HAND-WRITTEN CHARACTER RECOGNITION

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ABSTRACT

Handwritten character recognition is a technique for reading handwritten text using a machine interface. The form, size, and location of handwritten characters vary from one writer to the next, posing difficulties even when the same author uses the same character. In the realm of image processing, handwritten character recognition has proven to be one of the most difficult problems to solve. Bank checks and the conversion of any handwritten document into digital text form are only two of its many uses. There is a clear requirement to store information from handwritten images on desktop storage so that it can be processed again by computers in the future. Nevertheless, reading the other data from these image files would be exceedingly challenging to re-process this information. Consequently, a method to automatically decode and store data from image files is required, especially text. This study tries to categorise a single handwritten word in order to convert handwritten material for English alphabets into a typed or editable form. For this challenge, we employed Convolutional Neural Networks. We developed a model that can correctly anticipate words using this architecture. According to trends, the market value for these applications will rise tremendously in the future.

1 INTRODUCTION

The goal of this software algorithm project, "Handwritten Character Recognition," is to accurately recognise any handwritten character on a computer with input from a mouse, pen, or an old optical image.

Character recognition—often reduced to OCR or optical character recognition—is the mechanical or electronic conversion of images of handwritten, typewritten, or printed text into text that may be edited by computers. This area of study focuses on machine learning, artificial intelligence, and pattern recognition. Although academic research in the area is still being done, the emphasis on character recognition has switched to the use of tried-and-true methods. A computer can learn, comprehend, improvise, and interpret written or printed characters using a technique called optical character recognition. own language, but display in accordance with the user's specifications. Optical Character Recognition employs an image processing technology to recognise any character that has been manually or mechanically typed or printed. In this field, a lot of work has been done. However because algorithms need to have higher recognition accuracy, more persistency in the amount of right predictions, and longer execution durations, OCR approaches are constantly being improved.

Creating effective algorithms that accept input in digital image format is the idea. The image is then processed for better comparisons. The processed image is then compared to a library of font images that are already on hand. The character's forecast is presented in the final stage as a percentage of accuracy.

even though we Despite the availability of numerous typing and writing technologies, many people still use paper and a pen to record information they gather. Because this type of information is difficult to access, store, and share with others, this project aids in the conversion of handwritten data into text formats that can be quickly stored on any physical device or in the cloud and accessed whenever necessary.

2. LITERATURE SURVEY AND RELATED WORK

Offline Handwritten English Numerals Recognition using Correlation Method [1]

In contrast to other efforts, the author's suggested approach in this paper is more accurate and efficient at recognising offline handwritten numbers. Moreover, earlier handwritten number recognition systems only recognised single digits and were unable to recognise several numbers simultaneously. In order to isolate the digits, the author has concentrated on conducting segmentation efficiently.

Devnagiri Character Recognition Using Neural Networks [2]

The construction of an autonomous offline character recognition system is proposed using neural networks. Over 71 million people speak Devnagari, an Indo-Aryan language, primarily in the Indian state of Maharashtra and its bordering states. For Indian languages like Hindi, Kannada, Tamil, Bangla, Malayalam, and others, there is a tonne of work available, but for devnagari, there is virtually any, especially in the area of character identification. In this study, work on multilayer perceptrons with hidden layers for character recognition in Devnagari is presented. In the matrix (n*n), different character patterns are formed using binary form and saved in the file. For effective recognition, we used back propagation neural networks, and corrected neuron values were conveyed by feed-forward neural network technique.

Intelligent Systems for Off-Line Handwritten Character Recognition: A Review [3]

There is a high demand for optical character identification on handwritten papers, and handwritten character recognition is always a frontier area of research in the fields of pattern recognition and image processing. This study offers a thorough analysis of recent soft computing-based handwritten character recognition research from the last ten years.

Fuzzy Based Handwritten Character Recognition System [4]

In this study, a fuzzy technique to character recognition is presented. For the representation of fuzzy characters as well as for recognition, fuzzy sets and fuzzy logic are utilised as the foundation. In this study, a fuzzy based method is described. It first segments the character, uses a fuzzy system to suggest probable characters that fit the input, and then uses a defuzzication system to recognise the character.

An Overview of Character Recognition Focused on Off-Line Hand- writing [5]

Character recognition (CR) has undergone substantial research over the past 50 years and has advanced to the point where it can support technological applications. Today, the fast expanding processing power makes it possible to execute the current CR approaches and increases demand for more sophisticated methodologies from many burgeoning application sectors.

A Recognition System For Handwritten Gurumukhi Characters[6]

This study uses statistical data like zone density, projection histograms, and 8-directional zone density features in conjunction with geometric features like area, perimeter, eccentricity, etc. to depict the Handwritten Gurmukhi Character Detection system. The visual document is initially pre-processed using a variety of methods, such as binarization or phological operations (erosion and dilation) used to eliminate noise, before being segmented into isolated characters. With these features and a back propagation classifier, the greatest accuracy attained is 98%.

IMPLEMENTATION STUDY

Data collection is the first stage in building a machine learning model.

- Your data's quantity and quality determine how accurate our model is.
- Utilizing pre-collected data, such as datasets from Kaggle, UCI, etc., still fits into this stage. The conclusion of this step is typically a representation of data (Guo simplifies to specifying a table), which we will use for training.

Preparation of Data

- Gather information and prepare it for training • Clean up anything that could need it (remove duplicates, correct errors, deal with missing values, normalization, data type conversions, etc.)
- Visualize data to assist identify relevant correlations between variables, class imbalances (bias alert!), or carry out other tasks. • Randomize data, which eliminates the impacts of the specific sequence in which we acquired and/or otherwise prepared our data. exploratory analysis, with training and evaluation sets separately created

Choose a model.
• Various algorithms exist for various tasks; select the appropriate one.

Develop the Model

• The objective of training is to provide an accurate response or prediction as frequently as feasible.
The method would need to learn values for m (or W) and b (x is input, y is output) in a linear regression example. Each iteration of the process is a training phase.
Review the Model

Tests the model against previously unknown data, which is intended to be somewhat reflective of the performance of the model in the actual world but still aids in fine-tuning the model. • Uses some metric or set of metrics to "measure" objective performance of the model (as opposed to test data, which does not)
• A good train/evaluation split? 80/20, 70/30, or a comparable ratio, depending
Domain, data accessibility, specifics of the dataset, etc.

Setting parameters

This stage deals with hyperparameter tweaking, which is more of a "artform" than a science.
• Improve model performance by adjusting the parameters.
• Examples of simple model hyperparameters include initialization values and distribution, learning rate, and the number of training iterations.

Predictive Analysis
• Additional (test set) data that have previously been hidden from the model (and for which class labels are known) are utilised to test the model, providing a more accurate representation of how the model will behave in practise.
Loading The Data Set:
Modified A sizable collection of computer vision data from the National Institute of Standards and Technology (IAM) is widely used for developing and evaluating various systems. The I am dataset, which contains binary pictures of handwritten text, served as the basis for its creation. 250 participants contributed their handwriting to the training set, of which 50% were Census Bureau officials and the remaining 40% were high school students. Nonetheless, it is sometimes claimed that this dataset was the first among others to demonstrate the viability of neural networks. Any recognition process benefits from data pre-processing. Data preprocessing is a data mining technique used to turn the raw data into a format that is both practical and effective. To modify the source images in It uses a form that is appropriate for segmentation pre-processing. Before creating a model using these attributes, data preparation is required. Often, it takes place in phases.

- Data quality assessment
- Data cleaning
- Data transformation
- Data reduction

CONVOLUTIONAL NEURAL NETWORK

In plainer terms, CNN is an artificial neural network that excels in identifying and deciphering patterns. CNN has so proven to be most helpful for picture classification. A CNN model uses a variety of filters with variable numbers and sizes. The main thing that aids us in finding the pattern is these filters. Although they may be utilised with one-dimensional and three-dimensional data, convolutional neural networks, or CNNs for short, are a specialised kind of neural network model created for working with two-dimensional picture data.

3 PROPOSED WORK AND ALGORITHM

The recommended and proposed system can identify any learned items using the model created after training and the data sets we have already created (or those we create ourselves). Data sets are typically available online, where we can use them and perform any function on them according to our needs.

The system will be created in a way to guarantee offline Handwritten English Character Recognition.

We can restore our venerable and epic HCR literature in digital format.

Neural networks are used for classification.

A large number of training data sets will increase the suggested approach's effectiveness.

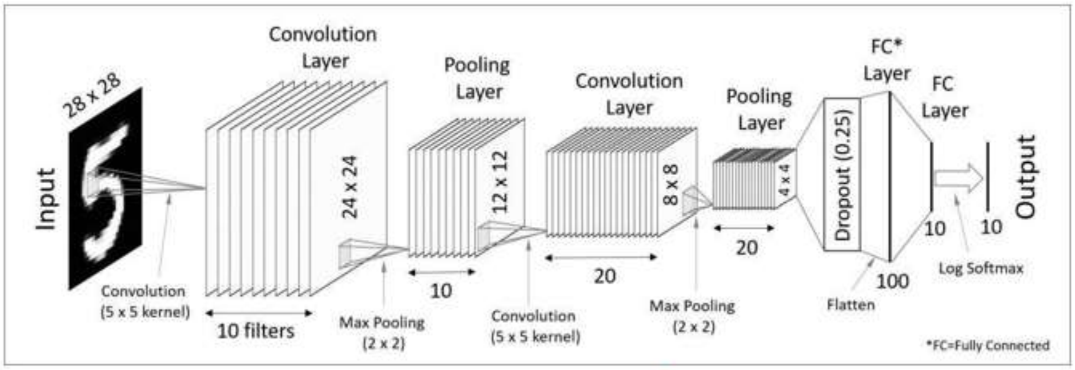


Fig: CNN Architecture For Handwritten Digit Recognition

4 In plainer terms, CNN is an artificial neural network that excels in identifying and deciphering patterns. CNN has so proven to be most helpful for picture classification. A CNN model uses a variety of filters with variable numbers and sizes. The main thing that aids us in finding the pattern is these filters. Although they may be utilised with one-dimensional and three-dimensional data, convolutional neural networks, or CNNs for short, are a specialised kind of neural network model created for working with two-dimensional picture data.

5 The convolutional layer, which gives the network its name, is at the core of a convolutional neural network. Convolution is an operation carried out by this layer.

6 Convolutional and pooling layers are the most common components of CNN models. It performs better. for data that are visualised as grid layouts; this explains why CNN performs effectively for issues involving image classification. When training, the dropout layer minimises offer fitting of the model by deactivating part of the neurons.

7 Artificial neurons are arranged in numerous layers to form convolutional neural networks. Artificial neurons are mathematical functions that compute the weighted sum of several inputs and output an activation value, roughly imitating their biological counterparts.

8 METHODOLOGIES

Methods for recognising handwritten characters

IAM, which consists of 70,000 handwritten raster images from 250 various sources, served as our main dataset for training the model. Of these, 60,000 were used for training, and the remaining 15,000 were used for training validation. Preprocessing, Model Building, Training & Validation, Model Assessment & Prediction are the primary stages of our suggested methodology.

Bring the libraries in:

Matplot, Pytesseract, Numpy, Torch, and OpenCv libraries are necessary.

Matplotlib:

A Python visualisation library for 2D visualisations of arrays is called Matplotlib. A multi-platform data visualisation framework called Matplotlib was created to interact with the entire SciPy stack and is based on NumPy arrays. There are numerous plots in Matplotlib, including line, bar, scatter, histogram, etc. A variety of hardcopy formats and publication-quality figures are produced with Matplotlib. ecosystems that are interactive across platforms. Python scripts, Python/IPython shells, web application servers, and a number of graphical user interface toolkits can all make use of Matplotlib.

pytesseract:

An Python-tesseract is a tool for optical character recognition (OCR). To put it another way, it will recognise and "read" any text that is present in images.

Python-tesseract is used to encase Google's Tesseract-OCR Engine. It is useful as a standalone invocation script to tesseract since it can read any image type supported by the Pillow and Leptonica imaging libraries, including jpeg, png, gif, bmp, tiff, and others. Moreover, when used as a script, Python-tesseract will print the recognised text rather than saving it to a file.In addition to mobile devices and large-scale distributed systems with hundreds of machines, there are CPU and GPU systems.

Numpy*:*

The cornerstone Python module for scientific computing is called Numpy.

The features it offers include a strong N-dimensional array object and sophisticated (broadcasting) functions.

- practical knowledge of linear algebra, the Fourier transform, and random numbers

Torch: The Python library PyTorch offers the following two high-level features:

- Tensor computing with robust GPU acceleration (like NumPy)
- Deep neural networks based on an automatic grading system with tape

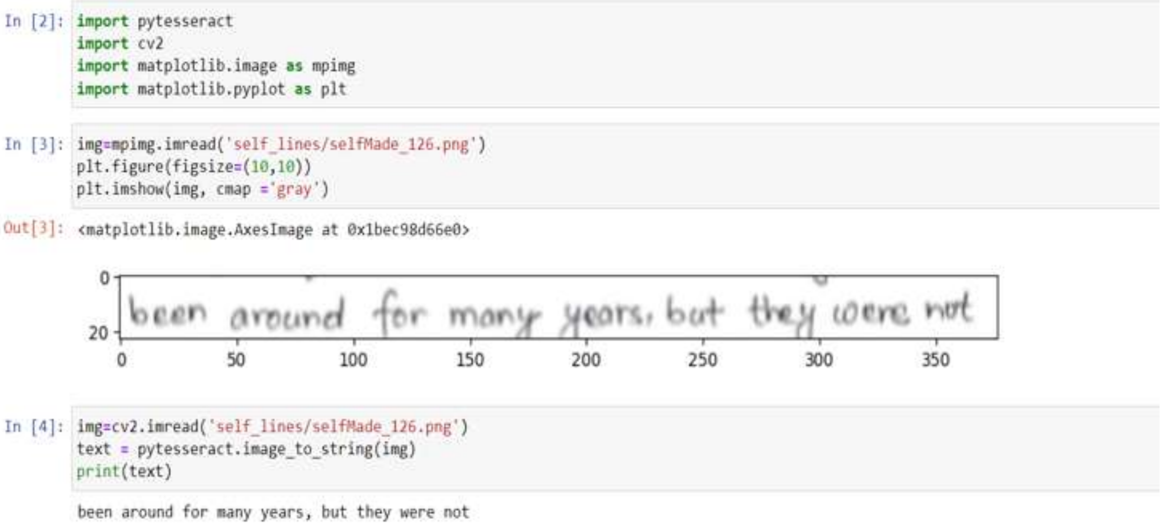
When necessary, you can utilise your preferred Python packages, such as NumPy, SciPy, and Cython, to expand PyTorch. Using a tape recorder and playing back recordings, PyTorch has a novel method for creating neural networks. Reverse-mode auto-differentiation is a PyTorch approach that enables you to alter the behaviour of your network at will and without any lag or extra processing time.

OpenCV: A collection of Python bindings called OpenCV-Python was created to fix issues with computer vision.

An image is loaded using the cv2.imread() method from the given file. This method produces an empty matrix if the picture cannot be read (due to a missing file, poor permissions, an unsupported or invalid format, etc.).

A sizable open-source library for image processing, machine learning, and computer vision is called OpenCV. Python, C++, Java, and many other programming languages are supported by OpenCV. It can analyse pictures and movies to find faces, objects, and even human handwriting. The amount of weapons in your arsenal rises when it is integrated with different libraries, such as Numpy, which is a highly optimised library for numerical operations. All operations that can be performed with Numpy can be combined with OpenCV.

RESULTS AND DISCUSSION SCREENSHOTS



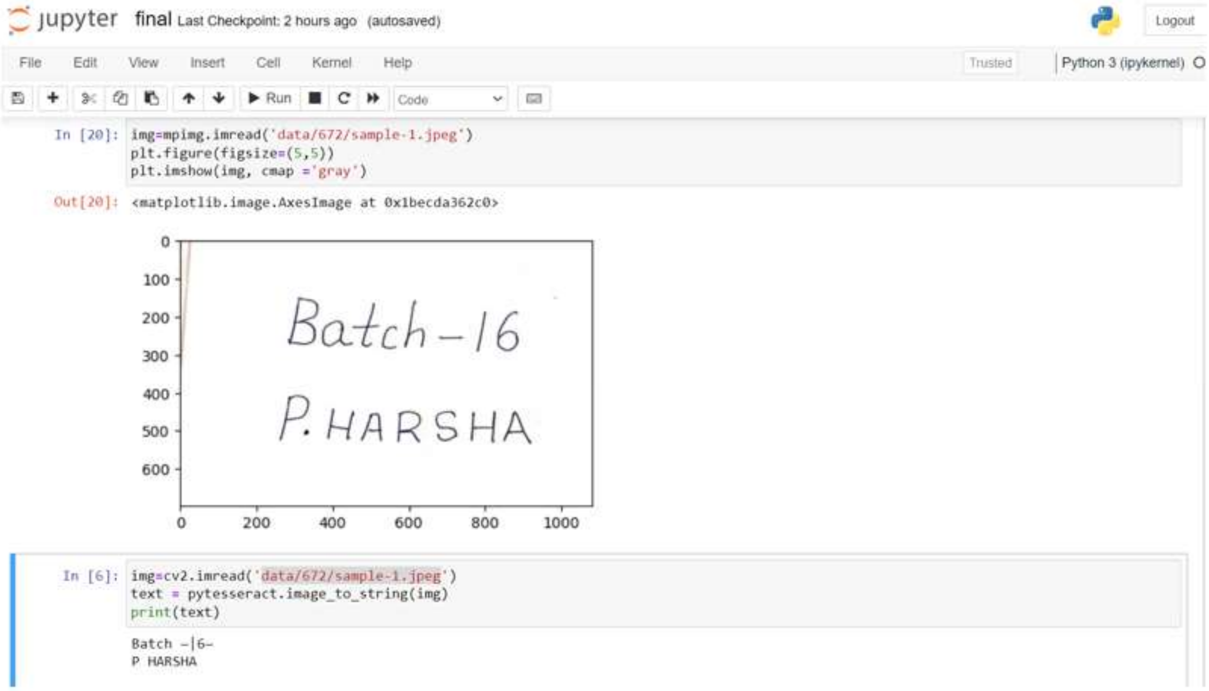
```
In [2]: import pytesseract
        import cv2
        import matplotlib.image as mpimg
        import matplotlib.pyplot as plt

In [3]: img=mpimg.imread('self_lines/selfMade_126.png')
        plt.figure(figsize=(10,10))
        plt.imshow(img, cmap ='gray')

Out[3]: <matplotlib.image.AxesImage at 0x1bec98d66e0>
```

```
In [4]: img=cv2.imread('self_lines/selfMade_126.png')
        text = pytesseract.image_to_string(img)
        print(text)

        been around for many years, but they were not
```



```
In [20]: img=mpimg.imread('data/672/sample-1.jpeg')
         plt.figure(figsize=(5,5))
         plt.imshow(img, cmap ='gray')

Out[20]: <matplotlib.image.AxesImage at 0x1becda362c0>
```

```
In [6]:  img=cv2.imread('data/672/sample-1.jpeg')
         text = pytesseract.image_to_string(img)
         print(text)

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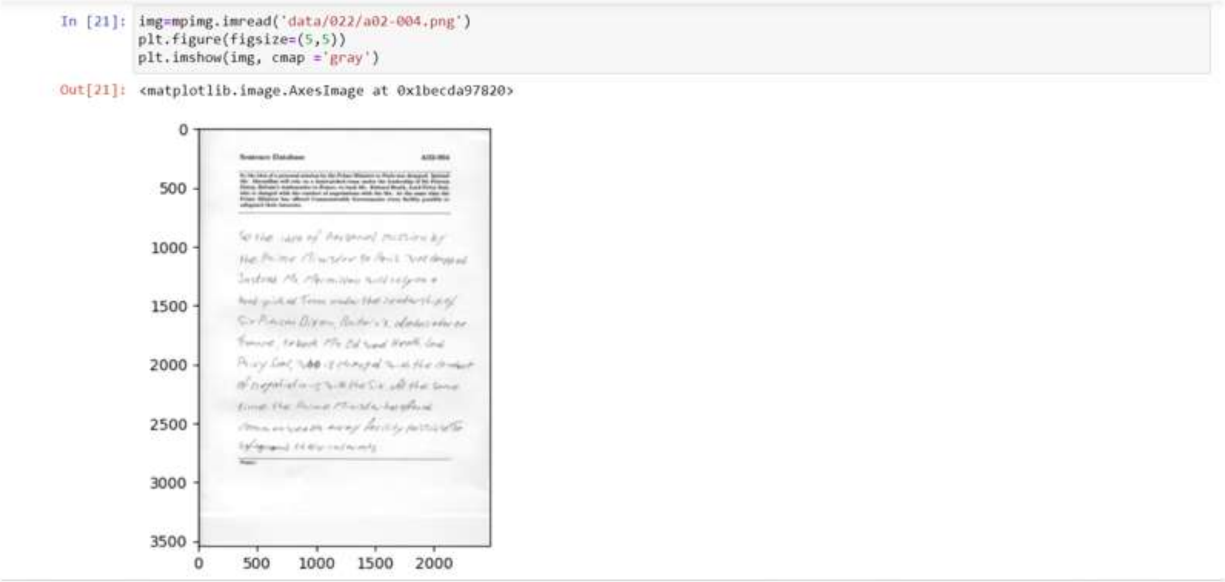
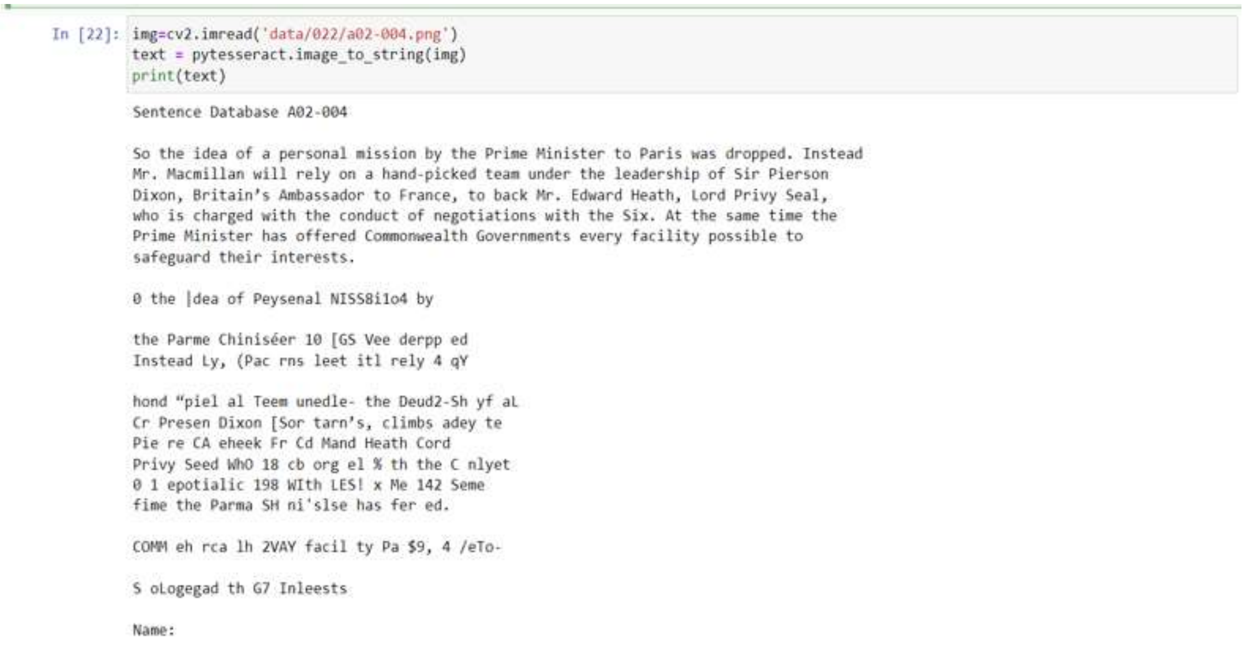


```
In [21]: img=mpimg.imread('data/022/a02-004.png')
         plt.figure(figsize=(5,5))
         plt.imshow(img, cmap ='gray')

Out[21]: <matplotlib.image.AxesImage at 0x1becda97820>
```



```
In [22]: img=cv2.imread('data/022/a02-004.png')
         text = pytesseract.image_to_string(img)
         print(text)

         Sentence Database A02-004

         So the idea of a personal mission by the Prime Minister to Paris was dropped. Instead
         Mr. Macmillan will rely on a hand-picked team under the leadership of Sir Pierson
         Dixon, Britain's Ambassador to France, to back Mr. Edward Heath, Lord Privy Seal,
         who is charged with the conduct of negotiations with the Six. At the same time the
         Prime Minister has offered Commonwealth Governments every facility possible to
         safeguard their interests.

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6. CONCLUSION AND FUTURE WORK

Conclusion

Many regional languages spoken around the world have distinctive writing styles that can be identified by HCR systems when the right algorithms and tactics are used. English character recognition is something we can learn. Because of the presence of strange characters or similarities in shape between several characters, it has been discovered that it is difficult to recognise handwritten characters. The characters are separated into distinct characters once the scanned image has been cleaned up through pre-processing.

Normalization and filtration are carried out during the preprocessing stage employing processing processes that result in noise-free and clear output. Our evolution algorithm can be managed with the right training, evaluation, and other step-by-step procedures, which will result in a successful system output with increased efficiency. utilising various statistical and geometrical aspects English character recognition will be improved via neural networks. The researchers' work on other scripts will benefit from this effort.

Future Plans

The character recognition for additional languages was a further extension of this work. It can be used to transform faxes and printed news articles into text. We can utilise many ANNs for categorization to identify words, phrases, or paragraphs. It can be used to read postal addresses in post offices.

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13. Sung-Bae Cho, "*Neural-Network Classifiers for Recognizing Totally Unconstrained Handwritten Numerals*", IEEE Transactions on Neural Networks, Vol. 8, No. 1, January 1997
14. N. Tripathy and U. Pal, "Handwriting *Segmentation of Unconstrained Oriya Text*"