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Chronological Evolution: Development and Identification of a Marathi Handwritten Character Dataset Using Deep Learning

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There is a level of saturation obtained about Online or Printed character recognition about Indian script. Comparing the research of different Indian languages obtained yet a few researches has been done for Marathi characters. There are still more research remains valid while recognizing handwritten Marathi script. To overcome these challenges a proper dataset is required for experimentation. The handwritten data collected from various Marathi writers. There are four process carried out to generate dataset i.e. data collection, Pre-processing, Segmentation and classification. Data is collected from different sources like school and college students, village people and small children from Indian Anganwadi centres etc. After collection it is arranged them into different age groups, gender and education level. In pre-processing selection of image, noise removal, normalization, conversation of grey scale to binary image, then converted binary images to inverted images. In this paper we have focused only handwritten simple characters that included vowels, consonants, numbers and special characters. We have created 100000 of character data of different varieties compared with other availability dataset and to find its better accuracy we have used `deep learning approach of keras like InceptionV3 and Resnet with different batch size and its epoch level and find its accuracy. We obtain an accuracy of 83.42% for the used model for our collected dataset. Our handwritten data is available publically and it will be useful for the researcher to continue their future research work and for the time being it can be available on request.

Keywords: Marathi Simple Characters, VGG annotation, Bounding box, Threshold, Binary image, Inverted Images, Deep learning, InceptionV3, Resnet

1. Introduction

An estimated 300 million people in India speak languages written in the Devanagari script, including the official language Hindi as well as Marathi, Sindi, Nepali, Sanskrit, and Konkani. The two most widely used languages written using the Devanagari script are Hindi and

Marathi. Although Maharashtra, one of India's largest states, uses Marathi as its official language, efforts to improve handwriting character recognition for Indian languages have been slow. Automated computer translation of scanned images of handwritten, typewritten, or printed text into machine-encoded text is known as optical character recognition (OCR). Over the past few decades, numerous academics have focused on optical character recognition (OCR), one of the most significant areas of pattern recognition. Creating an optical character recognition (OCR) system calls for substantial R&D efforts. Though many academics have focused on the topic for years, the end goal of optical character recognition (OCR) for Indic scripts in particular is to have computers read, edit, and process characters automatically without human interaction, much like a human reader. To this day, it's still a fascinating and difficult problem in pattern recognition. The adaptation of a person's writing makes the Marathi offline handwritten character identification an extremely challenging operation. Pattern recognition and computer vision are in the early stages of developing technology for handwriting recognition. The adaptation of a writer's style, strokes, and postures to their mood and behavior while writing makes offline handwritten character recognition a challenging task; as a result, there should be a larger quantity of handwritten images included in the training and testing datasets. There are several Marathi news datasets, such as C100, WikiAnn, Samandntar, Belebel, IndicGie, X-Fact, Dakshina, and IndicITS, but only a small number of handwritten datasets, such as MODI-HHDOC, MOLD, and DHCD, are available to the public. Some of the dataset is created combination of Indian script[1-5]. Till now there is no bench mark of dataset available and not created yet. There are few data set which are experimental based on curvature features of handwriting style, F-ration based weighted feature extraction, Kohnonen neural networks and multi font for Marathi simple characters[7-8]. This paper mainly focuses on

- Users data which is restricted to research purpose only
- No redistribution data set is allowed
- Dataset can be portioned into train and testing as per the requirement

The Marathi Characters:

Marathi alphabet consists of 48 letters, including 12 vowels ,36 consonants and 10 numerals. The alphabet in Marathi are called Vernamala and are written in the Devanagari script, which consists of 16 vowels and 36 constants [1,3,5] making of 52 letters. Currently Marathi is using the Balbodth Script. The vowels are called Barakhadi(Fig 2).

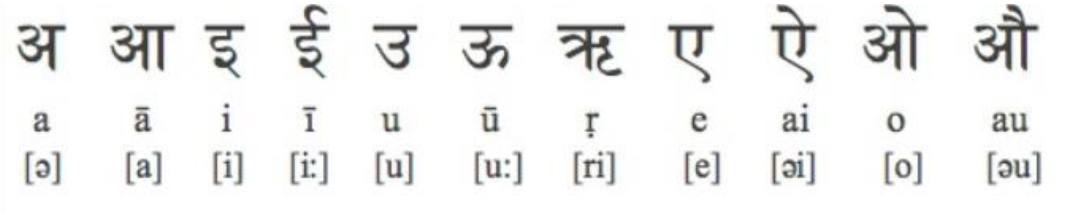


Fig 2: Marathi Vowels

(i) Marathi Vowels or Barakhadi (Fig 2) modifiers have a crucial role in Marathi script. There is a central component (core), a top component, and a bottom component to the Marathi

language. Every character, punctuation mark, and special symbol is located in the core component, while the top and bottom parts only provide swar modifiers and diacritical signs. The "shirorekha" (top line) separates the central part from the upper part. At the end of each sentence or phrase, a vertical line is utilized to indicate a purnaviram, which means full stop [5-6].

(ii) Marathi Consonants

Marathi Consonants (Fig 3) has its own set of consonant characters along with their transliteration in the Latin script. There are basic consonant characters used in Marathi script. Each consonant typically represents a single sound and additional characters or modifications can be used to represent variations in pronunciation or combined sounds. Marathi consonant characters can be classified into several type based on their pronunciation and manner of articulation. Here are the main types of Marathi consonants characters.

क	ख	ग	घ	ङ	च	छ	ज
ka	kha	ga	gha	ṅa	ca	cha	ja
[kə]	[k^{h}ə]	[gə]	[$g^{ɦ}$ə]	[ŋə]	[tɕə/tsə]	[$tɕ^{h}$ə]	[dʑə/dzə]
झ	ञ	ट	ठ	ड	ढ	ण	त
jha	ña	ṭa	ṭha	ḍa	ḍha	ṇa	ta
[dʑ^{ɦ}ə/dz^{ɦ}ə]	[ɲə]	[ʈə]	[$ʈ^{h}$ə]	[ɖə]	[$ɖ^{ɦ}$ə]	[ɳə]	[tə]
थ	द	ध	न	प	फ	ब	भ
tha	da	dha	na	pa	pha	ba	bha
[t^{h}ə]	[də]	[$d^{ɦ}$ə]	[nə]	[pə]	[p^{h}ə/fə]	[bə]	[$b^{ɦ}$ə]
म	य	र	ल	व	श	ष	स
ma	ya	ra	la	va	śa	ṣa	sa
[mə]	[jə]	[ɾə]	[lə]	[ʋə]	[ʃə]	[ʂə]	[sə]
ह	ळ	क्ष	ज्ञ				
ha	la	kśa	dña/jña				
[ɦə]	[ɭə]	[kɕə/kʂə]	[dnʲə]				

Fig 3: Marathi consonants

Types of Consonants:

(i) Gutteral consonants

These consonants are pronounced using the back of the tongue against the soft plate or the throat.

क (ka), ख (kha), ग (ga), घ (gha), ङ (ṅa)

(ii) Palatal consonant

These consonants are articulated using the middle part of the tongue against the hard palate

च (ca), छ (cha), ज (ja), झ (jha), ञ (ña)

(iii) Cerebral Consonants

These consonants are pronounced with the tongue curled back and touching the roof of the mouth (cerebrum).

ट (ṭa), ठ (ṭha), ड (ḍa), ढ (ḍha), ण (ṇa)

(iv) Dental Consonants

These consonants are articulated with the tongue against the upper teeth or the alveolar ridge

त (ta), थ (tha), द (da) , ध (dha), न (na)

(v) Labial Consonants

These consonants are formed by the lips coming together or contacting.

प (pa), फ (pha), ब (ba), भ (bha), म (ma)

(vi) Sibilant Consonants

These consonants produce a hissing or sibilant sound

य (ya), र (ra), ल (la), व (va), श (śa), ष (ṣa), स (sa), ह (ha)

(iii) Marathi Digits:

In Marathi script (Devanagari), the digits (numbers) are represented similarly to how they are in Hindi and other languages using the Devanagari script. Here are the Marathi digits (Fig 3) along with their transliterations:

There are 10 Marathi digits as shown in Fig. 4

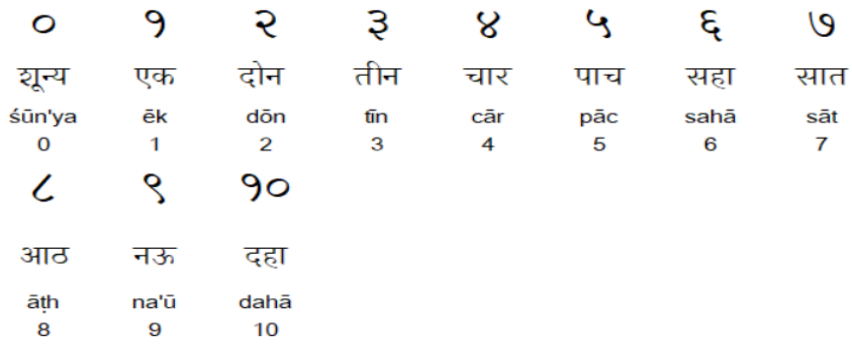


Fig 4: Marathi digits

(iv) Motivation

Many datasets are created for simple character and some of them are publicly available but to find its better recognition we need a huge amount of dataset. So, we decided to create a huge

number of datasets for Simple characters of Marathi script. In the discipline of deep learning, various methods are employed to train neural networks. The experiments conducted in the field of pattern recognition demonstrate that the performance of a recognition system is influenced not only by the selection of features and classification technique, but also by the size and quality of the data. The process of creating the dataset without human interaction is a tough task. This dataset has the potential to significantly reduce the time and resources required for developing the dataset. The main obstacle is the absence of Marathi databases for training the OCR engine [7-8]. Enhancements to the performance of Marathi OCR are necessary for real-time recognition. This dataset substantially inspires the study community in the topic by providing a high-quality collection of Marathi characters and numerals. Computer vision is commonly used for recognising handwritten characters [14]. Researchers are urged to improve recognition outcomes by employing diverse pattern recognition algorithms, which have shown beneficial in the offline text and digitalization procedure. The aim of the research is to:

- Excessive survey focus on various dataset is provided with different orders for simple characters.
- Presents an innovative approach to generate a dataset for the Marathi language in order to address the lack of available data. Using different deep learning technique to find its better accuracy and its recognition.

To test and validate the performance of the produced dataset, CNN models such as Resnet and Inception will be used [14] .

A. Objective

The main objective of this study is:

- To Review of the Hand-Written Marathi character dataset
- To create a dataset for offline handwritten Marathi characters
- To apply deep learning techniques on the dataset

B. Paper Outline

The article is organized by starting with introduction with motivation and objective. Section 2 describe the related study. Section 3 elaborate the Materials and Method of the research work. The paper describes the result in section 4 and finally it concluded in section 5 with future work.

2. Study of Related Works

Shriram Raghunathan and Diptee Chiknkurge (2023)[1] A number of convolutional neural network (CNN) models were addressed in the study "Enhancing Marathi Handwritten Character Recognition Using Ensemble Learning," which made use of AlexNet, lenet-5, VGG-16, and stacking and soft voting ensemble processes. When compared to the performance of a single CNN model, the ensemble technique clearly outperforms it. The proposed work employs a stacking and soft voting ensemble strategy to train a base classifier

ensemble using VGG16, Alexnet, and LeNet-5. In a soft voting ensemble with three CNN classifiers, the total accuracy of the suggested work is 98.66%.

The authors Minakshi and Anuradha (2015)[2] One paper presented at the International Conference on Embedded and Communication Systems (ICIECS) titled "Handwritten (Marthi) Compound character recognition" employed optical character recognition (OCR) to identify offline handwritten compound characters in Indian scripts like Devangari.

Bhanu Chauhan and Mimansha Agrawal (2022) [3] a comprehensive analysis of machine learning algorithms for devanagari character recognition from handwritten handwriting Devangari character image processing and deep learning techniques (convolutional neural networks, support vector machines, etc.) Feature extraction, pre-processing, segmentation, prediction, and post-processing are the five primary steps of this recognition system. Recognition of handwritten Devanagari characters is the subject of this paper's analysis. Several methods exist for resolving this. It achieved an accuracy of 82.04% using a number of approaches and recognitions.

Using feature extraction and segmentation, Padma Ramkrushna and Ajaya Anil (2016)[4] use a genetic algorithms approach to offline Marathi handwriting character recognition at the "International conference on global trends in signal processing, information computing and communication (ICGTSPIC)" in Jalgaon.With a total accuracy of 96.77%, the evolutionary algorithm was applied to a multi-layer perceptron convolutional neural network (CNN) classifier that had one hidden layer and made use of the Tan-log activation function.

Public datasets such as DHCD, which has 92,000 images and 46 distinct classes of Devanagari script characters, are utilized by Shadesh Acharya and Ashok Kumar Pant (2015) [5].They achieved better outcomes by utilizing a deep learning approach and CNN.

According to R.jain and C.V. Lakshmi (2008), "Handwritten Devanagari numerals recognition with higher accuracy" uses efficient techniques to identify individual handwritten Devanagari numerals. They use PCA for recognition and add new ideas about edge directions, histograms, and splines.

The authors of the 2022 paper "CNN based handwritten Odia character recognition" are Rabinarayan Panda and Sachikanta Dash.Analysis of deep learning techniques, such as CNN, for Odia character recognition was the primary goal.Using 6 layers of neurons, they achieved an accuracy rate of 95.6% when classifying characters using CNN. Neurons are connected in numerous layers to achieve optimal efficiency.

Using techniques such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), Rabinarayan Panda and Sachikanta Dash (2022)[8] achieved an accuracy of 88.7 percent in their paper "complex Odia handwritten character recognition using deep learning model" presented at the IEEE International Conference of the Electron Device Society Kolkata chapter.

Ajay Anil and Surendra Pandurang (2018)[9] "A simplified optical character recognition system for handwritten Marathi text document classification and recognition using SVM -ACS algorithms"; a simplified optical character recognition framework; and a projection profile segment technique that outputs less mistakes. PCA techniques reduce the recovered features and then split them into line, word, and character segmentation.The experimental results

compare the proposed method to two current methods, fish fly selection (FFS) and bat selection (BS), and evaluate its performance based on sensitivity, recall, accuracy, precision, and F-score.The accuracy, sensitivity, and specificity of the suggested approaches are 99.36%, 90%, and 89.93%, respectively.

(2014) by V. Karbhari, D. Prapti, and V. Sriniwas.In an article published in the international journal of Advanced Research in Artificial Intelligence, the authors described a Zernike moment feature extraction method employing SVM and KNN for handwritten Devangari (Marathi) compound character recognition.

The authors of the 2017 article "Handwritten Marathi character recognition using R-HoG features" (P.Kamble and R. Hegadi) made use of several forms of electronic and computational communication. implemented a dataset with 8000 samples A technique called SVM is used to normalize 40 base handwritten letters to 20*20 pixels. The accuracy rate is 85.88%.

In 2022, Rahul S. Narsing cited [12] Published in the "International research journal of engineering," the article titled "Devanagari Character recognition using image processing and machine learning" centered around visual elements.This experimentation makes use of 94640 photos.The overall precision is close to 90%.To breakdown images of characters, a scan of the handwriting is done and then an image transform is applied to each individual character.

Kirti Thakur and harish Kumar(2023)[13] “Variable selection methods ,comparison and their applications in machine learning a review ”,uses feature selection concepts to identify and remove irrelevant as well as redundant information .the workflow solved with feature selection problems .Here many surveys and empirical assessments were performed like classification , predictions , regression and clustering .

S. Gaonkar, B. Narkhede, and R. PatilIn 2023, there were fourteen The paper "Deep learning based Marathi sentence Recognition using Devanagari Character identification" was presented at the CSCITA international conference on computing and IT applications.With 4,000 pieces of data, we train and test a model based on feature extraction using SVM and R-HoG, and a classification model based on FFANN.

In "Chronological Evolution: Development and Identification of an Odia Handwritten Character Dataset Using Deep Learning," Rabinaraya Panda and Sachikanta Dash (2024) [15] provide the necessary background information. Used ResNet and Inception V3 to train a dataset of handwritten characters.

Rakesh Chandra Balabantaray and Raghunath Day (2019)[24] In this paper presented at the International Conference on Information Technology, the authors offer "A novel sliding window approach for Offline handwritten character recognition." They modify an existing feature representation technique to work with segmented handwriting. The segmented characters are vertically scanned using a sliding window to generate these features. The performance is evaluated by running experiments on a standard benchmark dataset and then computing and comparing the prediction accuracy.

3. Materials and Methods

To complete our process, we have followed with different technique step by step as shown

in Fig 6. We have created an extensive survey of numerous publications and a number of researchers working [21, 22]. To complete this process, we have gone through many steps like collection of data from the people of Maharashtra by visiting different school, colleges and public. We have collected nearly from 700 different writer's handwriting depending on different age group, gender basis, education level and finally we created 100000 individual images data only for Simple characters. We are planning to increase our volume in future. Here we have mentioned some of the simple character data set creation and its recognition depending on our CPU performance. To complete this process, we have gone through specific steps like pre-processing, segmentation, removing noise, feature extraction etc. After collection the handwritten data is scanned by scanner then applied Vgg annotation that creates a spreadsheet file which carries all the dimensional information of each character as per the sequence. It seeks to identify the presence of similar objects depicted in an image across an entire dataset. After annotation we have used the algorithm to create a grayscale image, converted them into binary and inverted images. We have used deep learning application to perform a wide range of Image processing. Each image of our data is dimensionally different so we used python software to remove the background colour and created all the image dimensionally equal in length. After creation of dataset the various forms of deep learning techniques are applied[23-27] for character recognition and the results are compared to obtain the suitable deep learning models like Inception, Resnet with different batch size and epoch level then compared with other research work .The dataset is compressed and stored in the internet. For accessing this dataset, it requires author's permission. Here we have mentioned the link where all the Marathi character dataset that included simple characters. The handwritten dataset is stored in the following cloud drive.

https://drive.google.com/drive/folders/1KUR8_LCe11t7RHBLqQe6WcDyyVoSqacb?usp=sharing

IV : (a) Steps involved for creation of dataset (Fig 1.1)

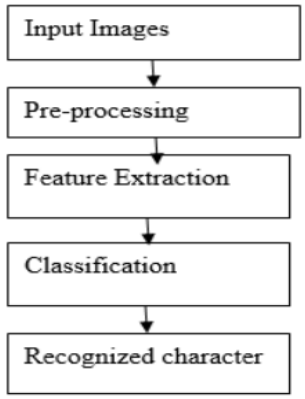


Figure 1.1 Steps involved in isolated handwritten character recognition

(b) Architecture:

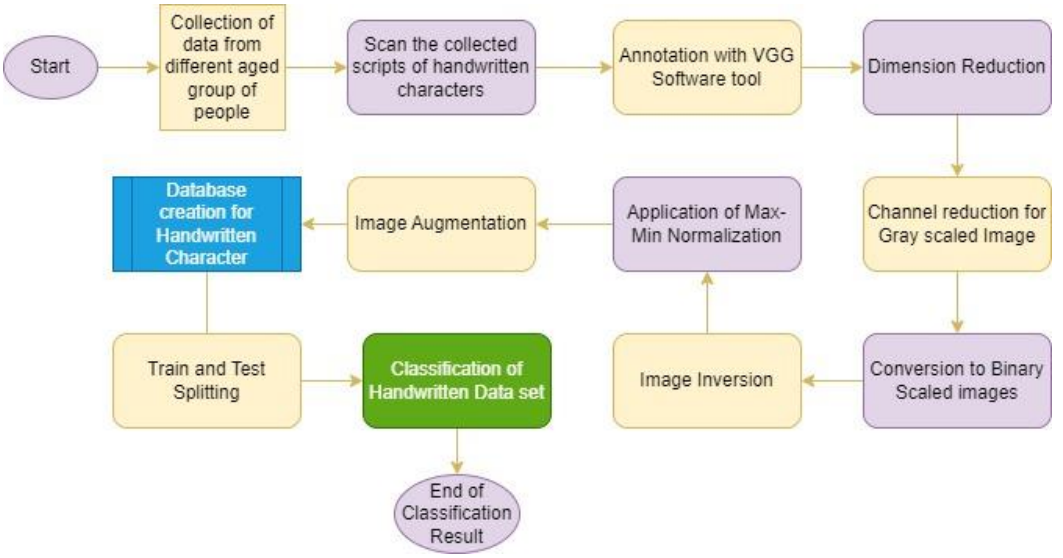


Fig 6 Proposed architectural configuration

A. Data Collection

To complete this process, we have gone through many steps like collection of data from the people of Marathi by visiting different school, colleges and public places. We have conducted an excessive survey from schools, colleges, Anganwadi and village people with different order like simple character including both vowels and consonant, as well as digits (0-9). Hand written Data collected from 800 volunteers for Simple character irrespective of their age, gender and education level image dataset for further research work. We have collected the data from plain paper, Newspaper etc. To make more challengeable we have taken noise paper. We have divided into different age group, different gender basis. Here we have represented some of the example of handwritten pages and we have mention one particular paper for its dataset creation.

Age group of participants:

We have collected and divided the handwriting document into different age

We have divided into three groups

5-15 age group (Fig 7(i), 15-50(Fig 7(ii) and 50-80 (Fig 7(iii)

Fig 7 (i) (ii). (iii)

Gender basis data collection:

Data is collected depending on their gender basis male

Fig 7(iv) and Female Fig 7(v) is represented.

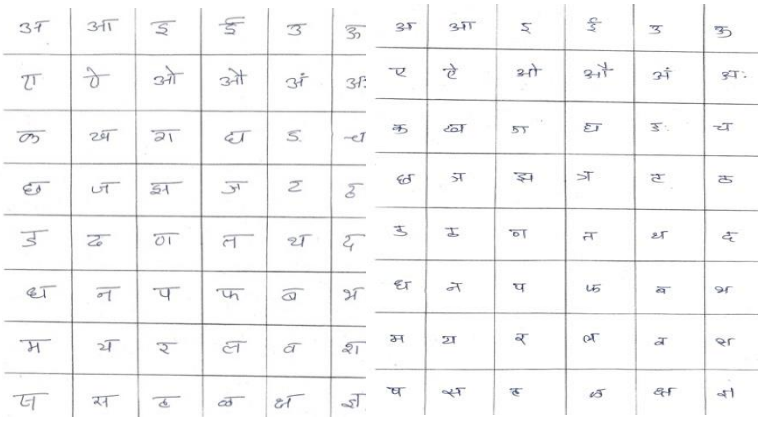


Fig: 7(iv) Fig 7 (V)

Newspaper data:

We have collected all the Indian language newspaper in Fig 9 and given public to write the characters. We have collected about 400 page of different news paper data to make our dataset creation and finding its accuracy more challengeable (Fig 8 (a),(b))

(a) Marathi Paper (b)

Fig 8: Data on newspaper

Table 1. Distribution of participants based on age and gender category

Participants Type	Numver of involvements
Number of people (05-15) years	700
Number of people(15-55) years	342
Number Old citizen	108
Number of small children	564
Number of male people	432
Number of female	243

(a) (b)

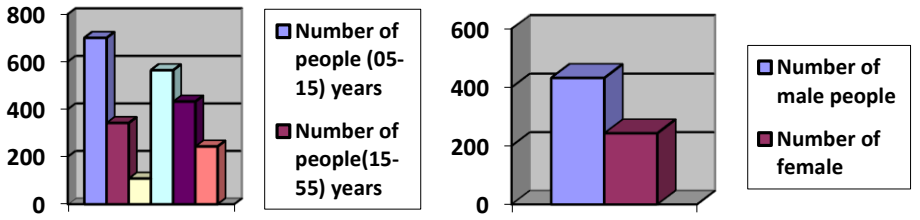
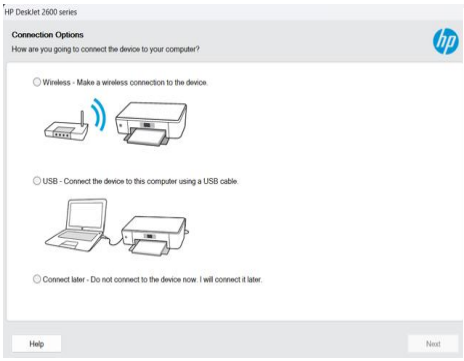


Fig 9: (a) Distribution of participation based on age (b) Distribution of participation based on Gender

B. Scanning:

It is the reading a text in order to find the specific information, Here we have used HP scanner. Hp scanjet pro2600 scanner, the configurationof this scanner is(Fig 10)



Feature	Description
1	**Power** button: Turns the printer on or off.
2	**Control panel display** : Indicates number of copies, wireless status and signal strength, Wi-Fi Direct status, warnings or errors, and ink levels.
3	**Ink Alert** light: Indicates low ink or cartridge problems. For more information, see Control panel error codes and status on page 97.
4	**Cancel** button: Stops the current operation.
5	**Resume** button: Resumes a job after a disruption (for example, after loading paper or clearing a paper jam). **Resume** light: Indicates the printer is in a warning or error state. For more information, see Control panel error codes and status on page 97.
6	**Wireless** button: Turns on or off the printer wireless capabilities. **Wireless** light: Indicates whether the printer is connected to a wireless network.

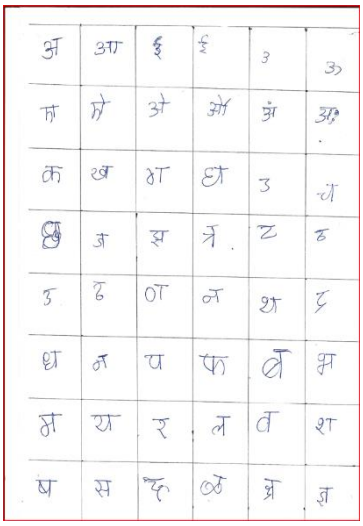
Fig 10 (i) Image of Scanner Fig 10(ii) Scanner configiuration

C. Annotation:

After human annotation of images in a dataset is complete, the labelled images are processed using a machine learning or deep learning model to reproduce the annotation without human intervention, a process known as image annotation [14–18]. Both human and automatic methods are possible. Accurate image annotation is possible with the use of pre-trained algorithms in automated annotation. Tools that aid in recording important points for easy data labeling and storage typically supplement manual annotation. Artificial intelligence is being employed in a relatively new domain, and it is necessary for tackling specific problems. Knowing the nature of the data and the job at hand is crucial for selecting the appropriate annotation tool. It has three steps :

- Modification of the realand collected data
- Usages of proper annotation tool
- Follow of format that the data can be stored

Vgg Annotation :vgg annotation tool that can be used to define regions in an image and create textual descriptions of those regions. It is a process of lableling of classifying an image using text,anotation tool or both to show the data features you want your model to recognize as it`s own(Fig 11)



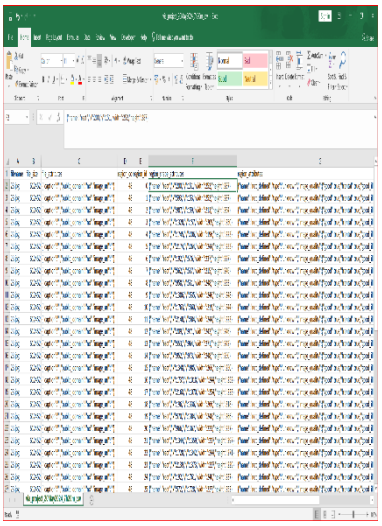


Fig 11(i): Handwritten Page Fig 11 (ii) (VGG Annotation file) Fig 11(iii) Spreadsheet file

D. Pre-processing:

Every sample image is converted into Grayscale. After gray scale image is obtained. Thresholding of intensity is done to minimize the complexity of the image. The characters don't have any background information and can be overloaded, thresholding eliminate the background. Its main objective is to enhance the quality of images for essential feature extraction. Each of the folder is fetched separetly and each images in the folder is re-sized and normilised[12].

Dimension Reduction:

Image have same size to the extent that they do not loose their detail and those all have to be fixed size. More the image size increased, the bigger the input vector for the neural network will be and makes complex architecture and processing.

Binarization:

It is a process in a conversion of color or grayscale image into two color black and white images .We can use a parameter threshold t, with the value of which the brightness of all is assigned one to the two possible value 0 (boundary object) and 1 (remaining object) it has two groups global and local. In a global thresholding the entire image is once and threshold remains constant but in adaptive or local the threshold is changing time to time. Here we have represented binary image of simple character is shown in Fig 12(i).

Binary and Inverted image of simple character:

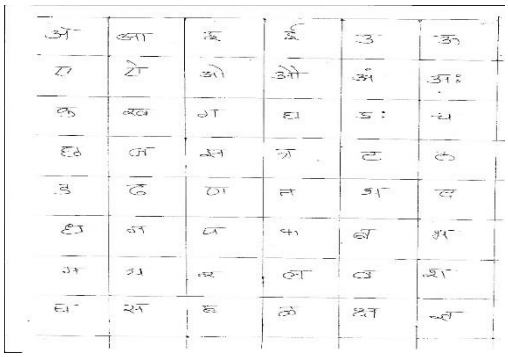


Fig 12 Handwritten page

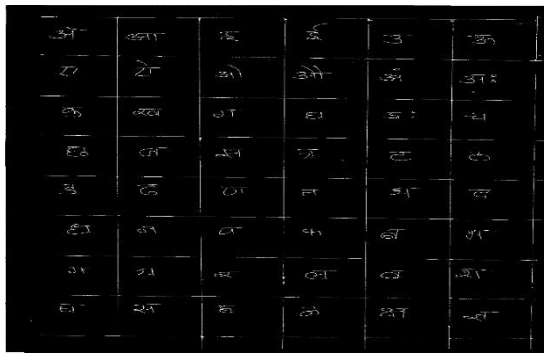


Fig 12 Binary Image

Segmentation and Reshaping:

Binary image undergoes the morphological operation to get true character information. There are two steps are morphological operations.

- Small noise is removed
- Larger connected area is identified

Noise reduction is achieved using opening operation. To locate the rectangular pixel bounding the pixel operation is collected will be further analyzed.

Normalization :

It is a process of adjusting the pixel values where each image consists of its pixel values. Images were normalized using Min-Max normalization method.

(i) Gray scale Image:

It is a kind of black & white or gray monochrome are composed exclusively of shades of gravity. It is one in which the only colors are shaded of grays. A pixel value is a scalar that quantifies the luminosity of a pixel. Each change in grey scale that occurs at an edge is accompanied by a description that includes the rate at which the grey scale changes at the edges. The grey scale undergoes a complete transformation in terms of edge length, curvature, and orientation. Gray scale images [7-8] of characters shown in fig. 13.

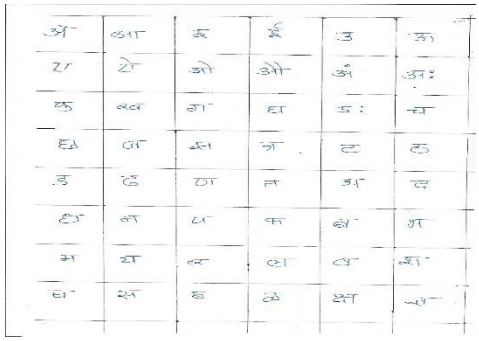


Fig 13 Simple grey scale image

E. Cropping:

To each form page to crop each letter block. The process was done manually using plain software. After cropped kept it in separate folder. All are saved, into same size. Each letter is written by many writters, resulting about 1000 images. All the similarity letters are kept into a folders. Each folder is resize and normalized. Median filter is used for removing salt and pepper noise.

F. Folder wise arrangement:

Each files and folder are arranged into equal size and arranged them as trained and validation set and applied convolutional neural network (Fig 14)

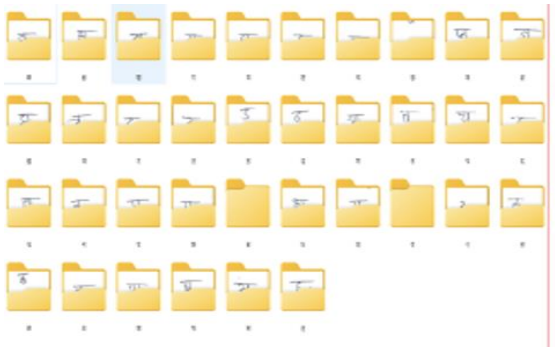


Fig : 14 (Folder wise arrangement)

G. Inception V3:

The Inception V3 model is a complex convolutional neural network (CNN) structure specifically created for the purpose of image categorization tasks. The model was created by Google researchers and belongs to the Inception series of models, renowned for their effectiveness and precision in tasks related to image recognition. Inception V3 enhances previous iterations by incorporating advancements in both architectural design and training methodology. It is also called Google Net. It uses lot of tricks to push performance. Inception V3 [7,8,14], a type of convolutional neural network, introduces a novel approach. These modules have parallel convolutional layers with varying filter sizes, which enhance the extraction of features across several scales. Factorized convolutions, such as convolutions with sizes of 1x1, 3x3, and 5x5 contribute to computational efficiency by maintaining representational power and improving performance without increasing the number of parameters. Using auxiliary classifiers during training helps to address the problem of vanishing gradient, promoting the reuse of features to enhance convergence and regularization. Batch normalization normalizes the activations of each layer, which speeds up the training process and improves the ability of the model to generalize. Preprocessing input photos in a standard manner guarantees uniformity and enhances the effectiveness of training by shrinking them to a specific size and normalizing the values of each pixel. Due to its high effectiveness, Inception V3 is commonly used as a pre-trained model for transfer learning. This allows researchers and practitioners to adjust it for specific datasets or tasks, taking advantage of the knowledge gained from the ImageNet dataset to improve model performance quickly.

we have used Loss function i.e “Categorical_Crossentropy” and Optimizer “adam” and find its accuracy.

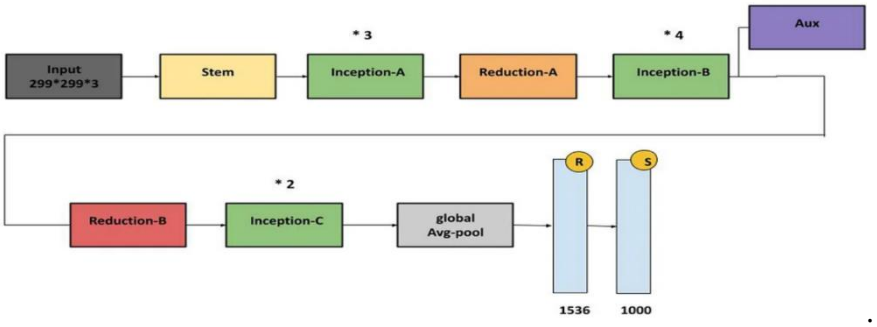


Fig 15 (Inception V3 model)

H: ResNet50:

It is one of several models in the Residual Network family that aim to solve problems with training deep neural networks. A variety of ResNet depths are available, including ResNet-18, ResNet-32, and others. being a medium-sized variation of ResNet-50.

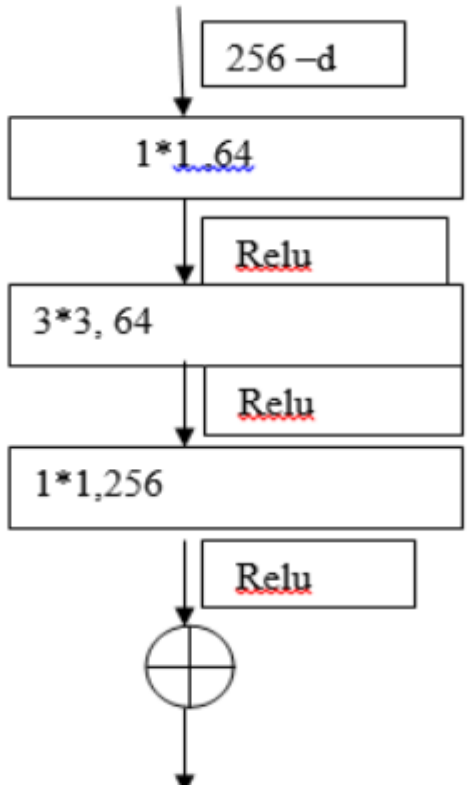


Fig 16 : ResNet by using Relu activation

ReLu only lets positive values through, and it's applied after every convolutional and batch normalization layer.

4. Result and Discussion

The dataset is implemented over inceptionV3 model and the following result obtained. The figure of the results is shown in fig. 16 and fig. 17

Running Process:

```
['/content/drive/MyDrive/Datasets/Bara_khadi/Training/ऐ',
 '/content/drive/MyDrive/Datasets/Bara_khadi/Training/आ',
 '/content/drive/MyDrive/Datasets/Bara_khadi/Training/अं',
 '/content/drive/MyDrive/Datasets/Bara_khadi/Training/ई',
 '/content/drive/MyDrive/Datasets/Bara_khadi/Training/अः',
 '/content/drive/MyDrive/Datasets/Bara_khadi/Training/ऊ',
 '/content/drive/MyDrive/Datasets/Bara_khadi/Training/उ',
 '/content/drive/MyDrive/Datasets/Bara_khadi/Training/ए',
 '/content/drive/MyDrive/Datasets/Bara_khadi/Training/अ',
 '/content/drive/MyDrive/Datasets/Bara_khadi/Training/इ',
 '/content/drive/MyDrive/Datasets/Bara_khadi/Training/ओ',
 '/content/drive/MyDrive/Datasets/Bara_khadi/Training/औ']
```

Batch Size :16 and Epoch 10

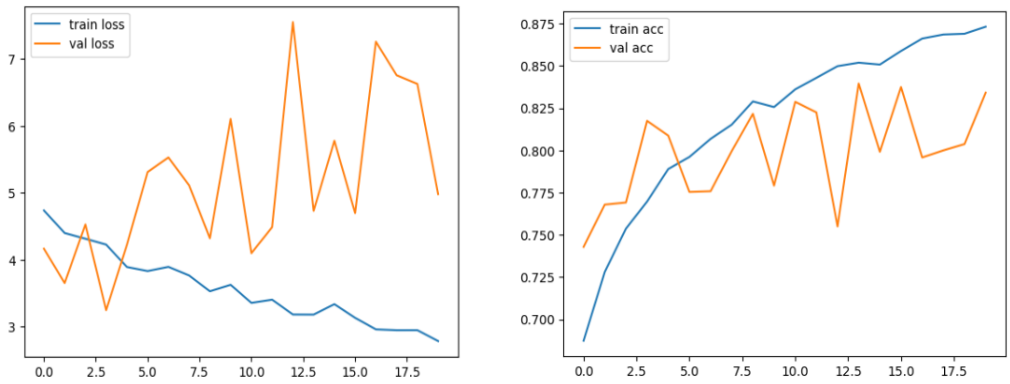
Fig 17 trained Inception V3 model

```
Epoch 1/20
1276/1276 [==============================] - 705s 553ms/step - loss: 4.7353 - accuracy: 0.6874 - val_loss: 4.1642 - val_accurac
y: 0.7425
Epoch 2/20
1276/1276 [==============================] - 243s 191ms/step - loss: 4.3984 - accuracy: 0.7281 - val_loss: 3.6501 - val_accurac
y: 0.7679
Epoch 3/20
1276/1276 [==============================] - 240s 188ms/step - loss: 4.3127 - accuracy: 0.7537 - val_loss: 4.5262 - val_accurac
y: 0.7692
Epoch 4/20
1276/1276 [==============================] - 239s 188ms/step - loss: 4.2250 - accuracy: 0.7697 - val_loss: 3.2448 - val_accurac
y: 0.8175
Epoch 5/20
1276/1276 [==============================] - 240s 188ms/step - loss: 3.8907 - accuracy: 0.7890 - val_loss: 4.2211 - val_accurac
y: 0.8087
Epoch 6/20
1276/1276 [==============================] - 242s 189ms/step - loss: 3.8295 - accuracy: 0.7961 - val_loss: 5.3101 - val_accurac
y: 0.7754
Epoch 7/20
1276/1276 [==============================] - 243s 190ms/step - loss: 3.8929 - accuracy: 0.8068 - val_loss: 5.5280 - val_accurac
y: 0.7758
Epoch 8/20
1276/1276 [==============================] - 240s 188ms/step - loss: 3.7635 - accuracy: 0.8153 - val_loss: 5.1101 - val_accurac
y: 0.7956
Epoch 9/20
1276/1276 [==============================] - 243s 190ms/step - loss: 3.5272 - accuracy: 0.8290 - val_loss: 4.3197 - val_accurac
y: 0.8217
Epoch 10/20
1276/1276 [==============================] - 245s 192ms/step - loss: 3.6243 - accuracy: 0.8256 - val_loss: 6.1035 - val_accurac
y: 0.7792
Epoch 11/20
1276/1276 [==============================] - 239s 187ms/step - loss: 3.3533 - accuracy: 0.8361 - val_loss: 4.0967 - val_accurac
y: 0.8288
Epoch 12/20
1276/1276 [==============================] - 240s 188ms/step - loss: 3.4016 - accuracy: 0.8429 - val_loss: 4.4857 - val_accurac
y: 0.8225
Epoch 13/20
1276/1276 [==============================] - 240s 188ms/step - loss: 3.1803 - accuracy: 0.8499 - val_loss: 7.5500 - val_accurac
y: 0.7550
Epoch 14/20
1276/1276 [==============================] - 238s 187ms/step - loss: 3.1789 - accuracy: 0.8519 - val_loss: 4.7286 - val_accurac
y: 0.8396
Epoch 15/20
1276/1276 [==============================] - 239s 187ms/step - loss: 3.3348 - accuracy: 0.8508 - val_loss: 5.7779 - val_accurac
y: 0.7992
Epoch 16/20
1276/1276 [==============================] - 238s 187ms/step - loss: 3.1300 - accuracy: 0.8588 - val_loss: 4.6948 - val_accurac
y: 0.8375
Epoch 17/20
1276/1276 [==============================] - 239s 187ms/step - loss: 2.9581 - accuracy: 0.8662 - val_loss: 7.2581 - val_accurac
y: 0.7958
Epoch 18/20
1276/1276 [==============================] - 243s 191ms/step - loss: 2.9454 - accuracy: 0.8686 - val_loss: 6.7566 - val_accurac
y: 0.8000
Epoch 19/20
1276/1276 [==============================] - 240s 188ms/step - loss: 2.9458 - accuracy: 0.8690 - val_loss: 6.6261 - val_accurac
y: 0.8037
Epoch 20/20
1276/1276 [==============================] - 240s 188ms/step - loss: 2.7832 - accuracy: 0.8732 - val_loss: 4.9794 - val_accurac
y: 0.8342
```

Accuracy obtained: 83.42

Fig 18 : Accuracy of Inception V3 model

The graph obtained LossVal_Loss and AccVal_acc by using train loss and validation loss for Bara_khadi character data are shown in figure 17 (a)and (b).



(a) (b)

Fig. 19. Graphical representation a) Loss data b) Accuracy data

Resnet: Running Process

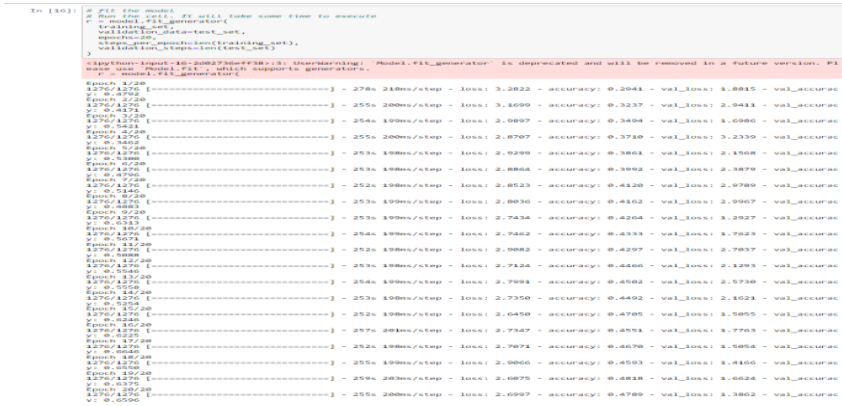


Fig .18: Running process of ResNet

Accuracy of ResNet V3 model 65

The graph obtained LossVal_Loss and AccVal_acc by using train loss and validation loss for Bara_khadi character data are shown in Figure 19 (a)and (b).

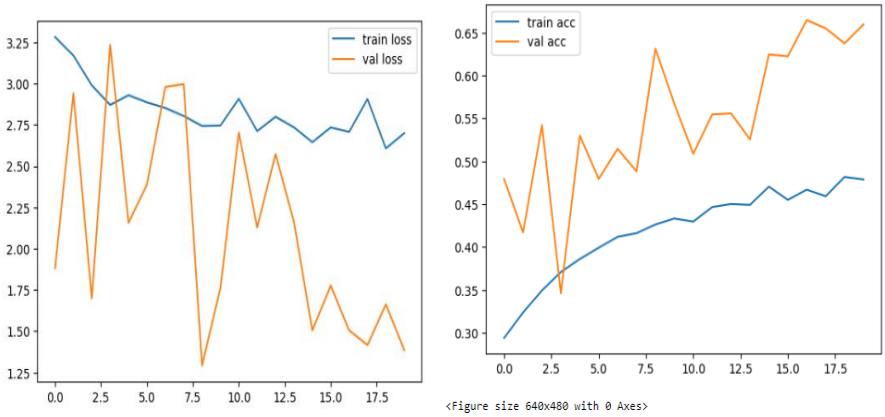


Fig 19 (a) Loss data b) Accuracy data

The graph obtained Loss Val_Loss and AccVal_acc by using train loss and validation loss for Bara_khadi character data are shown in figure 19 (a) and (b)

5. CONCLUSIONS:

The quality and similarity exits with other existing bench mark dataset is computed and compared .we represented analysis report in tabular way but it is time consuming but better analysis . after comparing many literature we concluded that there need a benchmark character dataset for better research and it give ample opportunity for the researcher for their research work . We have created a bench mark dataset for both simple character that include vowels and consonant, special character, digits as well as compound character. After going through different processing steps are carried out to standardise the input images by using matlab and Python OpenCv finally we created a grayscale image but due to noise we converted into binary images then Inverted images. Finally, we created huge dataset by using augmentation technique. To extend our manuscript we have taken only vowels characters for further processing and created spastically analysis. Our dataset is publicly available and access right can be given by the owner's concern. In the future we are planning to create a dataset from old letters, manuscripts, revenue handwritten data and news manuscript hand written data that boost our language for further level.[15-25]

To extend our dataset we have created Marathi Compound Character dataset and implemented different deep learning technique .we are going to publish our next article. We have collected different Indian language newspaper like kerla , tamil , telgu, bengli, hindi, odia, English and hindi etc and scanned and annotation work completed and created a dataset that we can represent our next manuscript .Here we have represented few example of some of the annotation data of compound character as well as newspaper handwriting character data.

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The dataset created for this study is not applicable to this paper.

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