ML & DL approach for Handwritten Character Recognition for Gujarati Characters

Dr. Priyank D. Doshi[1*], Dr. Pratik A. Vanjara[2]

[1*]Department of Computer Application, Atmiya University Rajkot-360005, India. doshipriyank@gmail.com
[2]Department of Computer Science, Shree M.P. Shah Commerce College Surendra Nagar-363002, India, pavanjara@gmail.com

ARTICLEINO	ABSTRACT
	English language should not be a barrier for education. So In India Government has decided to promote Local language or Mother tongue as a language of his primary education. In context of this, in my state Gujarat, there is lots of scope to adopt different model or tool based on AI to help students and general public for their education and daily work. Gujarati Character Recognition plays crucial role for the ease of communication between Gujarati people or in Gujarat Region. The proposed model Gujarati Handwritten Character and modifier recognition (GHCMR) is based on Machine Learning and Deep Learning and giving 97% accuracies using enough images set for all characters. It shows good performance in training as well testing the model. **Keywords—** Convolution Neural Network, Support Vector Machine, Hand Written Character Recognition (HCR)

I. INTRODUCTION

Initially, Dr. H. R.Thaker and Dr. C. K. Kumbharana researched on this areas of Handwritten character recognition. Their model was based on decision tree classifier to recognize some characters [1]. This model gives benefits to different areas of daily like from education to each clerical office.

In the proposed model we need to follow certain steps like Image Acquirement, Pre-processing, Segmentation, Feature extraction, classification and post processing [2] [3]. Many technologies and methods has been applied and it was surveyed by us and other authors previously [4].

Since handwritten text can vary by person to person due to their personal habits and writing skills. So data set can fluctuate the rate of performance. So we tried to take huge set of images. To solve the problem we adopt Convolution Neural Network. There are good dataset like MNIST, CEDAR, and CENOARMI for digits and roman characters. Similar effort is taken to build the images. Hence the outcome of the study depends of Deep Convolution Neural Network (DCNN) and Images taken.

II. PROPOSED MODEL

As shown in Figure 1, it shows stages like Image Acquirement, Segmentation, DL Feature extraction, ML classification, Mapping between prediction output and Byte code and at last Formation of Text in Required Font. Hybrid Model ensemble different feature extraction techniques and classification techniques of ML or DL. Feature extraction process carried out by Deep Learning models while classification process performed either ML or with conjunction with DL.
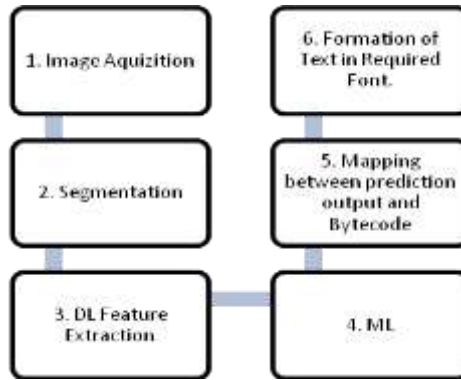
Fig. 1. Gujarati Handwritten character and Modifier Recognition

A. *COMPARISION OF DL & ML*

TABLE I. DEEP LEARNING VS. MACHINE LEARNING

PARAMETERS	DL	ML
No. of Images	High	Comparatively Low
Accuracy	High	Comparatively Low
Training Time	Longer	Comparatively Short
Hardware Dependency	GPU required	Can Train on CPU
Hyper Parameter Tuning	More	Limited

To rise efficiency and accuracy in machine learning fine tuning of parameters is required. Data set creation, Training of data set, Evaluation Methods and model types are such factors using which we can improve ML algorithm.

B. *Features of Gujarati Language*

• Gujarati language does not have upper line support like Hindi language. Green segmented images indicates disconnected characters and Brown segmented images are connected characters. So it affects our algorithm and performance. Here we tried to take enough set of images to avoid this kind of problem. There are also problem of skewers of characters. Some characters itself are confusing to recognize like 'શી' -'રી'and

' झी' - 'રી'etc.

Fig. 2. Segmented Characters of Gujarati Language

C. *Feature Extraction*

There is no need for feature extraction when using a deep network as one can just pass the images directly to the network and generally achieve good performance. This completely eliminates the big and gruelling point engineering stage of the whole process. It rises network layers to perform feature extraction itself.

Classical ML algorithms frequently bear complex point engineering. Generally, a deep dive exploratory data analysis is first performed on the image set to extract features. A dimensionality reduction might also be done for easier processing. Finally, features must be precisely named to pass over to the ML algorithm.

III. REVIEW OF DEEP HYBRID MODELS

In detection of brain tumours from MRI images, R. Hashemzehi, S. J. S. Mahdavi, M. Kheirabadi, and S. R. Kamel proposed hybrid model using CNN and NADE. This model consisted two separate networks. CNN used to extract features from raw high dimensional data automatically and exploit patterns that lead the model to correct output. A ConvNADE is an autoregressive model which uses convolutional layers instead of fully connected hidden layers. [5]

For remote sensing image recognition with fused deep learning architectures, F. Özyurt proposed model which is using per-trained architectures for feature extraction based on Alexnet, VGG16, VGG19, GoogleNet,

ResNet and SqueezeNet. Obtained features applies to the ReliefF feature selection algorithm to obtain efficient features. Then, selected features are given to the support vector machine classifier with the CNN-learned features to obtain excellent results.[6]

In solution of web personalization recommendations to provide information quickly and efficiently to user, the work of A. Singh Rajawat and S. Jain proposed intelligent map reducer model is based on machine learning concept. In this training and testing of big datasets for Map Reduce Fusion Deep Learning Based on Back Propagation Neural Network algorithm established classification problems. In this fusion recommender System using deep learning they used hybrid filtering and back propagation Neural Network to give solution. [7]

Deep learning architecture proposed by P. -Y. Ting et al. to capture the hidden features required to predict the travel time for the vehicle traveling on the freeway which includes the GRU neural network model, the XGBoost model, and the Hybrid model that combines the GRU and XGBoost through linear regression. [8]

M. E. Basiri, M. Abdar, M. A. Cifci, S. Nemati, and U. R. Acharya proposed system by which patient-written medical and health-care reviews and useful textual content on social propose can be processed. It uses two deep fusion models based on three-way decision theory to analyze the drug reviews. "The first fusion model, 3-way fusion of one deep model with a traditional learning algorithm (3W1DT) developed using a deep learning method as a primary classifier and a traditional learning method as the secondary method that is used when the confidence of the deep method during classification of test samples is low. In the second proposed deep fusion model, 3-way fusion of three deep models with a traditional model (3W3DT), three deep and one traditional models are trained on the entire training data and each classifies the test sample individually".[9]

In the era of the covid-19, to detect face mask M. Loey, G. Manogaran, M. H. N. Taha, and N. E. M. Khalifa proposed a hybrid deep transfer learning model with machine learning methodes. For feature extraction Resnet50 model used, while in the second part to detect face mask, classical machine learning algorithms Support Vector Machine (SVM), decision trees have been used. [10]

Based on deep learning and machine learning a fusion models proposed by Liu R, Pan D, Xu Y, Zeng H, He Z, Lin J, Zeng W, Wu Z, Luo Z, Qin G, Chen W. to classify benign, malignant, and intermediate bone tumors based on patient clinical characteristics and conventional radiographs of the lesion . [11]

Posture and human health status are somehow related to each other. S. Liaqat, K. Dashtipour, K. Arshad, K. Assaleh, and N. Ramzan proposed a system to monitor remotely the posture such as standing, sitting and walking. "This proposes a novel hybrid approach based on machine learning classifiers (i. e., support vector machine (SVM), logistic regression (KNN), decision tree, Naive Bayes, random forest, Linear discrete analysis and Quadratic discrete analysis) and deep learning classifiers(i. e., 1D-convolutionalneural network(1D- CNN), 2D-convolutional neural network (2D-CNN), LSTM and bidirectional LSTM) to identify posture detection." [12]

Review of above proposed model shows that ML and DL are used according their need but in our HCR problem we are using DL for feature extraction with sufficient data set. Hybrid way achieved with ML to use as a classifier for achieving good result.

IV. OUTPUT & DISCUSSIONS

 Following figure 3 shows characters that are segmented from the main images and corresponding output is given in figure 4 by the classifier with byte-code conversion.

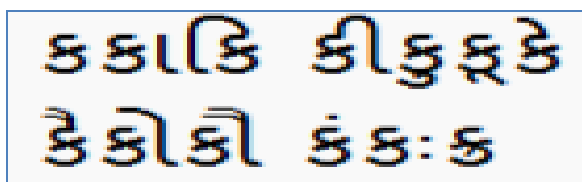**Fig. 3.** Segmented Characters with combination of vowels

Fig. 4. Output of Classifier with bytecode conversion

Architecture of CNN for classification comprised of 8 layers where 1st, 3rd and 7th layers are convolution layers in that features are maps@1024 bits per images and the 2nd, 4th and 6th layers are pooling layers. Last two layers are fully connected layers. Output layer gives 504 different outputs in terms of probabilities of these characters.

V. CONCLUSIONS

To achieve 100% accuracy still the improvement is needed, we could achieve 97% of accuracy in GHCR. Training and Testing of this model is also giving satisfactory results. We have proposed model which is working in hybrid mode. Feature extraction task carried out by deep learning model and Machine learning model used as a classifier. It is more promising that HCR for Gujarati Language character modifier recognition can be successfully achieved by CNN. Sufficient and rich data set has been prepared and used to get result of 504 probabilities and then converted into required Gujarati byte-code script.

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