Arabic Handwritten Characters Recognition using Convolutional Neural Network

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***Abstract*—Handwritten characters present significant challenges for recognition due to their variability in writing styles. This study focuses on recognizing Arabic handwritten characters using a Convolutional Neural Network (CNN). Unlike previous research which has largely concentrated on printed text, this work employs a deep CNN model to achieve high accuracy in recognizing Arabic handwritten characters. The proposed CNN model was trained and tested on a customized version of the Arabic Handwritten Characters Dataset (AHCD) which includes samples of Arabic letters in all their positional forms: beginning, middle, and end. The model achieved an accuracy of 83.85% on this personalized dataset.**

***Index Terms*—Character recognition, Handwritten text recognition, Convolutional Neural Network, Optical Character Recognition, Arabic OCR.**

I. Introduction

Arabic is a widely spoken language with over 420 million speakers worldwide. Despite advancements in handwritten character recognition for many languages, Arabic remains a challenging language due to its complex script and diverse character set, which includes 28 basic characters and multiple forms depending on their position in a word. The variability in handwriting further complicates the recognition process. This paper proposes a deep CNN model for the recognition of Arabic handwritten characters, addressing the challenges posed by the language's unique script and handwriting variability.

II. Related Work

Previous research in the field of handwritten character recognition has predominantly focused on printed text. Several techniques, including traditional machine learning methods and more recent deep learning approaches, have been applied to the recognition of Latin, Chinese, and other scripts. However, Arabic handwritten character recognition has received comparatively less attention due to its intrinsic complexities.

III. Dataset

For this study, we utilized a customized version of the Arabic Handwritten Characters Dataset (AHCD). This dataset includes samples of all basic Arabic characters in all their positional forms: isolated, beginning, middle, and end. Each image in the dataset is in RGB mode and resized to 128x128 pixels. This customization ensures that the model can accurately recognize each character regardless of its position in a word. The dataset was divided into 60% (23,838 files) for training, 20% (5,959 files) for validation, and 20% (5,959 files) for testing. The input shape for the model is (128, 128, 3).

IV. Methodology

We propose a CNN-based model designed to predict classes of character images. The input size of the model is 128x128x3, capable of predicting 64 different Arabic characters in their various positional forms.

A. Model Architecture

The proposed model utilizes the ResNet50 architecture pretrained on the ImageNet dataset, with the top layers removed. The ResNet50 model was followed by a GlobalAveragePooling2D layer and a dense layer with 64 output units and a softmax activation function.

B. Training Process

The model was compiled with the Adam optimizer and categorical cross-entropy loss function. A learning rate scheduler was used to reduce the learning rate when the validation loss plateaued. The model was trained for 10 epochs.

V. Results

The model achieved an accuracy of 83.85% on the validation set. The performance metrics are summarized below:

VI. Example of Dataset

Figure 3 shows an example of the images from the dataset. The image represents one of the Arabic handwritten characters in the dataset.

VII. Conclusion

This study presented a CNN-based approach for recognizing Arabic handwritten characters. The proposed model demonstrated high accuracy on a customized version of the AHCD, indicating its robustness in handling diverse handwriting styles and positional forms of characters. Future work could explore segmentation of full words and integration of character recognition into larger OCR systems.

References

Model Name	Training Accuracy	Test Accuracy	Validation Accuracy
Our Model	83.85%	70.298%	70.295%

Fig. 1. Model Performance

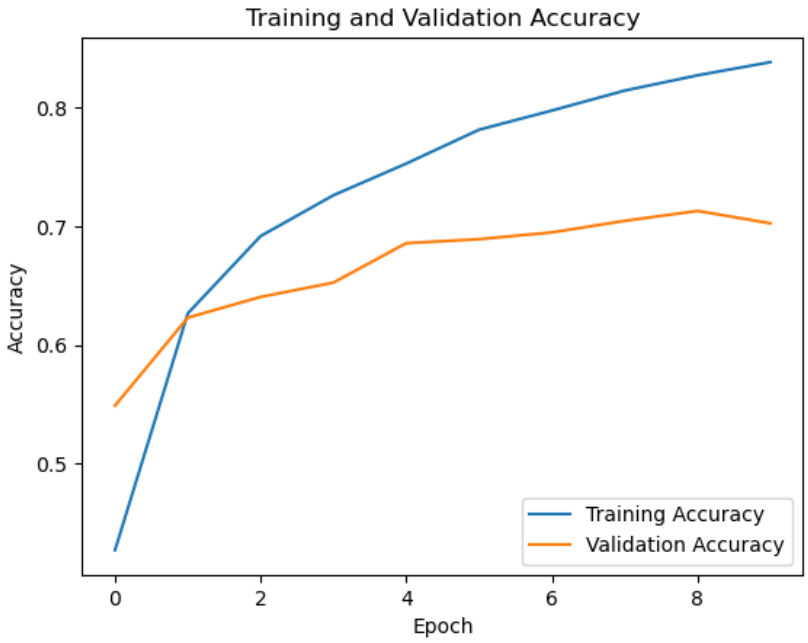

Fig. 2. Evolution of Training and Validation Accuracy during Epochs

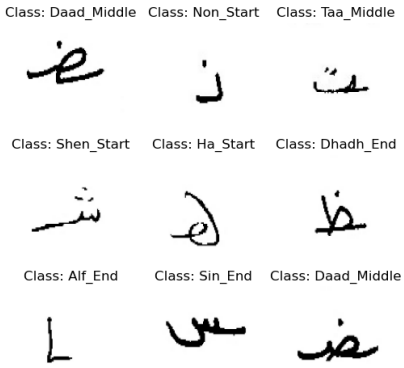

Fig. 3. An example image from the Arabic Handwritten Characters Dataset

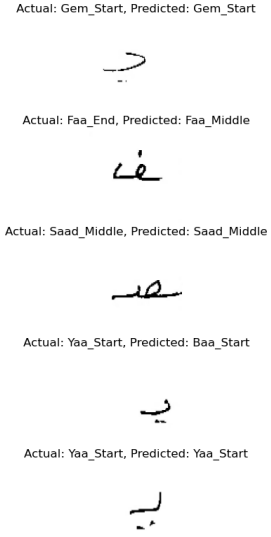

Fig. 4. Actual Class vs. Predictions