

Literature Survey - Handwritten Digit Recognition Using ML (Deep Learning Approach)

Sr. No.	Title Of Paper	Name of Author	Published Year	Remark
1	Bangla Handwritten Digit Recognition Using an Improved Deep Convolutional Neural Network Architecture	Chandrika Saha, Rahat Hossain Faisal and Md. Mostafijur Rahman Dept. of Computer Science and Engineering University of Barisal Barisal, Bangladesh	2019	<ul style="list-style-type: none">• This paper proposes a Deep Convolutional Neural Network (DCNN) based Bangla handwritten digits recognition scheme.• A seven-layered D-CNN architecture is developed• The architecture is applied to recognize Bangla handwritten digits• They obtained 94% accuracy on CMATERdb3.1.1 dataset• Another study was proposed by Hassan et al. [14] where they used Local Binary Pattern (LBP) [15] as feature descriptor and K-NearestNeighbor (KNN) algorithm for classification. They obtained 96.7% accuracy on CMATERdb 3.1.1 dataset• The D-CNN architecture used for this paper is inspired by LeNet-5 architecture [22]. This architecture consists of 7 layers. The input images are feed to the network taking 50 images as a batch at a time. All images are re sized to have 32 x 32 dimensions and all these images are true color or RGB images.• The proposed system is implemented with Keras framework [23] with Tensorflow [24] as backend.• Total 40 epochs were used to train the model.• A seven layered D-CNN model is proposed in this

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				paper for Bangla handwritten isolated digits, which provides up to 99.9% accuracy on training data and 97.6% accuracy on test data
2	Handwritten Digit Recognition Using CNN	<p>Mayank Jain Electronics and Communication Engineering Department Department Amity University Greater Noida, India</p> <p>Gagandeep Kaur Electronics and Communication Engineering Department Department Amity University Greater Noida, India</p> <p>Muhammad Parvez Quamar Electronics and Communication Engineering Department Department Amity University Greater Noida, India</p> <p>Harshit Gupta Electronics and Communication Engineering Department Amity University Greater Noida, India</p>	2021	<ul style="list-style-type: none"> Handwritten digit recognition can be performed using the Convolutional neural network from Machine Learning. Using the MNIST (Modified National Institute of Standards and Technologies) database and compiling with the CNN gives the basic structure of my project development. So, basically to perform the model we need some libraries such as NumPy, 'Pandas', TensorFlow, Keras. MNIST data contains about 70,000 images of handwritten digits from 0-9. So, it is a class 10 classification model. This dataset is divided into 2 parts i.e. Training and Test dataset. Image representation as 28*28 matrix where each cell contains grayscale pixel value. Pre-processing the dataset : change some parameters such as colour of the images, size of the images CNN consists of 4 hidden layers which help in extraction of the features from the images and is able to predict the result.[7] The layers of CNN are (a) Convolutional Layer (b) ReLu Layer (c) Pooling Layer (d) Fully Connected Layer. Reason we are using CNN is because the fundamental favourable

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				position of CNN contrasted with its archetypes is that it consequently recognizes the significant highlights with no human management.
3	HDSR-Flor: A Robust End-to-End System to Solve the Handwritten Digit String Recognition Problem in Real Complex Scenarios	Byron Leite Dantas Bezerra (byron.leite@upe.br)	2020	<ul style="list-style-type: none">• Handwritten Text Recognition (HTR) research field, for example, has demonstrated a dramatic advance through Convolutional Recurrent Neural Networks (CRNN) [9]–[12] as optical models, in which the convolutional layers are responsible for extracting the features from text images, while the recurrent layers propagate and decode the extracted features through a Connectionist Temporal Classification (CTC), resulting in the final text.• The very low volume datasets for training optical models. Thus, several works were developed to solve this problem and achieve better results, such as models composed by K-sparse Auto Encoders [5], CRNN [15], ResNet with RNN-CTC [6], [7], CNN [16], ResNet-41 [17], and YoLo [8].• Furthermore, a different model approach to string recognition was presented by Zhan et al. [16], where it uses an entirely CNN architecture and avoids the disadvantages brought by RNNs.• The ORAND-CAR dataset [13] consists of 11,719 images obtained from the Courtesy Amount Recognition (CAR) field of real bank checks, and is

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				<p>composed by two sources, which give the images different characteristics, such as type of noise and handwriting style. Therefore, considering the two different sources, this dataset is divided into two subsets: (i) CAR-A, that comes from an Uruguayan bank; and (ii) CARB, that comes from a Chilean bank.</p> <ul style="list-style-type: none"> • The CAR-A dataset consists of 5,793 images, where 2,009 are for training and 3,784 for testing. • The CAR-B dataset consists of 5,936 images, where 3,000 are for training and 2,936 for testing.
4	<p>Capsule-Based Persian/Arabic Robust Handwritten Digit Recognition Using EM Routing</p>	<p>Ali Ghofrani Faculty of Media Technology and Engineering IRIB University Tehran, Iran</p> <p>Rahil Mahdian Toroghi Faculty of Media Technology and Engineering IRIB University Tehran, Iran</p>	2019	<ul style="list-style-type: none"> • In this paper, the problem of handwritten digit recognition has been addressed. However, the underlying language is Persian/Arabic, and the system with which this task is a capsule network (CapsNet) which has recently emerged as a more advanced architecture than its ancestor, namely CNN (Convolutional Neural Network). The training of the architecture is performed using Hoda dataset, which has been provided for Persian/Arabic handwritten digits. The output of the system, clearly outperforms the results achieved by its ancestors, as well as other previously presented recognition algorithms. • In this paper, we concentrate on Persian/Arabic-based digital numbers which are the same, however quite different from the English digits gathered in MNIST dataset. Hence, here we use

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				<p>Hoda dataset [7], which is recorded for Persian/Arabic language and alongside a new method being proposed in this work the results are compared with the state-of-the-art</p> <ul style="list-style-type: none"> • The data in our study is provided from Hoda dataset which contains handwritten Persian/Arabic images, which contains 60000 training-data, as well as 20000 test-data samples, in grayscale with 32×32 bits resolution. For cross-validation, 5000 data samples is considered for each epoch. • In this paper the problem of handwritten digit recognition for Persian/Arabic language, was addressed. For the first time, capsule network was employed and trained using EM algorithm. By comparing the results achieved on Hoda dataset, with the state-of-the-art on the same dataset, we could see the superiority of the capsule network on recognizing the handwritten digits, using all the previously applied methods. The power of the system against the noisy input images are further investigated, and the outputs have been proven to be robust against various noise effects and transformations.
5	Mobile Client- Server Approach for Handwriting Digit Recognition	Hasbi Ash Shiddieqy School of Electrical Engineering and Informatics, Institut Teknologi Bandung University Center of Excellence on	2019	<ul style="list-style-type: none"> • In this paper, we propose a client-server system implementation for handwriting digit recognition. A client-server is set based on TensorFlow with multiple models for classifications.

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		<p>Microelectronic, Institut Teknologi Bandung, Indonesia</p> <p>Trio Adiono School of Electrical Engineering and Informatics, Institut Teknologi Bandung University Center of Excellence on Microelectronic, Institut Teknologi Bandung, Indonesia</p> <p>Infall Syafalni School of Electrical Engineering and Informatics, Institut Teknologi Bandung University Center of Excellence on Microelectronic, Institut Teknologi Bandung, Indonesia</p>		<ul style="list-style-type: none"> • The client is set based on a mobile application that the user inputs the digit by touch panel of the mobile. In this paper, the models at the server are trained and tested by using MNIST database of handwritten. In addition, we use convolutional neural network (CNN) to improve the performance of the neural network. • The client-server system included a user interface in mobile client and executing the function from input in the server computer system. Most of the application will run in server and small quantities data will be passed between mobile user to the server. • Because the most process that requires a large resource is running on the server so that the mobile client barely requires high specifications device for running the application. Overall performance can be represented with the server performance. • Example of client-server system-based services is AI Services (AWS), Cloud AI (Google Cloud), AI Platform (Microsoft Azure), AICS (IBM)/ • Disadvantages of the client-server based system eliminate the ability to run offline, concern in data privacy and protection, the cost for service managing servers • Among all, the LeNet5 is one of the basic and significant CNN architecture that designed for handwritten recognition. Gradient-Based
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				<p>Learning Applied to Document Recognition</p> <ul style="list-style-type: none">• Input from user then processed into images. The image represents of handwriting digit from user. After that the images sent to server via TCP connection. The server processes the image and replies to the user result of handwriting recognition.• The system operates and capable to classify handwritten digits with an accuracy of 99% in the test data MNIST and 56% in real user data from android.
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