses the various challenges that researchers have faced in developing effective handwritten digit recognition systems, including issues related to variability in handwriting style, variability in image resolution and quality, and variability in the size and orientation of digits. In addition to discussing the latest research in the field, the paper also provides an overview of some of the most widely used benchmark datasets for evaluating handwritten digit recognition systems, such as MNIST and NIST.

In [7] It is a research paper that compares the performance of various handwritten character recognition techniques. The techniques compared in the paper include traditional methods such as HOG (Histogram of Oriented Gradients) and SVM (Support Vector Machines), as well as more recent approaches such as deep learning. The paper evaluates the performance of each of these techniques on a number of benchmark datasets and compares the accuracy of each method in terms of recognition rate and computational efficiency. The paper also discusses the advantages and

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disadvantages of each method, and provides insights into the factors that affect the performance of handwritten character recognition systems.

III. PROPOSED SYSTEM

Recognition of Handwritten text has been one of the active and challenging areas of research in the field of image processing and pattern recognition.

In the proposed System we have used CNN which improves recognition rate. We use Character extraction and CNN Algorithm which is a type of ANN for training the neural network to classify and recognize the handwritten characters.

We train Convolutional Neural Networks (CNN) that can make predictions for edges directly from image patches.

Compared to other ANNs, such as Multi-layer Perceptron (MLP) networks or Recurrent Neural Networks (RNNs), CNNs have several advantages for HCR

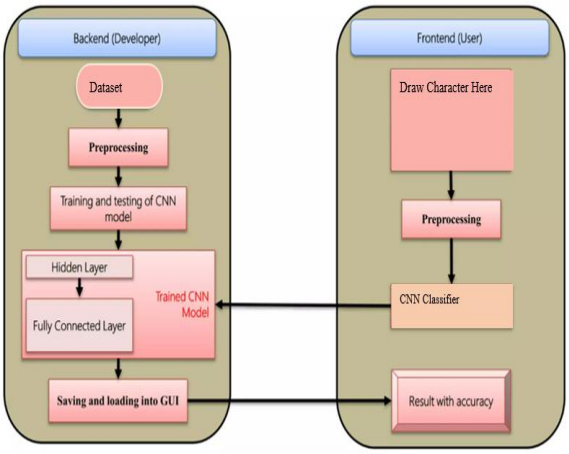

Fig.2 System architecture

In Software Architecture, Implementation of the system is divided into 2 parts:

CNN Model:

It is the main part of the system which is present in the backend of the system. By this system can classify the character.

GUI Window:

UI window is the main part of the frontend of the system. By which this user can draw the character on it, which is taken as a input to the system which will further go for classification as well as recognition to CNN.

The following are the Modules and the Methods Included in the System.

1.USER

2.RECOGNITION ENGINE

- Pre-Processing
- Segmentation

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- Feature Extraction

3. TEXT GENERATOR

- Classification and Recognition

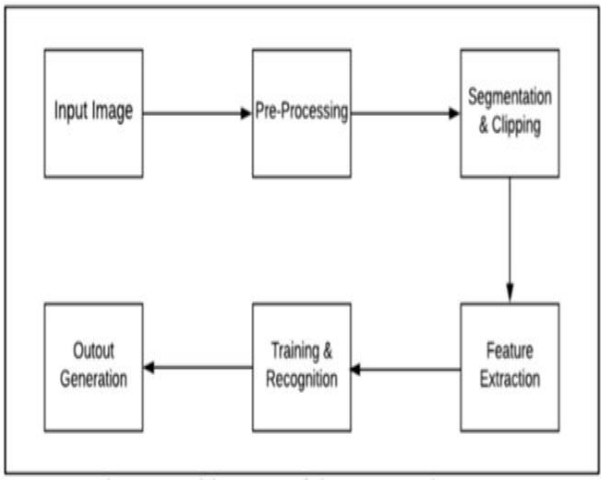

Fig.3 Classification and recognition

1.**USER**: User Gives the Input as a character and sends to the Recognition Engine for further processing.

2.**RECOGNITION ENGINE**

Recognition engine is a critical component of a Handwritten Character Recognition (HCR) system, as it is responsible for actually recognizing the characters in the input image.

In Character Recognition Module, the character is been recognized with some techniques or methods, The Methods include:

• **Image Pre-processing**: The image is pre-processed using different image processing algorithms like Inverting image, Gray Scale Conversion and image thinning.

• **Segmentation:** After pre-processing of the image segmentation is done. The goal of segmentation is to separate individual characters from a handwritten text image and isolate each character for recognition.

This method uses deep learning techniques, such as Convolutional Neural Networks (CNNs), to segment the characters in the image. The CNN is trained on a large dataset of character images and their corresponding masks, and it can then be used to predict the masks for new images, allowing individual characters to be isolated.

• **Feature Extraction:** Feature extraction is a key step in Handwritten Character Recognition (HCR) systems, as it involves transforming the raw pixel values of an image into a set of meaningful features that can be used for recognition. These features should capture the unique characteristics of the characters in the image and represent them in a way that allows them to be distinguished from one another Classification. The CNN is trained on a large dataset of character images and their corresponding labels, and it can then be used to extract features from new images that can be used for recognition

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3. TEXT GENERATOR: The text generator module in HCR systems is a component that generates text from the recognized characters.

Classification is the process of assigning a recognized character to a specific class or category, such as the alphabet, numbers. This is typically done by comparing the features of the recognized character to a set of predefined templates or reference images, and choosing the closest match.

Recognition, on the other hand, is the process of identifying the specific character from the set of predefined classes or categories. This is typically done using machine learning techniques.

CNN (Convolution Neural Network)

Convolutional Neural Network Technique is basically neural network systems that utilize convolution instead of general network systems with similar number of layers. Convolutional Neural Networks (CNNs) are commonly used in image recognition tasks, including handwritten character recognition.

The basic idea behind a CNN for handwritten character recognition is to apply multiple filters to the input image to extract relevant features, such as edges and corners. These features are then passed through multiple layers of the network to learn higher-level representations. Finally, a fully connected layer is used to map the features to the output classes (e.g., the different characters).

In a typical CNN architecture for handwritten character recognition, the input image is first passed through a series of convolutional and pooling layers to extract features. These features are then flattened and passed through a series of fully connected layers to make the final prediction.

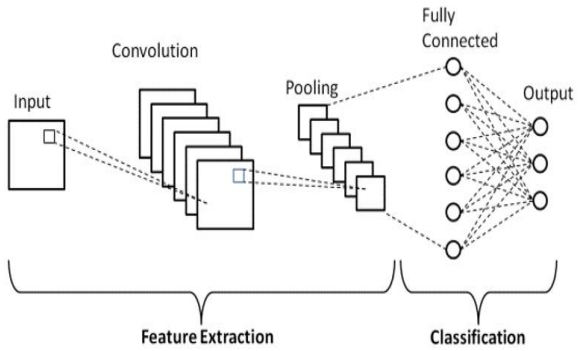

Fig.4 The CNN layer

The Layers present in the CNN are;

- Input Layer
- Convolution Layer
- Pooling Layer
- Fully Connected Layer

Input Layer:

The input layer is responsible for accepting the input image of a handwritten character. The input layer is typically represented as

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a 2-dimensional array, where each element of the array represents the intensity value of a pixel in the image.

The input layer can be thought of as the first layer of the CNN, and the shape of the input layer defines the shape of the input image. For example, if the input image is 28x28 pixels, then the input layer will have 28x28=784 neurons, one for each pixel

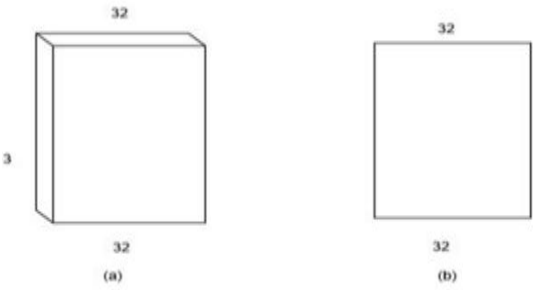

Fig.5 Input Layer

Convolution Layer:

The purpose of the convolution layer is to extract meaningful features from the input image. In a convolution layer, a set of filters (also known as kernels or feature detectors) are convolved with the input image to produce a set of feature maps. Each filter is a small matrix that slides across the input image and performs element-wise multiplications and summations to produce a new feature map. The filters in a convolution layer can be thought of as detecting different patterns in the input image, such as edges, corners, and textures.

Pooling Layer:

The location of Pooling layers is between convolutional layers in a convolutional architecture. Pooling layers reduce the quantity of components when the images are excessively large. Pooling layers are used to reduce the dimensions of the feature maps. Thus, it reduces the number of parameters to learn and the amount of computation performed in the network.

Fully Connected Layer:

The layer identified as FC layer is the last layer of the neural network system. A fully connected layer that utilizes the output from the convolution process and predicts the class of the image based on the features extracted in previous stages. In this stage, the classification process begins to take place. Once the Network is trained, the match pattern is obtained to generate the associated Character

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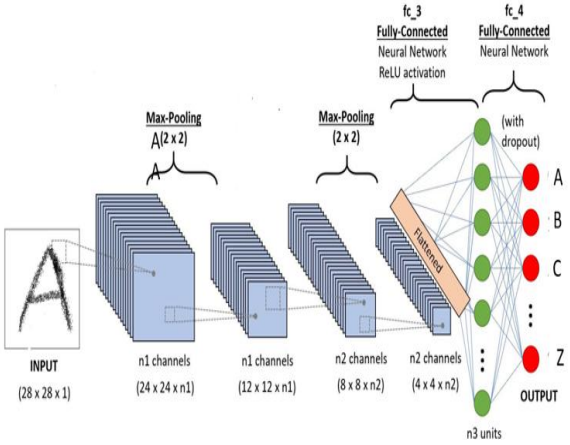

Fig.6 Fully connected layer

IV. RESULTS

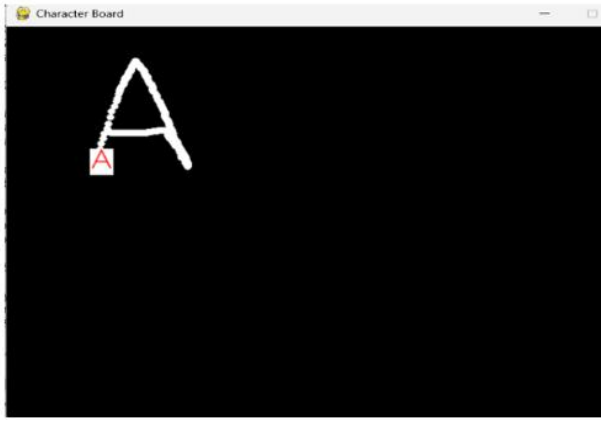

Fig.7-character board with Letter A

Fig.8 Character board with letter 5

Fig.9 Character board with various characters

V. CONCLUSION

In conclusion, handwritten character recognition using CNNs is a challenging task that has been successfully addressed by machine learning techniques. With the availability of large datasets and powerful computing resources, deep learning models such as CNNs have achieved state-of-the-art performance on various benchmarks. Scanned image is pre-processed to get a cleaned image and the characters are isolated into individual characters. Pre-processing work is done in which normalization, filtration is performed using processing steps which produce noise free and clean output. Managing our evolution algorithm with proper training, evaluation other step wise process will lead to successful output of system with better efficiency. While the

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technology has come a long way in recent years, there is still room for improvement in terms of the accuracy and robustness of the models. Use of some statistical features and geometric features through neural network will provide better recognition result of Different languages as well as in recognizing sentences. This work will be helpful to the researchers for the work towards other script.

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