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Handwritten Devnagari Character and Joint Devnagari Character Recognition Using Deep Learning

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Abstract: In our day to day life we use devnagari to communicate with each other verbally. There are many people in our country who still like to write their documents in devnagari only. In our project we recognizing devnagari as well as joint devnagari characters. The character images in our dataset are imposed by joint characters, this particular aspect leads to various conflicting behaviors of the recognition algorithm which in turn reduces the accuracy of recognition. The training of joint devnagari character image samples are carried out by using one of the deep convolution neural networks known as CNN. The handwritten datasets is collected artificially from users in the age range of 18–21, 22–25, and 26–30. It consists of joint devnagari text that are used to evaluate the experiment's performance. The datasets are comprised of many classes.

Those classes include devnagari characters, devnagari digits as well as joint devnagari characters. After performing essential steps. It is observed that the performance of CNN Classifiers like Random Forest is overall high. An overall accuracy of 94% is achieved during the recognition of devnagari character set and an accuracy of over 90% is accomplished with respect to handwritten data samples with training and testing proportions of 70% and 30% in both of the cases for the number of classes of over 58

Keywords: Devnagari characters, Joint devnagari character, CNN, DCNN, Handwritten, Recognition

I. INTRODUCTION

The recognition of handwritten Devanagari characters and joint Devanagari character sequences using deep learning techniques is the focus of this project. Devanagari is a script widely used for languages such as Hindi, Marathi, and Nepali. Accurate recognition of handwritten Devanagari characters is vital for applications such as optical character recognition (OCR), document digitization, and language processing.

Handwritten Devanagari character recognition poses significant challenges due to the complex structure of the script and variations in individual writing styles. Joint Devanagari character sequences further compound the difficulty, as multiple characters are combined to form ligatures.

To address these challenges, this project aims to develop a deep learning-based system capable of accurately recognizing both individual Devanagari characters and joint character sequences. In the past deep learning models, particularly convolutional neural networks (CNNs) and recurrent neural networks (RNNs), have demonstrated remarkable performance in various pattern recognition tasks. Leveraging the power of these models, we seek to improve the accuracy and robustness of handwritten Devanagari character recognition.

The project will involve the following key steps:

1) *Data Collection and Preprocessing:* A diverse dataset of handwritten Devanagari characters and joint character sequences will be collected. The data will undergo preprocessing steps such as normalization, rotation correction, and noise reduction to enhance the quality of the input.
2) *Dataset Annotation:* The collected data will be annotated with ground truth labels, indicating the individual characters and joint character sequences. This annotated dataset will serve as the foundation for training and evaluating the deep learning models
3) *.Model Development:* Deep learning models, such as CNN, will be designed and implemented to recognize individual Devanagari characters. These models will be trained on the annotated dataset, utilizing techniques such as deep learning and data augmentation to improve performance.

4) Joint character sequence recognition: Techniques for recognizing joint Devanagari character sequences will be explored. This may involve approaches like segmentation, ligature modeling, and sequence-to-sequence modeling to effectively handle the complexity of ligatures.
5) Model training and evaluation: The developed models will be trained on the annotated dataset, and their performance will be evaluated using appropriate evaluation metrics. The accuracy, precision, recall, and F1 score will be considered to assess the models' effectiveness in recognizing both individual characters and joint character sequences.

The successful completion of this project will lead to advancements in handwritten Devanagari character recognition using deep learning techniques. The developed system can find practical applications in OCR systems, language processing, and accessibility tools. Moreover, the project's findings can contribute to the broader field of character recognition, opening doors for further research in complex scripts and languages.

A. Proposed Methodology

CNN or Convolutional Neural Network, is a type of deep learning model that is widely used for various computer vision tasks, such as image classification, object detection, and image recognition. It is inspired by the organization of the visual cortex in animals and is particularly effective in processing grid-like data, such as images.

1) CNN Working

a) Input Layer

The input layer receives the preprocessed image of a handwritten character or joint character combination.
The image is typically represented as a matrix of pixel values, where each pixel corresponds to a specific intensity or color value.

b) Convolutional Layers

The convolutional layers consist of multiple filters or kernels that perform convolutions over the input image.
Each filter is a small matrix that slides across the input image, computing dot products with local patches.
As the filter moves, it takes spatial information and detects important features, such as edges, corners, or textures.
The convolutions result in feature maps, which are matrices that capture the response of each filter at different spatial locations.

c) Pooling Layers

Pooling layers reduces the spatial dimensions of the feature maps while preserving important information.
Max pooling and average pooling are common techniques used in CNNs.
Max pooling selects the maximum value within a region of the feature map, while average pooling computes the average value.
Pooling helps to make the representation more compact, reduce computation, and enhance the network's ability to generalize.

d) Activation Function

After each convolutional and pooling operation, an activation function is applied element-wise to introduce non-linearity.
Rectified Linear Unit (ReLU) is a commonly used activation function in CNNs.
ReLU sets negative values to zero and keeps positive values unchanged, effectively introducing non-linear behavior.
Non-linear activation allows the network to learn complex patterns and enhances its expressive power.

e) Output Layer

The output layer of the CNN produces the final classification results.
In character recognition tasks, the output layer typically consists of neurons representing different character classes.
Each neuron computes a score or probability indicating the likelihood of the input belonging to the corresponding character class. Softmax activation is commonly used in the output layer to convert the scores into a probability distribution, ensuring the sum of probabilities is 1.
The layers within a CNN, from the input layer to the output layer, are interconnected through learnable parameters (weights and biases) that are adjusted during training using backpropagation and optimization algorithms such as gradient descent. The network learns to recognize patterns and features relevant for accurate classification.

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B. System Architecture

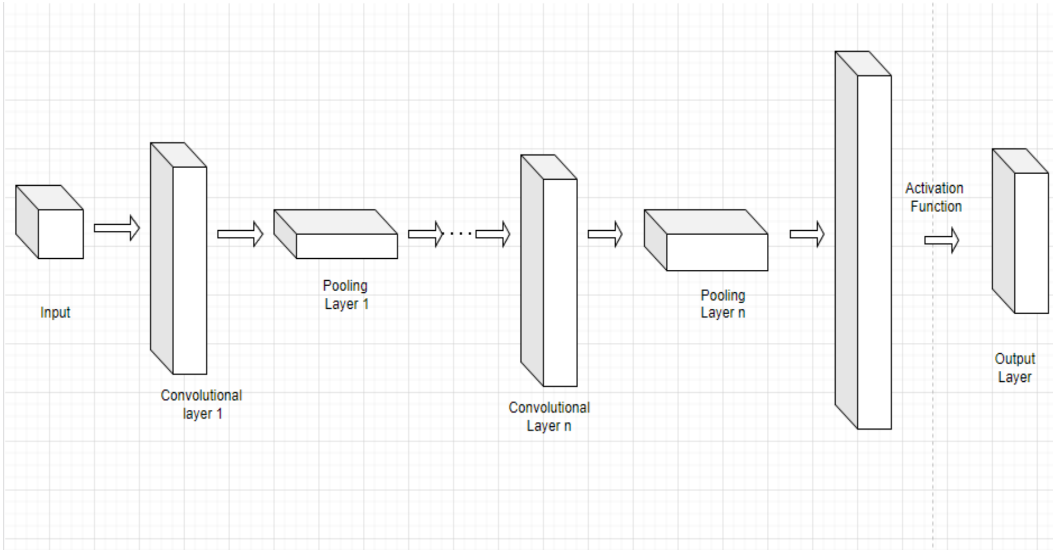

Figure 1: System Architecture

The proposed convolutional neural network (CNN) Model is build Recognizing Simple with Joint Devanagari Handwritten Characters. The model consists of two convolutional layers with ReLU activation, followed by max pooling for downsampling. Dropout layers are included for regularization, and a flatten layer is used to reshape the output. Two fully connected layers with ReLU activation and softmax activation are added for classification. The CNN architecture aims to extract image features, reduce spatial dimensions, and classify images into 58 classes**.**

C. Input and Output

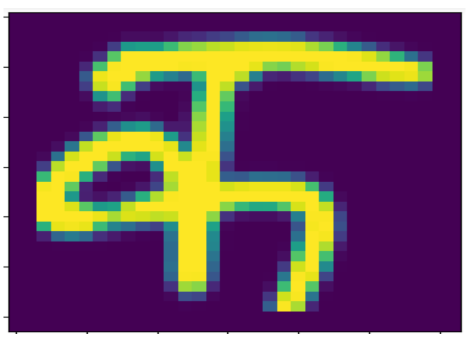

Figure 2: Input of Devnagari character

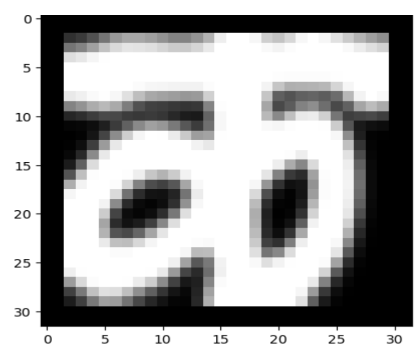

Figure 3: Output of Devnagari character

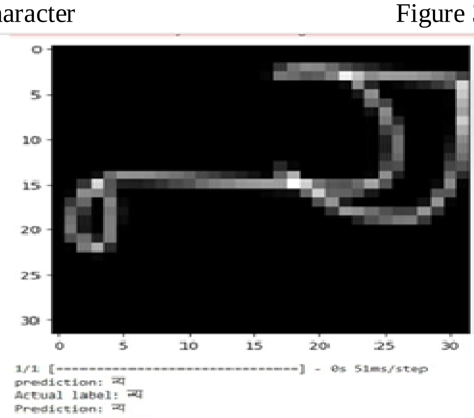

Figure 4: Output of Joint Devnagari character

D. Accurracy

Sno.	Accuracy	Accuracy obtained
1.	Proposed accuracy	90%
2.	Actual accuracy	94%

Table: Accuracy Table

From this table it is observed that our proposed accuracy was 90% and we were able to obtain an accuracy of 94%.

II. CONCLUSIONS

In conclusion, this research paper presented a comprehensive methodology for handwritten Devanagari character and joint Devanagari character recognition using deep learning techniques, specifically Convolutional Neural Networks (CNNs). The proposed methodology encompassed various stages including image acquisition, preprocessing, segmentation, feature extraction, classification, and post-classification.

Through the implementation of the proposed methodology, we successfully addressed the challenges associated with recognizing both individual Devanagari characters and joint character combinations. By leveraging the power of CNNs, the model effectively learned and extracted meaningful features from the preprocessed images, enabling accurate classification.

The CNN architecture demonstrated its ability to capture spatial information and detect important patterns, such as edges, corners, and textures, through the convolutional layers. The pooling layers aided in reducing the dimensionality of the feature maps while preserving critical information.

The experimental results showcased the effectiveness of the proposed methodology in accurately recognizing handwritten Devanagari characters and joint character combinations. The trained model achieved high classification accuracy, demonstrating its potential for practical applications such as optical character recognition (OCR), document processing, and language processing.

The findings of this research contribute to the advancement of Devanagari character recognition techniques, offering valuable insights into the capabilities of deep learning approaches. However, further research can explore enhancements, such as exploring advanced network architectures, optimizing hyperparameters, or integrating advanced data augmentation techniques, to further improve the recognition performance.

In conclusion, the proposed methodology provides a strong foundation for the development of robust and accurate handwritten Devanagari character and joint character recognition systems. By leveraging deep learning techniques, we have opened up new possibilities for automating tasks that require the recognition of Devanagari characters, which can have significant implications for various domains, including language processing, cultural preservation, and information retrieval.

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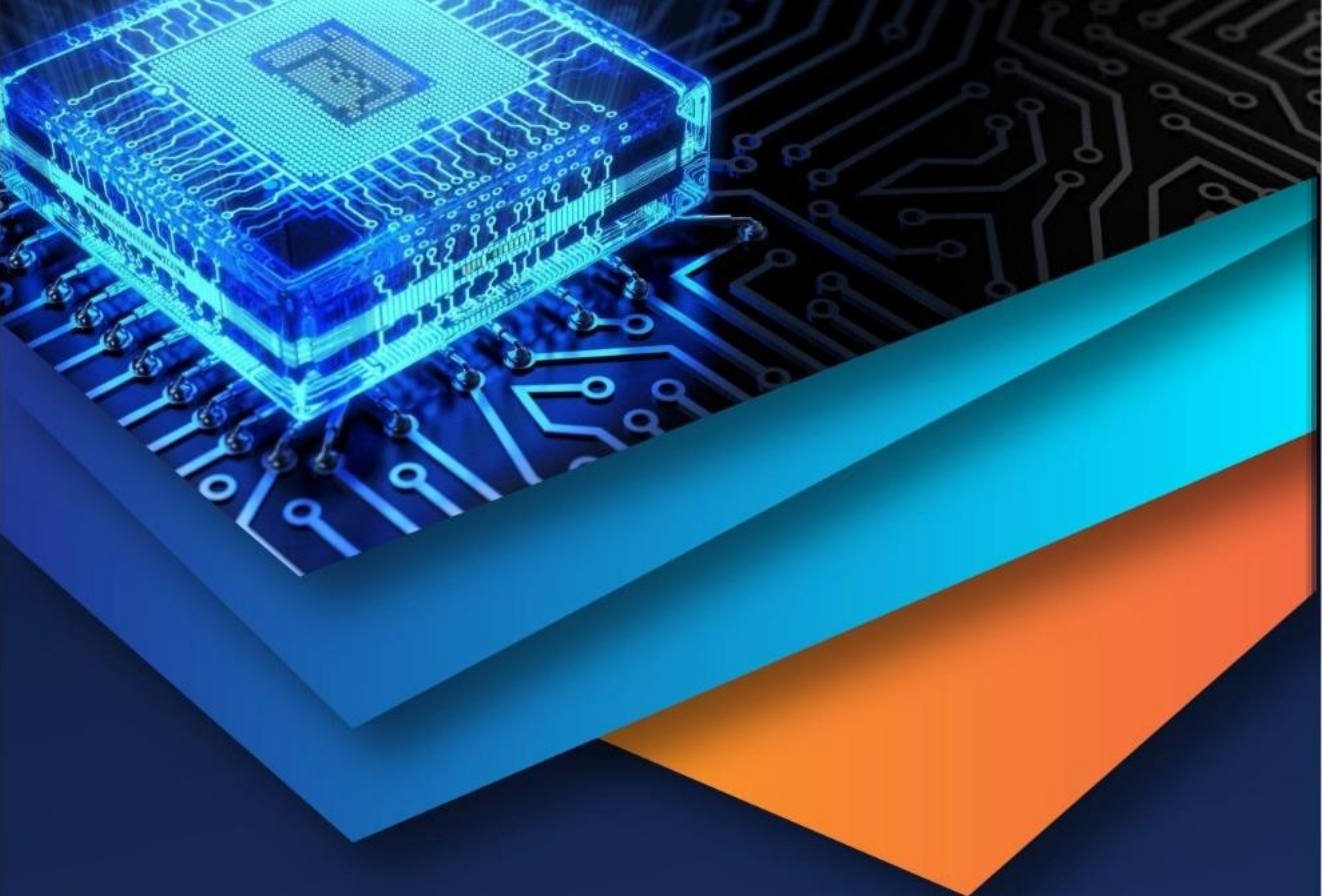

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