

A CNN-BASED HANDWRITTEN ENGLISH CHARACTER RECOGNITION

Submitted by

**Aleesh Suvarna M S,
Arun A,
Robert Sakthi V,
Shergin N S,**

Under the Supervision

of

Mrs. I. S. SREE LEKSHMI, M.E,A.P

**GOOD SHEPHERD COLLEGE OF ENGINEERING AND
TECHNOLOGY, MARUTHAMPARAI-629101**

ABSTRACT

Recognition of handwritten documents facilitates efficient data management and enhances accessibility in areas such as archiving, finance, and healthcare. This research focuses on utilizing Convolutional Neural Networks (CNNs) for the recognition of handwritten English characters and words. A dataset of handwritten images is employed for training and evaluation. The proposed framework addresses challenges arising from variations in individual handwriting styles by leveraging CNNs to accurately identify handwritten characters and words. Experimental results demonstrate an accuracy of 94.36% for uppercase characters and 88.97% for lowercase characters. Furthermore, the model achieves 92.36% accuracy in recognizing uppercase words and 98.48% accuracy in recognizing lowercase words, highlighting the effectiveness of CNN-based approaches in handwritten text recognition.

1.Introduction

Handwritten document recognition plays a crucial role in modern data management, enabling efficient storage, retrieval, and accessibility of information in sectors such as healthcare, finance, and archiving.

Despite the widespread use of digital text, a significant amount of data remains in handwritten form, which poses challenges for automated processing due to variations in individual handwriting styles, inconsistencies in stroke patterns, and differences in character formation.

This research focuses on the application of CNNs to recognize handwritten English characters and words. By leveraging a dataset of handwritten images, the study aims to address the challenges associated with handwriting variations and demonstrate the effectiveness of CNN-based approaches in achieving high accuracy for both character-level and word-level recognition. This research addresses the problem of accurately recognizing handwritten English characters

ACKNOWLEDGEMENT

The authors would wish to acknowledge that I.S.Sree Lekshmi, Professor, Department of Computer Science and Engineering, Good shepherd college of engineering and technology, is of priceless guidance, constant assistance, and positive recommendations during the entire research process of this study. Their experience and support have played a significant role in achieving success in this paper.

The authors also would like to thank the members of faculty and staff of the Department of Computer Science and Engineering, Good shepherd college of engineering and technology, who were able to offer necessary resources and conducive environment to conduct research.

We owe our friends and peers that it is because of their cooperation, encouragement and wise comments that we have been able to come up with this work.

Lastly, we would like to thank our families to have supported us all the time, and encouraged us to complete this research successfully.

2. Literature Review

2.1 Deep Learning Approaches

With the advancement of deep learning, Convolutional Neural Networks (CNNs) have become widely used for handwritten character recognition. CNNs automatically learn relevant features from input images, reducing the need for manual feature engineering.

- Noisy or low-quality images
- Cursive or connected handwriting

2.1.2 CNN Combined with RNN and LSTM

Researchers have also combined CNNs with other techniques such as Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks to improve word-level recognition. This combination helps in recognizing sequences of characters, enabling better performance on handwritten words rather than individual letters.

2.2 Optical Character Recognition (OCR) Systems

In addition to deep learning approaches, Optical Character Recognition (OCR) systems such as Tesseract have been widely used for extracting text from images. While OCR systems perform well for printed text, their performance on handwritten text varies depending on preprocessing and image quality. Recent studies have focused on integrating OCR with deep learning models to enhance recognition accuracy.

2.3 Research Gaps

Although many approaches have been developed for handwritten recognition, there are several gaps that still need attention:

- Handling variations in individual handwriting styles
- Improving accuracy on lowercase and cursive writing
- Integrating additional features such as text correction, translation, and voice-based interaction

2.4 Motivation for the Proposed System

The identified research gaps highlight the limitations of existing handwritten document recognition systems, such as lower accuracy, lack of adaptability to different handwriting styles, and limited real-time capabilities. These challenges create a strong motivation to design a more advanced and efficient solution that can overcome these issues and provide reliable results in practical applications.

To address these gaps, the proposed system integrates Convolutional Neural Networks (CNNs) with Optical Character Recognition (OCR) techniques, enabling more accurate and robust recognition of handwritten text. In addition, the system incorporates intelligent features such as image preprocessing, translation, and voice interaction, which enhance usability and make the system more user-friendly for diverse users and applications.

i. Variability in Handwriting Styles

One of the primary motivations is the high variability in individual handwriting. Different people write the same character in diverse ways, with variations in size, shape, orientation, and stroke order. Existing systems often struggle to generalize across such differences, leading to reduced accuracy. The proposed system aims to handle this variability more effectively.

ii. Limitations of Traditional Methods

Earlier recognition techniques relied heavily on handcrafted features and rule-based approaches. These methods lack robustness when dealing with complex or noisy data.

iii. Demand for Automation

There is a growing demand for automating tasks such as digitizing historical documents, processing handwritten forms, bank cheque verification, and postal address recognition. Manual processing is time-consuming and error-prone, which drives the need for a reliable automated recognition system.

3. Methodology

The proposed system for handwritten English character recognition is based on a Convolutional Neural Network (CNN) model integrated with a document upload and processing pipeline. The methodology consists of the following stages:

3.1 Data Collection

A dataset of handwritten English characters and words is collected from multiple sources. The dataset includes both uppercase and lowercase characters with variations in writing styles, sizes, and orientations to ensure robustness.

3.2 Data Preprocessing

Before feeding the data into the model, several preprocessing steps are applied:

- **Image resizing** to a fixed dimension (e.g., 28×28 or 64×64 pixels)
- **Grayscale conversion** to reduce complexity
- **Noise removal** using filtering techniques
- **Normalization** to scale pixel values between 0 and 1
- **Segmentation** to isolate individual characters from words

These steps improve the quality and consistency of input data.

3.3 CNN Model Architecture

The core of the system is a CNN model designed for feature extraction and classification. The architecture includes:

- **Convolutional layers** to extract spatial features
- **Activation function (ReLU)** to introduce non-linearity
- **Pooling layers (Max Pooling)** to reduce dimensionality
- **Fully connected layers** for classification
- **Softmax layer** for output probability distribution

The model is trained using a labeled dataset with categorical outputs representing different characters.

3.4 Training and Testing

- The dataset is divided into **training and testing sets**
- The model is trained using **backpropagation and optimization algorithms (e.g., Adam optimizer)**
- Performance is evaluated using **accuracy metrics**

3.5 PDF Upload and Processing

The system allows users to upload handwritten documents in PDF format. The process includes:

- **PDF upload interface** for user input
- Conversion of PDF pages into images
- Extraction of handwritten text regions
- Passing extracted images to the trained CNN model

3.6 Text Recognition and Output

- The CNN model predicts characters from input images
- Characters are combined to form words and sentences
- The recognized text is displayed to the user
- Option to download the output as a text or PDF file

4. Conclusion

This research presented a Convolutional Neural Network (CNN)-based system for handwritten English character and word recognition. The proposed approach effectively handles variations in handwriting styles and improves recognition accuracy through proper preprocessing and model design. The results show that the system achieves high accuracy for both uppercase and lowercase characters, demonstrating its reliability.

5. References

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