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HANDWRITTEN TELUGU COMPOUND CHARACTER PREDICTION USING CONVOLUTIONAL NEURAL NETWORK

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Abstract: Whether in Telugu or another language, handwriting recognition has been a difficult job for a very long time. Handwritten characters frequently have many curves, particularly in Indian languages. With the development of machine learning, handwritten recognition has long been an open task. However, there are still many difficulties because feature extraction is a challenging job because characters are more prevalent in Indian languages. Pick a handwritten Telugu compound character named Guninthalu (a character made up of Telugu vowels and consonants) to be recognised in this essay. Since each character in Guninthalu is nearly identical to the others, Telugu. It's difficult to classify things. Although there are many machine learning methods, achieving accuracy is the main obstacle. Consequently, applying deep learning. Convolutional neural networks are being used to build a machine-learning model for Telugu Handwriting Gunithalu. Create a dataset, and the IEEE Data port will have it accessible.

Keywords: Telugu Character Prediction, Convolutional Neural Network, Deep Learning, Handwritten Letter Prediction.

1. Introduction

Handwriting recognition is one of the most difficult and active research areas in pattern recognition and image processing. Several commercial character recognition systems have been developed and deployed. Offline handwriting systems are required for several applications such as mail reading, cheque processing, sorting, document reading, and postal address recognition. It is difficult for machines to recognise the character. The machine interpreted it as a pixel document. Handwritten recognition has many real-time applications, such as sorting letters in post offices and processing handwritten characters in banks, among others. As a result, pattern recognition is an important application. The automatic reading of optically sensed document text materials to translate human-readable characters into machine-readable codes is known as optical character recognition (OCR). Handwritten Character Recognition, on the other hand, is a difficult task when compared to OCR. Handwritten files contain handwritten styles that differ structurally for each symbol in the language. Telugu is India's ancient language. According to the 2011 census, there are over 8.11 crore Telugu-speaking people in India. Telugu has progressed from the ancient Brahmi script. As a result, it is an area of ongoing research.

Each object has unique properties. The characteristics are referred to as Features. Feature extraction is a time-consuming process. The recognition is based on the features that are chosen. It is difficult to work with a dataset that contains multiple classes. Telugu is an ancient language with 16 vowels, 36 consonants, and 560 guninthalu (characters formed by combining Telugu vowels and consonants). And their other characteristics are formed by combining one consonant with the other. Because it is a multi-classification problem, recognising handwritten Telugu characters, particularly Telugu Guninthalu, is difficult because each character is nearly identical to the other.

Many researchers have attempted to recognise Indian languages, particularly Telugu, and their findings have been published in the literature for the recognition of compound characters using template matching and a variety of other methods. Some of the important works include the use of a template weighted match degree algorithm for digit recognition in printed forms, printed Telugu character recognition using structural features, handwritten Devanagari character recognition using chain codes and moments, handwritten Farsi/Arabic numeral using the template matching technique, Telugu and Hindi printed character recognition using principle component analysis features, and Telugu and Hindi printed character recognition using principle component analysis features. Handwritten Character prediction is the prominent domain of pattern recognition that many researchers working since the last few decades. This is a difficult task because everyone's handwriting style is different. The ability of a computer to receive and interpret intelligible handwritten input from sources such as photographs, touch screens, paper documents, and other devices is known as handwriting recognition. Recently, neural networks have been used to solve various pattern recognition problems. A neural network is playing an important role in handwritten character recognition. We can improve the accuracy of the machine learning model for predicting handwritten Telugu characters by using an ensemble of different classifiers.

Handwritten recognition is a challenging task for a long time for Indian languages since letters is having many curves. It has been an open challenge for a long time. With the advent of Machine Learning, handwritten recognition becomes easier. However, many challenges persist, because feature extraction is a difficult task since the characters are more in Indian languages. There are numerous machine learning techniques to predict handwritten characters, however, accuracy is the key challenge to achieve.

In this framework, Introduction was discussed in section 1. Related work will be discussed in section 2, the proposed work will be described in section 3 and section 4 consists of the results of our proposed work, and section 5 will be concluding the paper.

2. Related Work

The use of a deep-seated neural network in alphabet character classification based on specification status based on images uploaded is investigated in this study. With thirty (30) deep convolutional neural networks and an initial learning rate of 0.0001, the network achieved an accuracy of 84%. Throughout the course, any images of classrooms were used. The photographs in the data set for training and research have been compiled or downloaded from the device.

Recent advances in CNNs have allowed researchers to vastly improve image recognition accuracy. Characters and pests are found using images collected with a heterogeneous backdrop in the real world and experimented on our massive dataset with many state-of-the-art neural networks in this deep learning-based approach. The results show that characters of alphabets can be detected and recognised effectively using a deep neural network, with the highest accuracy of 84.53% in the test set. Where to accurately and quickly detect characters. It will aid in the prompt administration of medical medications.

Here is an algorithm for the best alphabet character segmentation technique used in the medical domain and treatment. Whereas the health sector is something on which our country's economy is heavily reliant. This is one of the reasons why character detection in the medical or health sector is so important to our country's development. If proper care is not taken in this area, it can have serious consequences for patients. An algorithm is used to perform character segmentation, which is an important aspect of the health sector in detecting prescriptions written by health experts.

Taking into account the preceding works, we developed a system that will recognise images using the Convolutional Neural Network (CNN) model. The sections that follow will describe our proposed work.

Table 1: Related Works Summary

AUTHOR/ YEAR OF PUBLICATION	TITLE	METHODS	INPUTS
Muppalaneni, Naresh Babu[1]/ 2020 International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE). IEEE, 2020	Handwritten Telugu compound character prediction using a convolutional neural network.	Convolutional Neural Network	Combination of Telugu vowels and consonants
Ganji, Tejasree, Muni Sekhar Velpuru, and Raman Dugyala./ IOP Conference Series: Materials Science and Engineering. Vol. 1042. No. 1. IOP Publishing, 2021. [2]	Multi-variant handwritten Telugu character recognition using transfer learning	Transfer Learning	Combination of Telugu vowels and guninthalu.
Basha, Shaik Johny 2021 Second International Conference on Electronics and Sustainable Communication Systems (ICESC). IEEE, 2021. [3]	A Novel Approach for Optical Character Recognition (OCR) of Handwritten Telugu Alphabets using Convolutional Neural Networks.	Convolutional Neural Network	Telugu Alphabets
Suresh, Gade, Ch Rajendra Prasad, and Sreedhar Kollem/2022 3rd International Conference for Emerging Technology (INCET). IEEE, 2022 [4]	Telugu Optical Character Recognition Using Deep Learning	. Deep Learning	Telugu Vowels
Sujatha, P., and D. Lalitha Bhaskari. /Int. J. Innov. Technol. Explore. Eng 8 (2019) [5]	Telugu and Hindi Script recognition using deep learning techniques	Deep Learning	Hindi vowels
Naresh Babu Muppalaneni, Repudi Ramesh, IEEE Dataport, 2019. [6]	"Handwritten Telugu Gunintam (Ka)",	Convolutional Neural Network	Ka guninthalu
S. T. Soman, A. Nandigam and V. S. Chakravarthy, 2013 National Conference on Communications (NCC), [7]	"An efficient multiclassifier system based on CNN for offline handwritten Telugu	Convolutional Neural Network	Random Vowels

	character recognition,"		
Dhanikonda, S.R., Sowjanya, P., Ramanaiah, M.L., Joshi, R., Krishna Mohan, B.H., Dhabliya, D. and Raja, N.K., 2022. Recognition. Scientific Programming, 2022. [8]	An Efficient Deep Learning Model with Interrelated Tagging Prototype with Segmentation for Telugu Optical Character Recognition	Deep Learning	Telugu Vowels
Lakshmi, K.M., 2021. Turkish Journal of Computer and Mathematics Education (TURCOMAT), 12(11), pp.3247-3255. [9]	An efficient telugu word image retrieval system using deep cluster	Deep Cluster	Telugu script
Rani, N.S., Vasudev, T., Chandrajith, M. and Manohar, N., 2020. 2D morphable feature space for Procedia Computer Science, 167, pp.2276-2285. [10]	handwritten character recognition.	2D morphable feature space	Kaa segmentation

3. Methodology

This section clearly describes the procedure for developing our system.

- To begin, we require a dataset of the characters. We gather images of the alphabet's characters and prepare our dataset for the process. We will perform the augmentation on the prepared dataset after it has been prepared.
- Perform preprocessing on the considered dataset after it has been prepared and augmented. Remove noise from the data and divide the dataset into train and test data during preprocessing.
- Build the proposed network using Keras and TensorFlow during the training process. In this case, the deep learning model Convolutional Neural Network is used (CNN).
- A neural network model underpins the proposed CNN architecture. The proposed model is composed of a convolution layer, a pooling layer, flattening, and ReLu layers.
- When the data training is finished, the model is ready for testing. The proposed model's testing is considered the front end.
- In the testing section, an image is uploaded, and our train part performs the operation and classifies the image based on the proposed model.
- Here the proposed model mainly detects the alphabet which we have produced in our system.
- Based on this proposed model classification, the output is displayed for the uploaded image.

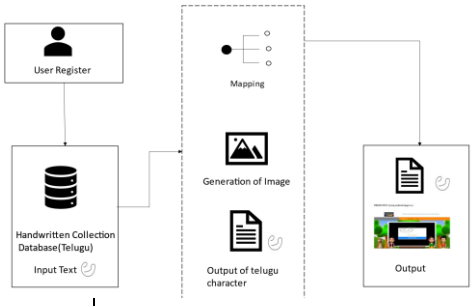

Fig 3.1 System Architecture

A. Convolutional neural network

Convolution network is a deep learning algorithm that is primarily used for visualising and analysing images. This is primarily based on neural networks. There are also different names for them based on the weights shared by them in the architecture of the considered kernels of convolution that are used for scanning the hidden layers. This network is also used in other applications based on image and video recognition. These are used in a variety of fields for image segmentation, classification, and analysis. The name of this convolution is primarily determined by the operations performed using mathematics. This operation is used in the network layers for matrix multiplications.

This neural network is made up of three layers: input, hidden, and output. In a neural network, the middle layers of feed-forward are named as hidden because activation is used which is a function for input and output masking. Whereas some of the layers are also included in these hidden layers for the convolution operation. And these layers are included for the operation of multiplication and some product operations. ReLu is commonly used as a function for activation. Along with this, other layers such as pooling, fully connected, and normalisation are present.

Convolutional layer

A convolution layer should follow some of the attributes in a neural network. Those are shown as follows:

- Convolution filters or also called kernels which means height and width, which are hyperparameters
- The consideration of input and output channels that are to be used.
- The depth of the filter or kernel in an input channel of the convolution should be the same as channels of the depth of the input.
- Padding size and strides are used in the operation of the convolution.

The input from the layers of the convolution is considered and those are passed to the next layers. This is considered equal to the neuron response in the visual cortex to the stimulus.

- **Pooling layer**

Local layers or global layers are the pooling layers that are included in the convolution networks which are used for the computation. These layers are used for reducing the dimensions in the considered data where the outputs are combined of the clusters of neural into a single neuron. Here there are two types of pooling: the max layer and the average layer. Max is used for calculating the maximum values and the average is used for calculating the average values.

- **Flattening**

This will be a brief breakdown of the flattening process and how we move from pooled to flattened layers when working with Convolutional Neural Networks.

- **ReLU Layer**

ReLU is called a rectified linear unit, which is used for the function of activation. This is mainly used for removing the negative values from the activation and making them zero values. This is used for increasing the properties of non-linear that which are used for making the affectless fields of the convolution.

Along with this ReLU, some other functions have also been used that help in the non-linearity improvement.

4. Results and Discussions

Discuss the results obtained using the above-mentioned method and how they are extracted using the CNN architecture.

After completing the pre-process and training, proceed to the testing phase. Then, upload some of the images of the handwritten characters. The system will predict and display the detected character of the uploaded image based on the training by our model.

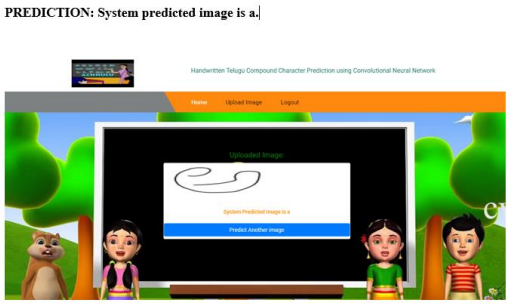

Fig 4.1 System Detected Character is A:

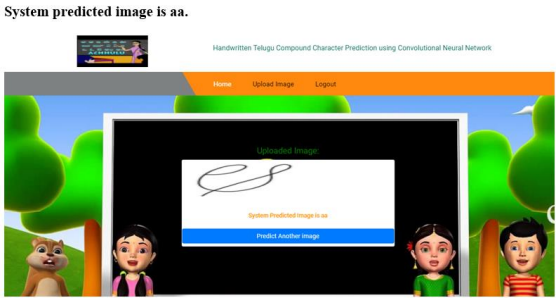

Fig 4.2 System Detected Character is Aa:

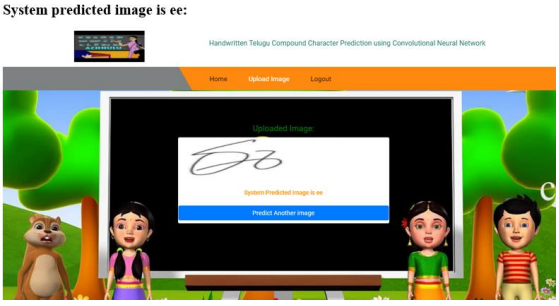

Fig 4.3 System Detected Character is Ee:

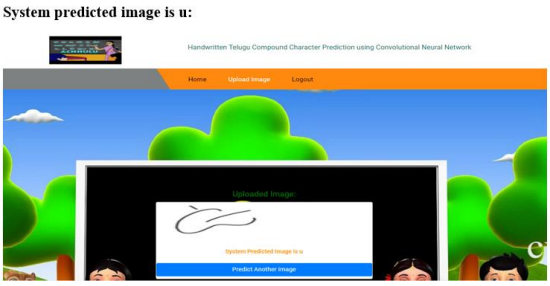

Fig 4.4 System Detected Character is :

From the above-shown figures see the results of the uploaded images. Here they are mainly detecting images of alphabets.

5. Conclusion

Handwriting recognition is one of the most difficult and active research areas in pattern recognition and image processing. It is difficult to work with a dataset that contains multiple classes. Consider Handwritten Telugu Guninthalu for prediction using Convolutional Neural Network in this paper. The characters are then collected and hosted in the IEEE Data port. Each character in Telugu Guninthalu is nearly identical to the others, making classification difficult. With a small dataset of 516 samples, the CNN architecture demonstrated in the paper achieves an accuracy of 79.61%. In the future, a large number of samples will be collected to improve accuracy. Include a capsule network to deal with images of varying orientations.

References

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4. Suresh, Gade, Ch Rajendra Prasad, and Sreedhar Kollam. "Telugu Optical Character Recognition Using Deep Learning." 2022 3rd International Conference for Emerging Technology (INCET). IEEE, 2022.
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