WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

HANDWRITTEN CHARACTER AND DIGIT RECOGNITION USING CNN

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1.ABSTRACT :

Hand writing recognition, the technology that allows computers or digital devices to recognize and interpret handwritten text. It involved analyzing and interpreting handwritten text images, identifying the characters or words present in image and converting them into machine-readable text. It could be used in a variety of applications, such as digitizing handwritten notes or documents, recognizing handwritten addresses on envelopes, converting handwritten text into typed text in text editors or email clients, and even recognizing handwritten signature for authentication purposes. It had applications in many fields, including education, finance, healthcare, and law enforcement. Handwritten character and digit recognition using Convolutional Neural Networks (CNNs) is a technology that automates the process of identifying characters, digits and special characters in handwritten images. Handwritten Digit and character Recognition is the capability of a computer to recognize the mortal handwritten integers from different sources like images, papers and classify them into 10 predefined classes (0-9) for digit. It involves collecting and preprocessing a dataset, designing a CNN architecture with convolutional, pooling, and fully connected layers, training the model to learn features and patterns, and then using it to make predictions. The CNN extracts features from the input images, and the output layer produces class probabilities. After training and evaluation, the model can be deployed in applications like cheque reading, form processing, and more where handwritten character recognition is needed. CNNs excel in this task because they can automatically learn relevant features from the data, making them highly effective for image-based recognition.

2.Keywords CNN, Optical Character Recognition, MNIST Datasets

3.Introduction :

Handwriting recognition, also known as Handwriting Recognition (HWR) or Handwritten Text Recognition (HTR), is the ability of a computer to receive and interpret human-readable handwritten data from various sources, such as paper documents, images, photographic touchscreen displays, and other electronic devices. This process involves several tasks, including formatting, splitting letters, and identifying the most relevant words, all of which are handled by the handwriting recognition system.

Automatic handwriting character recognition has been a subject of significant academic and commercial interest. One of the primary challenges in handwritten character recognition is dealing with the wide variety of writing styles exhibited by different authors. Handwriting styles can vary significantly, making it difficult for recognition systems to accurately interpret and transcribe the text. Some complex handwriting scripts even have distinct styles for writing individual words. Depending on the language, characters can be written separately (e.g., English, Bangla, Arabic) or joined together in a cursive manner. In some cases, characters are interconnected, which adds another layer of complexity to the recognition process. Researchers in the field of Natural Language Processing (NLP) have long recognized the challenge posed by diverse handwriting styles and have worked on developing algorithms and models to address this issue. The goal is to create systems that can accurately transcribe handwritten text regardless of the specific style or script in which it is written.

Additionally, handwritten digit recognition is a specific subfield of handwriting recognition, where the goal is to identify and transcribe numeric characters (0-9) written by hand. This task can be particularly sensitive to environmental noise, as variations in writing style and the quality of the input (e.g., smudges, uneven ink, or distortions in scanned images) can make recognition more challenging.

SVM, KNN, and other machine learning procedures had been created to recognize written by hand digits. Profound learning strategies like CNN had the most noteworthy precision when compared to the foremost commonly utilized machine learning calculations for manually written character acknowledgment.

Design acknowledgment and large-scale image classification were both done with CNN. Penmanship character acknowledgment might be acquired about field in computer vision, manufactured insights, and design acknowledgment. It could be claimed that a computer application that conducts handwriting recognition had the capacity to procure and recognize characters in photos, paper documents, and other sources, and change over them to electronic or machine-encoded shape. Profound learning could be a well-known field of machine learning that employments progressive structures to

memorize high- level deliberations from information. Concurring to references, the accessibility of innovation CPUs, GPUs, and difficult drives, among other things, machine learning calculations, and expansive information, such as MNIST manually written digit information sets were all variables in profound learning's success.

Deep learning had indeed gained significant popularity as a method for extracting and learning to recognize intricate patterns from large datasets. It excelled in producing patterns from data at multiple layers or depths, which is why it's often referred to as "deep learning." This technique proved to be remarkably effective in various applications, including image recognition, classification, pattern identification, and feature extraction.

One of the most powerful deep learning algorithms for image-related tasks is Convolutional Neural Networks (CNNs). CNNs are designed to process and analyze visual data efficiently. They have been highly successful in image classification tasks, where they can distinguish between different objects, animals, or scenes in images. However, in our project, we used the packages Tensorflow, Keras, Matplotlib &
Numpy.

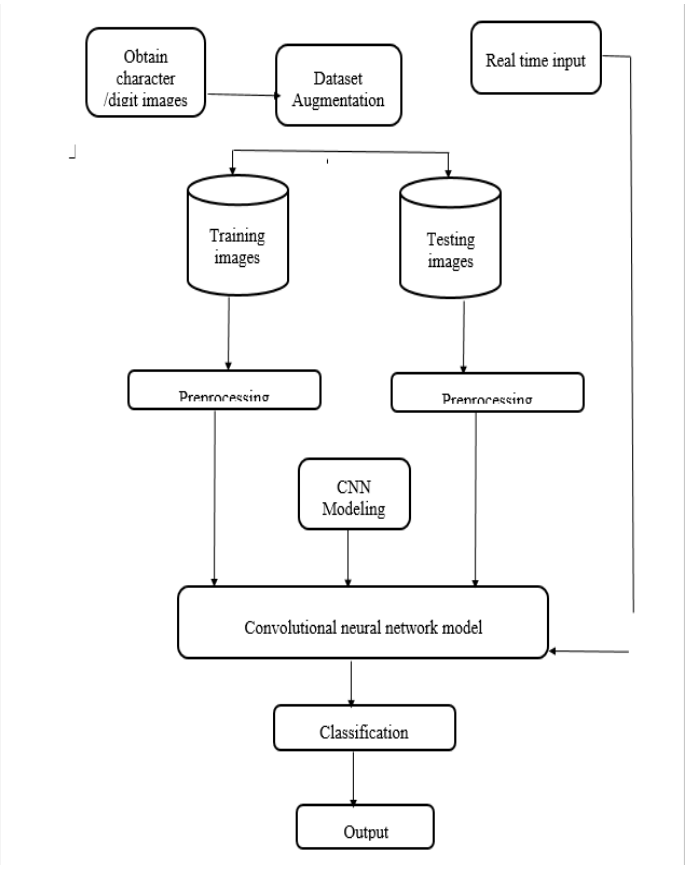
4. Proposed System :

In our proposed system for handwritten digit and character recognition, I plan to harness the power of Convolutional Neural Networks (CNNs), a proven and highly effective deep learning technology. CNNs offer numerous advantages for this task, including automatic feature learning, high accuracy, adaptability to diverse handwriting styles, scalability to handle a wide range of characters and digits, robustness to noise, and efficient training facilitated by modern deep learning frameworks like TensorFlow and Keras.

The key components of the proposed system will start with data collection, where a diverse dataset of handwritten digits and characters will be gathered, ensuring representation of various writing styles and languages. Data preprocessing will include tasks like image resizing, normalization, and data augmentation to enhance model generalization. The heart of the system lies in the model architecture, involving the design of a CNN structure with convolutional layers and fully connected layers. Options such as using pre- trained models or creating custom architectures will be considered. Subsequent stages include training the CNN, evaluation of its performance using metrics like accuracy, precision, and recall, hyperparameter tuning for optimization, d Documentation and maintenance will be pivotal to ensure the system's long- term reliability. Ultimately, this proposed system using CNNs will provide an accurate and adaptable solution for recognizing handwritten characters and digits across various applications, including Optical Character Recognition (OCR) and document processing.

5.1 System Architecture :

Before the rise of deep learning, traditional machine learning algorithms like Support Vector Machines (SVM), Random Forests, k-Nearest Neighbors (k- NN), and Decision Trees were widely used for character and digit recognition. These methods often require handcrafted feature extraction, where relevant features are extracted from the input data (e.g., pixel values) and used to train a model. Traditional methods often require handcrafted feature engineering, which can be time-consuming and may notfully capture all relevant characteristics of the handwriting. This process relies on domain expertise and may not generalize well to different handwriting styles. HMMs have been used for recognizing handwriting sequences. HMMs model the temporal dependencies in the handwriting, which can be particularly useful when recognizing cursive or connected script. Traditional methods do not

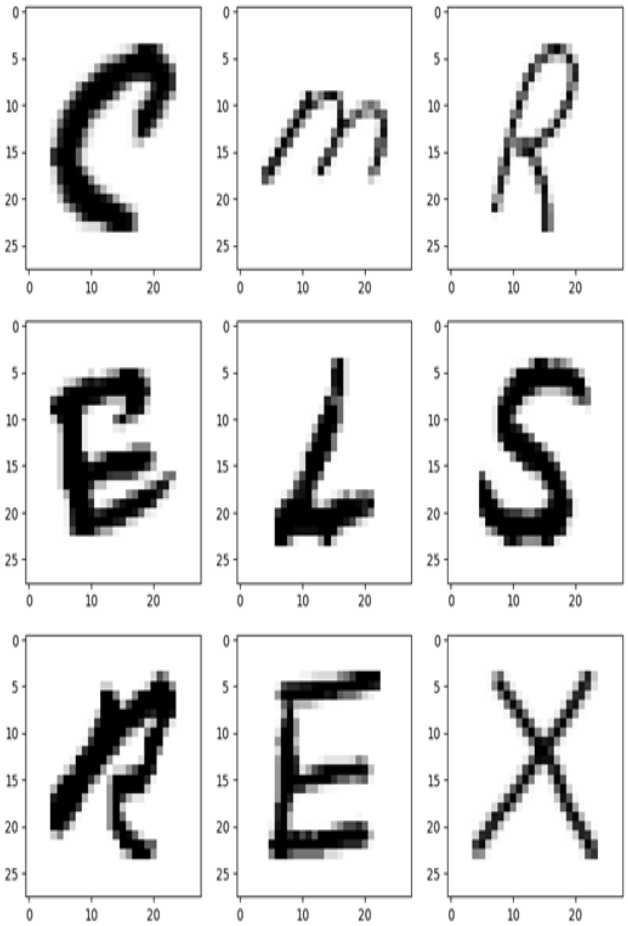


perform hierarchical feature learning as effectively as CNNs. CNNs are designed to automatically learn hierarchical features, which can be crucial for recognizing complex patterns in handwriting. Traditional feed-forward neural networks (also known as multi- layer perceptron's) have been used for character recognition. These networks may require more manual feature engineering compared to CNNs. The choice of approach depends on the specific requirements of the recognition system, the amount and quality of training data, and available computational resources.

6. Conclusion :

The proposed approach for handwritten alphabet and digit recognition demonstrates impressive accuracy rates on test images from the A-Z Handwritten Alphabets dataset, which are comparable to earlier research results. Specifically, for the A Handwritten Alphabet dataset, the system achieves an exceptional precision rate of 99.50%, representing the highest reported accuracy on this dataset to date. This highlights the effectiveness of the approach in recognizing handwritten alphabet characters. Moreover, the approach showcases the utility of unsupervised pre-training, even in scenarios where the datasets are independently and randomly collected. This suggests that the pre-training method can be valuable in improving recognition accuracy across various data sources. In every experimental scenario, the model employing Convolutional Neural Networks (CNN) outperforms the model using only ConvNets, further underscoring the efficacy of the CNN architecture in achieving superior accuracy in character recognition tasks. Furthermore, the approach yields state- of-the-art results for the MNIST dataset, a widely recognized dataset for handwritten digit recognition, and delivers excellent results for the A-Z Hand Written dataset, extending its applicability to both digits and alphabet characters. This demonstrates the versatility and effectiveness of the proposed method in various recognition tasks and datasets, reaffirming its significance in the field of character and digit recognition.

7. Sample Output :



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