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Hindi-Handwritten-Character-Recognition using Deep learning

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Abstract: ***Recognizing handwritten Hindi characters poses a significant challenge in the realms of machine learning and computer vision, particularly in the context of India's accelerating digitization. To address this, accurate and efficient algorithms are imperative for applications ranging from document analysis to postal automation and data entry. Leveraging the advancements in deep learning, we propose a novel approach to Hindi Handwritten Character Recognition. Our method employs a combination of Convolutional Neural Networks (CNNs) to extract image features and Recurrent Neural Networks (RNNs) to capture temporal dependencies within character sequences. Through rigorous evaluation on a standard benchmark dataset, our approach achieves state-of-the-art recognition accuracy. Furthermore, we validate its practical utility by successfully recognizing handwritten postal addresses on envelopes and other real-world applications. This research offers a promising solution to the challenges of Hindi Handwritten Character Recognition, with potential implications for advancing the digitization efforts not only in India but also in analogous regions.***

Keywords: image classification, CNN, Softmax classifier, Pooling, LSTM, Deep Learning.

I. INTRODUCTION

Introducing Hindi handwriting character recognition through deep learning presents an exciting opportunity to bridge technology with linguistic diversity. The rich tapestry of the Hindi script, Devanagari, encompasses a plethora of characters, each with its unique strokes and forms. At the core of this endeavor lies the acquisition or creation of a diverse dataset comprising handwritten Hindi characters, capturing the intricacies of various handwriting styles. Preprocessing steps, including image cleaning and normalization, set the stage for the subsequent model architecture design. Leveraging Convolutional Neural Networks (CNNs) or Recurrent Neural Networks (RNNs), tailored to the sequential nature of handwriting strokes, forms the backbone of the recognition system. Training involves data augmentation techniques and hyperparameter tuning to optimize model performance. Evaluation metrics such as accuracy, precision, and recall validate the model's efficacy on a test dataset. Ultimately, the deployment of the trained model into user-friendly applications can facilitate seamless interaction, offering potential applications in document digitization, language learning, and assistive technologies. Despite challenges like data scarcity and computational complexity, this pursuit embodies the fusion of linguistic heritage with cutting-edge technology, promising innovative solutions in the realm of character recognition and beyond.

II. PROBLEM STATEMENT

The problem statement for Hindi handwriting character recognition using deep learning involves developing an accurate and robust model capable of deciphering handwritten Hindi characters, known as Devanagari script, amidst the script's intricate variations and complexities. This entails addressing challenges such as the scarcity of annotated datasets covering diverse handwriting styles, the need for sophisticated preprocessing methods to clean and standardize input images, and the design of deep neural network architectures tailored to the nuances of the Devanagari script. Additionally, the system must generalize well across various handwriting styles and conditions, necessitating techniques like data augmentation and transfer learning. Evaluation metrics such as accuracy, precision, and recall will gauge the model's performance, with the ultimate goal of facilitating tasks such as document digitization, language processing, and accessibility for users with diverse linguistic backgrounds. Through this endeavor, the aim is to bridge the gap between traditional handwritten communication and modern digital workflows, thereby advancing technology's role in linguistic diversity and accessibility.

III. LITERATURE SURVEY

The paper "Hindi Handwritten Character Recognition using Deep Learning Techniques" by S. Sarika and M. P. Sebastian presents a significant contribution to the field of handwritten Hindi character recognition using deep learning methods, particularly focusing on Convolutional Neural Networks (CNNs).

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The authors propose an approach that utilizes CNN architecture to achieve accurate recognition of handwritten Hindi characters. Their method achieved an impressive accuracy of 96.94% on the dataset used, demonstrating the effectiveness of the deep learning approach for recognizing handwritten Hindi characters. The authors also explore the use of radial basis function networks and multilayer perceptron neural networks for comparison purposes. They employ the backpropagation error algorithm to enhance the recognition rate of the models.

The dataset used in their study comprises 245 samples written by five different users, ensuring diversity and robustness in the evaluation. Through comparative analysis, the authors find that the multilayer perceptron (MLP) networks outperform radial basis function networks in terms of recognition accuracy. However, they note that MLP networks require longer training times compared to radial basis function networks.

Overall, the results obtained from their experiments highlight the effectiveness of CNN-based approaches for handwritten Hindi character recognition, with MLP networks showing promising performance. This research contributes valuable insights into the optimization of deep learning models for recognizing characters in the Devanagari script, with implications for various applications such as document analysis, optical character recognition, and natural language processing.

IV. REQUIRED TOOLS

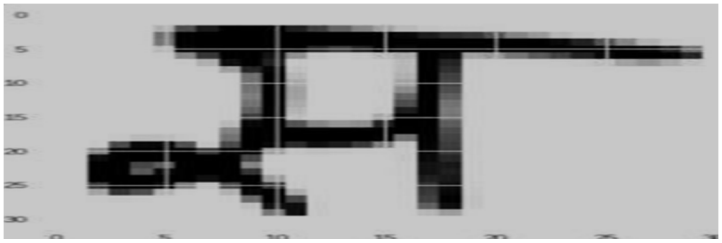
Python for programming.
Deep learning frameworks like TensorFlow or PyTorch.
Image processing libraries such as OpenCV.
Data manipulation with NumPy.
Visualization with Matplotlib.
Optionally, GPU support for faster training.
Handwritten Hindi character datasets for training and evaluation

V. METHODOLOGY

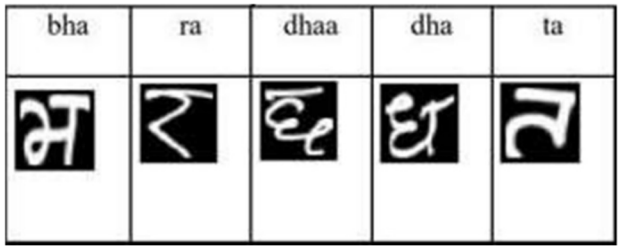
Handwritten Hindi character recognition using deep learning involves a multi-step methodology aimed at accurately deciphering handwritten characters in the Devanagari script. Initially, a diverse dataset comprising handwritten Hindi characters is acquired or created, encompassing variations in handwriting styles and character forms. Preprocessing steps are then employed to clean and standardize the input images, including techniques like noise removal, contrast enhancement, and normalization. Subsequently, deep learning models, particularly Convolutional Neural Networks (CNNs) or Recurrent Neural Networks (RNNs), are designed and trained on the preprocessed dataset. These models learn to extract relevant features from the input images and classify them into respective character categories. During training, techniques such as data augmentation, transfer learning, and hyperparameter tuning are utilized to enhance the model's performance and generalization capabilities. Following training, the model is evaluated on a separate test dataset to assess its accuracy and robustness. Finally, the trained model can be deployed into applications or services where users can input handwritten Hindi characters for recognition, facilitating tasks such as document digitization, language processing, and accessibility for individuals with diverse linguistic backgrounds. Through this methodology, handwritten Hindi character recognition using deep learning offers a promising solution to bridge the gap between traditional handwritten communication and modern digital workflows.

VI. EXPERIMENT RESULTS

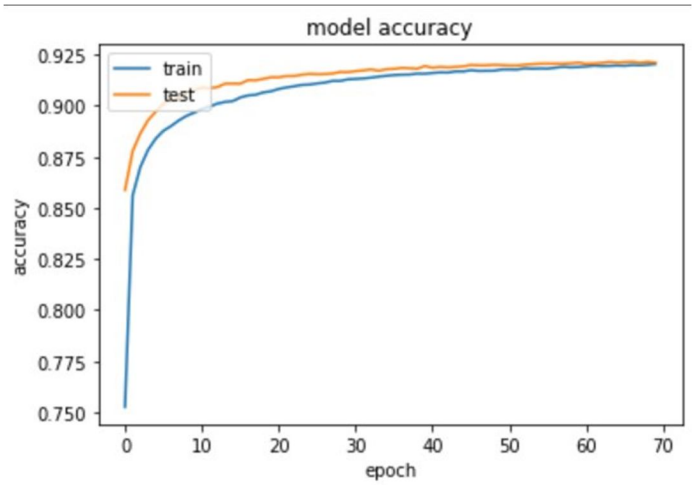
The utilization of deep FFNNs with multiple hidden layers and a large number of neurons offers a powerful framework for tackling challenging image classification tasks, providing a balance between model complexity and computational efficiency while achieving notable performance improvements.

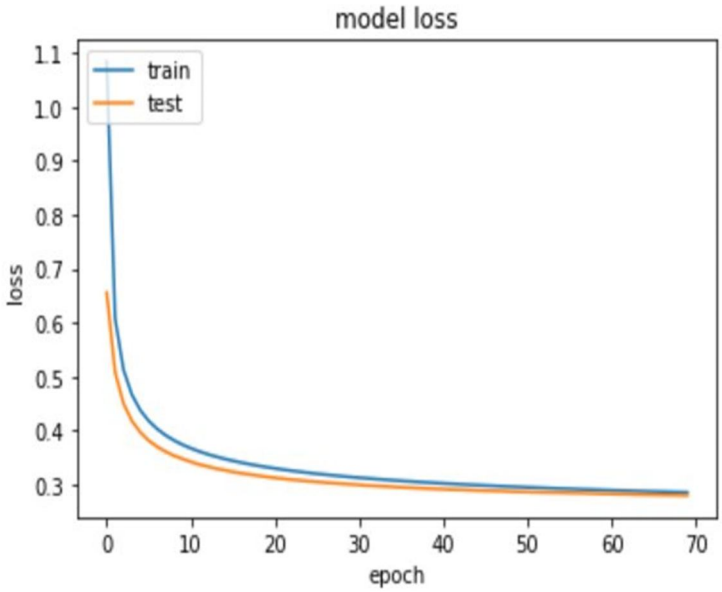


Example-1



Example-2 Parameters setup for CNN with ADAM optimization





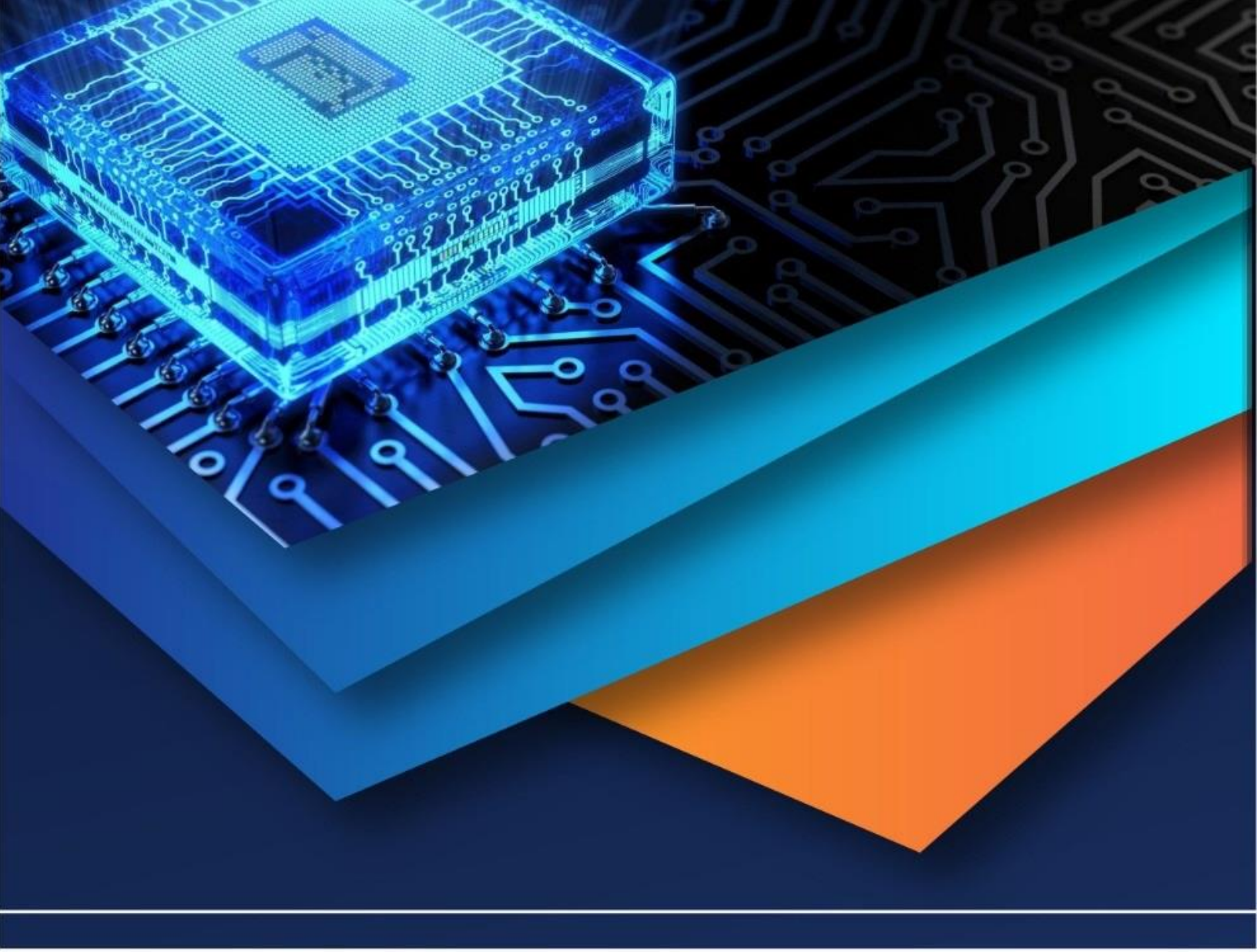
VII. CONCULSION

In our paper, we introduced various neural network methodologies for Handwritten Hindi character recognition. We conducted performance evaluations using Convolutional Neural Networks (CNNs) with optimized techniques and Deep Feed Forward Neural Networks (DFFNNs). These models were trained and tested on a standardized dataset collected from diverse users. Our experimental findings indicate that DFFNN, CCN-Adam, and CNN-Prop exhibited superior accuracy for recognizing Handwritten Hindi characters compared to alternative techniques. The proposed method demonstrated promising results, achieving a high accuracy rate in character recognition tasks.

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