

**DE‑PARTMENT OF SCHOOL OF COMPUTER SCIENCE**

A PROJECT REPORT ON

“REAL TIME HANDWRITTEN RECOGNITION”

**Under the Guidance of**

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**CERTIFICATE**

This is to certify that Mr. Vishal Singh, Mr. Sudhanshu Sakhala , Mr. Tushar Bhansali , Mr. Aditya Vazarkar and Ms. Samiksha Gawande student of class FYMCA (science) has satisfactorily carried out his

project work on

“Real Time Handwritten Recognition”.

under the guidance of

Dr. C.H. Patil.

For the academic year 2022-23.

**Project Guide** **Class In-Charge**

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**ABSTRACT**

A machine receives and deciphers handwriting using a real-time handwritten recognition system. Due to

It is challenging for a machine to understand handwriting recognition due to the variance in shape and orientation of the writing. Due to its numerous uses, including the automatic processing of bank checks, billing, and postal services, real-time handwritten recognition is a huge field of study. An Offline Handwritten Recognition System is provided in this thesis.

The feature extraction from handwritten images and the dimension categorization of the feature vector are the two main components of the recognition system.

We offer descriptors based on the Histogram of Oriented Gradient (HOG) feature for real-time handwritten recognition.

One of the most popular feature vectors used in object recognition in computer vision. To classify features, a linear Proximal Support Vector Machine Classifier is recommended. Using the One versus all approach, this binary classifier is then converted into a 10 classifier. The standard PSVM classifier is favored over the traditional Support Vector Machine (SVM) Classifier because of its rapid training time.

Training and evaluation pictures of handwriting are obtained from the MNIST database. The system's performance is evaluated based on four metrics: sensitivity, accuracy, positive predictive value, and specificity.

Both optical character recognition (OCR) and handwritten character recognition (HCR) have to be tailored to each individual use case.

**INTRODUCTION**

**The major drawback in the arena of pattern recognition with huge datasets is real-time hand written recognition.**

**Since the beginning of computer science, a natural means for the interaction of computers and people has been a focus of considerable research.**

**The method of Real-Times handwriting recognition is used by computers to identify and read the number and distinct characters written by hand in free-hand.**

**There are two types of handwriting recognition: online handwriting recognition, which involves using a web camera to recognize handwriting in real time, and offline handwriting recognition, which involves scanning handwriting and having the computer interpret it.**

**Numerous studies have been conducted on Arabic (Urdu) and European languages. Local languages like Hindi, Punjabi, Bangla, Tamil, and Gujarati, on the other hand, have received very little research due to their low usage.**

***MODEL DETAILS***

**IMAGE PROCESSING**

An intricate method of image processing was utilized at the beginning of the project. What exactly is image processing then?

The mechanism of applying varied operations to an image to either generate a better image or extract some pertinent information is called image processing. The picture serves as the input for this kind of signal processing, while the output may be a modified version of the original image or some of its features. Rapid advances in this field have made it an important focus for engineers and computer scientists.

Basically, image scanning involves the following three steps:

1) Uploading the picture using image-acquisition software

2) Examining and modifying the picture

3) A report or updated image that was the consequence of the output from the image analysis.

In this journey, the thought of picture handling is primitive for the final organize of determination to require the input specifically from the webcam (Genuine Time), to customize that picture, and for the surprisingly to begin with arrange of preparing make use of the MNIST dataset picture reshaping and the genuine life dataset composed reshaping, cutting, and sifting. The ventilate will scrutinize each picture assemble thought in turn.

The influence of image processing will be explored in two parts because this project is still in two stages.

1) Using training data for image processing.

2) Image processing for data testing.

IMAGE PROCESSING IN TRAINING DATA

In the training set, the neural network model was trained using data from two different sources.

MNIST is the name of the first dataset (Modified National Institute of Standards and Technology Database).

2. Self-created dataset using the easyocr. This two dataset nearly fills the training model with 60500 elements and successfully iteratively trains the model nearly five times.

A). The Miniature National Institution for Standardization (MNIST) database has a large collection of handwritten numbers (Modified National Institute of Standards and Technology database).

Testing and training in machine learning very often make use of the database. Samples from the initial MNIST datasets were "re-mixed" into it. Since the testing dataset was derived from American high school students and the training dataset was derived from employees of the American Census Bureau, the creators of MNIST believe that it was not suitable for machine learning research. In order to fit within a 28x28-pixel bounding box, the black-and-white photos from MNIST were also normalized and anti-aliased, which contributed to the grayscale levels.

B). Self-created handwritten characters or numbers almost double the number of entries in the dataset's training. This is more productive. Compared to the MNIST dataset for this project, and it should be used at the end of the training model because it might run into other problems that are similar to these during testing. Unique features can be found in this dataset.

1. The image's value is not fixed.

2. A mobile image of a newspaper.

3. The algorithm receives many characters and then trims them.

4. Saving it to the specific directory after the process of cutting and resizing.

Before delivering this dataset to the neural model, a lot of image processing effort was necessary. This image or dataset has a number of unlabelled variables that need to be under control.

1. You need to cut a number of random characters or numerals.

2. The real-time mobile image may have various tones.

3. A noisy image will appear; we need to eliminate the noise.

4. Depending on the quality loss, the image needs to be resized.

**Characters drawn on paper of a mobile image**

Characters from a paper are depicted in a mobile image.

This phase involves writing some characters on black and white paper since they are easier to read, unless you can write on a page with margins as well.

It will be more nicer to write with a sketch pen, marker, or gel pen because they produce continuous characters.

Good character writing is important if you want your writing to be scanned and recognised by machines for optical character recognition (OCR), as ballpoint pens and fine-point pencils can cause disconnected components in a character.

Take a snapshot after you've written something on paper.

This procedure is straightforward; all that is required is a clear photo of the characters.

**Countless algorithms applied for babble,refine**

This process focuses entirely on data cleaning, noise removal, and data filtering to extract the subject-specific information from the image.

**1.Normalisation**

Real-world data persists in a variety of formats, and on the off chance that a scatterplot of the black white fluctuation is made, it will also produce findings with the median filled.

For this reason, normalisation is essential in order to have an accurate cleaning procedure.

Here, the image has been standardised using the MIN,MAX Normalisation approach.

Here, the picture's colour range has been eliminated, and a range—such as 0 and 1—has been provided for each and every pixel (Peter Roelants – 2016).

Vi' = (vi-minA)\*(newmaxA-newminA) (maxA-minA)

The range of the new pixel is from new min A to new max A, At vi' is the latest standardize component number and vi is the previous component number (from minA to maxA).

Despite a fact that there are other normalisation methods, minmax was selected since tests have shown it to be the most effective for cleaning handwritten characters. More effectively, it turns noisy grey pixels (grey pixels) into white and turns black pixels to black.

**Filtering**

An image can be sharpened or smoothed using filters. Cells with extremely high or extremely low frequencies are removed during this process. Low pass filters only retain the bottommost frequencies whereas evict the higher frequencies. The outcry pass mechanism works by evict commotion from the picture and smoothing it down.

By only maintaining the higher frequencies, high elapse clean eliminates the lower frequencies. Images without a background (such as those with a black background) can be sharpened using high pass filters is the first low-pass filter used to reduce noise.

High pass filter and applied pyrmeanshiftfiltering() are recommended.to evacuate more commotions on the primary stage. This performs the first stage of mean shift segmentation of a picture. PyrmeanShiftFiltering is the Pyrdown() method of the imgproc class applied to an image to perform Pyramid Mean Shift Filtering.

**Contour Detection**

After the image has undergone noise cancellation, normalisation, and filtering, the contour detection approach is fully applied.

There are some serious problems with this approach that only apply to handwritten characters. This document includes several contour detection components. To address the actual contour detection problems, one must deal with several components one at a time.

Contours are a few curves or lines that connect spots along the boundary that are the same hue or intensity.

This tool, which uses the subjected forms from an image, is incredibly helpful for object detection and recognition. Binary pictures or canny pictures should be taken where the subject configuration and circumstances are drastically incompatible vigorous for improved contour accuracy.

The 28x28-pixel dataset is utilized to prepare the entire display. The computation of the riddle pick out relents within the yield surface and the volume and escalated of inputs in the input layer both influence the neural organization show.

This demonstration necessitates the use of a one-dimensional flock of the dangerous dataset, which must be provided to the neural contrivance in stages along with the completed MNIST dataset for this demonstration to be successful. Flattening and sequentializing all input to the neural system is required.

**WORKING PRINCIPLE**

Picture capture, pre-processing, division, highlight unsheathing , classification, and pole-processing are the six stages that typically make up handwritten recognition.

**INPUT DATA**

A digitized or digital image serves as the first input. Devices widely used is the digitizer or electronic tablets.

An electronic pen serves to operate these devices. Scanners, cameras, or writing directly into the computer with a pen can play the role to capture input images for handwritten characters

**PREPROCESSING**

Pre-processing is the fundamental structure of character awareness, which is the source of low confession wage. Pre-processing stages' vital objective is to institutionalize strokes and dispense with fluctuations that would existent else make acknowledgment more troublesome and lower the rate of acknowledgment. A few of these inconsistencies or mutilations include the content's erratic estimate, lost focuses during write development collections, content jitter, a cleared out or right twist in the writing, and uneven disconnection between focuses from adjacent locations. Estimate standardization and centering, adding for lost focuses, smoothing, incline adjustment, and resampling of focuses are five common preprocessing strategies.

**Segmentation**

The operation of separating the individual characters in an image is called segmentation. The mechanism of processing documents typically follows a stratified structure. Primo, lines are segmented using row histograms.

**Feature Extraction**

The extraction of the appropriate pattern for classification is the primary goal of the feature extraction step. “The attributes of individual characters that are used to train the system can be drawn out using Principle Component Analysis (PCA), Linear Discriminant Analysis (LDA), Chain Code (CC), Scale Invariant Feature Extraction (SIFT), zoning, Gradient-based features, and Histograms.”

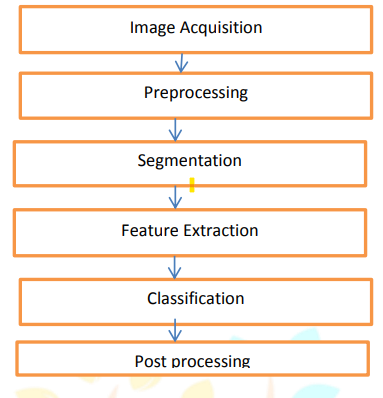
**Classification**

The apotheosis of the input picture are recoup when it is given to the HCR framework, and they are at that point utilized as inputs for think up classifiers such counterfeit neural systems or back vector machines. Classifiers select the splendid coordinating lesson for input by comparing the input include with the put away construction.

**Post Processing**

The exercise of amending results that have been erroneously categorized through the use of linguistic expertise is known as post-processing.

It processes the results of shape recognition. By including linguistic particulars, unalloyed shape identification accuracy can be amplified. A number of form recognizers provide a single character string for handwritten input, whereas others produce many alternatives for each character, sometimes with a confidence rating.



Block Diagram of Real-Time Handwritten Recognition

**LITERATURE SURVEY**

In 1959, Grimsdale attempted character recognition research in a significant way for the first time. A significant amount of research that was carried out in the early 1960s was based on the analysisbysynthesis method, which Eden first proposed in 1968. The work of Eden was significant because it clearly demonstrated a concept that had been implied in previous works: A limited number of schematic components produce all handwritten characters

1. **K. Gaurav, Bhatia P. K.**

His work discusses the various character identification pre-processing techniques that are utilized with a variety of images, such as handwritten forms with straightforward backgrounds and papers with intricate backgrounds and varying intensities. Here, we will discuss a number of these preprocessing techniques, including skew detection and correction, contrast stretching, binarization, noise reduction, normalization, segmentation, and morphological processing.

1. **Sandhya Arora**

used four techniques for extracting features: intersection, shadow, chain code, and linear regression. Global shadow features are produced for images of characters, while segmentation is employed to compute features such as intersection, chain code histogram, and line fitting. The total identification rate for Devanagari characters in testing using a dataset of 4900 samples was 92.80%.

1. **Brakensiek, J. Rottland, A. Kosmala, J. Rigoll**

In this research, they detail an offline cursive handwriting detection system based on a Hidden Markov Model (HMM), which utilizes both discrete and hybrid modeling approaches.

Different hybrid approaches, each combining discrete and semicontinuous structures, are put through their paces in tests of handwriting recognition, with the results being compared to one another. A neural vector quantizer-based hybrid modeling strategy for HMMs (hybrid MMI) has been shown to beat both discrete and hybrid HMMs based on fatigued mixture structure (hybrid - TP) in terms of recognition rate performance, although working with a smaller data set.

1. **R. Bajaj, L. Dey, S. Chaudhari**

For the purpose of classifying Devanagari digits, we employed density features, moment features, and descriptive component features. Their suggested multi-classifier connectionist architecture correctly identified 89.6% of handwritten Devanagari digits.

1. **G. Pirlo and D. Impedovo**

In his research on, presented a new kind of membership function called fuzzymembership functions (FMFs) for use in zoning-based categorization. The classification performance of these FMFs is optimized by simply adapting them to the specifics of the job at hand. In this research, we offer a realcoded evolutionary algorithm for simultaneously optimizing both the best feasible FMF and the best zoning, as characterized by Voronoi tessellation. The results of the experiments on digit and character recognition transcription reveal that ideal FMF is superior to other enrollment skills when considering the unique level, positioning level, and estimation level weighting models.

1. **Sushree Sangita Patnaik and Anup Kumar Panda**

Particle swarm optimization (PSO) and bacterial foraging optimization (BFO) are two techniques that are recommended for use in this May 2011 paper. These algorithms are developed to effectively compensate for harmonics by reducing the losses that are inherent to the APF. Two methods are compared for their usefulness and ease of implementation across two supply chain situations. The total harmonic distortion (THD) of an APF system, a measure of its effectiveness, is decreased to roughly 1% when BFO is applied. The findings show that BFO works better than both traditional and PSO-based approaches, even while operating with an unbalanced supply, since it guarantees improved APF functionality and rapid triumph over harmonics in the source current.

1. **M. Hanmandlu, O.V. Ramana Murthy**

We have shown that it is possible to employ a fuzzy model constructed from exponential membership functions to accurately recognize handwritten Hindi and English digits.

Fuzzy sets are recognized by fine-tuning the exponential membership functions that have been fitted to them. The Box technique is used to calculate normalized distances, which are then used as features in the construction of fuzzy sets. Under the premise of membership parity, estimates of two structural elements that might modify the membership function are provided. Overall, 95 percent of people can recognize Hindi numbers, whereas 98.4 percent can recognize English numerals.

1. **Renata F. P. Neves**

have suggested an offline SVM-based technique for interpreting handwritten numerical input. The authors assert that SVM provides higher accuracy than a multilayer perceptron classifier. The NIST SD19 standard dataset has been subjected to 12 different tests so far. MLP's power is in its capacity to divide into smaller subsets classes that are not ordinarily divisible. However, MLP is prone to a local minimum area, where training will halt because it has reached the ideal spot on the error surface. The number of hidden layers and perceptrons to utilize is a key factor in determining the ideal network architecture for solving the issue. These disadvantages suggest that an MLP-based digit recognizer may not provide the promised low mistake rate.

**“Comparision Between Different Techniques**

|  |  |  |
| --- | --- | --- |
| **Method** | **Accuracy** | **Purpose** |
| Hand printed symbol recognition. | 97% overall. | Take the necessary global, regional, and local measures to determine the character. |
| OCR for cursive handwriting. | 88.8% for lexicon size 40,000. | The goal is to use cursive handwriting segmentation and recognition techniques. |
| Hill climbing algorithm for handwritten character recognition. | 93% for uppercase letters. | To implement hill climbing algorithm for selecting feature subset. |
| Optimization of feature selection for recognition of Arabic characters. | 88% for numbers and 70% for letters. | To apply a method of selecting the features in an optimized way. |
| Binarisation and normalization. | normalization 88.8% | Multi-layer network. |
| Recognition of handwritten numerals based upon fuzzy model. | 98.4% overall. | The aim is to utilize the fuzzy technique to recognize handwritten.” |

**MODELS THAT CAN BE USED**

* **SUPPORT VECTOR MACHINE**:

One of the most popular controlled learning techniques for dealing with Order and Relapse problems is the Support Vector Machine (SVM). However, the vast majority of these applications include some kind of AI order problem. The SVM algorithm seeks the best line, or decision limit, to partition the space of n features into subspaces that may be used to efficiently categorize additional data in the future.

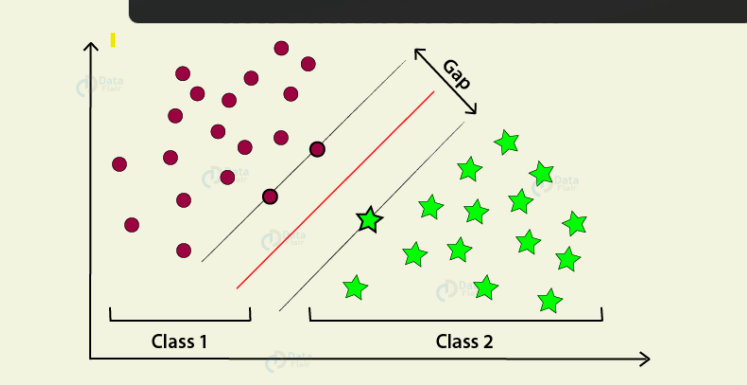
This optimal decision boundary is referred to as a hyperplane

The most out-there axes and coordinates that help shape the hyperplane selected by the support vector machine. In the SVM method, these outliers are represented by support vectors.

There are several applications for the SVM method, including face identification, picture classification, and text categorization.

* **SVM can be of two types**:
  + **Linear SVM**: Linear support vector machines work well with data that can be cleanly separated into two groups by a straight line. We use a classifier called a Linear Support Vector Machine to get this kind of data.
  + **Non-linear SVM**: A classification algorithm is referred to as a non-linear SVM classifier when a dataset cannot be identified by drawing a straight line.

**Example:** SVM can be comprehended using the KNN classifier illustration we used. Assume we want a model that can distinguish between cats and dogs, and we come across a peculiar cat that, at first glance, may be mistaken for a dog. Such a model may be built with the help of the SVM algorithm. Before we put it through its paces with this out-of-the-ordinary animal, we will put it through its paces with a series of images of cats and dogs to acquaint it with the varied traits of cats and dogs. Since the support vector forms a line between the two sets of data (cats and dogs), it will notice the outliers and use that information to label the object as a cat.



SVM Working Graph

The followings are important concepts in SVM –

• **Support Vectors** − Support vectors are the data points that lie along the hyperplane with the least amount of distance between them. The position of the cutoff will be calculated using the collected data.

**• Hyperplane** - As can be seen in the above picture, this decision plane or space is made up of items from a wide range of categories.

**• Margin** − The nearest data points of different categories may be used to establish the gap between the two lines. The distance along the perpendicular drawn across the line and the support vectors may be used to get this value. The wider the margin, the better, and the smaller the margin, the worse.

**DISCUSSION & CONCLUSION**

Each significant development in the area of handwritten character recognition is dissected in great detail in the paper. The best answer that may be offered in this regard depends on the kind and quality of the subject matter under consideration.

For handwriting recognition systems, various character recognition techniques are delineated in this paper. The various approaches that have been put forward, hence, are compared in detail in Table 1. A high rate of character recognition necessitates the correct selection of classification and feature extraction techniques, according to the study's analysis to date. The research presented in the paper demonstrates that both the rate of character recognition and the algorithms themselves can still be ameliorated.

**FORESEEABLE ENHANCEMENT**

A large field of artificial intelligence and machine learning can perceive content in an picture and show it to others, like a trade name spotter. Then again, this enlarge can be elongate to include all known character sets. Since there will be a large number of assembly sets and testing values that the neural network model will be unable to recognize, the complete English alphabet was not chosen for this project. Assume a bystreet car detector based on AI that, in effect, requires the user to equip the target. All of these advancements are applications of plane analysis, which will be utilized in future AI conceptualization, neural organization, and image processing.

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