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Kannada Digit Recognition using Deep Learning

Shrisha H. S[1] and Saumya Y. M[1]
Department of Computer Science and Engineering[1]
St. Joseph Engineering College, Mangaluru, India
shree.1259@gmail.com and saumya2087@gmail.com

Abstract*: Kannada is a south Indian language with a history of two thousand years and spoken by more than sixty million people. Kannada language has its own script for alphabets and digit representations. So, there is a need for Convolution Neural Networks (CNN) model to recognize Kannada language scripts. Designing a CNN model to recognize Kannada digits can be challenging due to data overfitting. Data overfitting occurs when a trained model only classifies cases provided during training, leading to lower accuracy for new test instances. To address this issue, datasets are separated into training and testing sets. The disadvantage of this technique is the limited number of instances to train the CNN. While increasing the number of training examples is beneficial, it's important to address the difficulty of data collecting. This research examines the effectiveness of Generative Adversarial Network (GAN) as a data generator. The experiment found that data augmentation has a positive impact on CNN, GAN-generated data meets qualitative requirements for train and test datasets, and epoch value influences data underfitting and overfitting.*

Keywords: Kannada language; Generative Adversarial Networks, Convolution Neural Networks, Accuracy

I. INTRODUCTION

Kannada is a native language of south India and efforts are being made to preserve and modernize the areas of application of this language. step towards this goal is publication of Kannada-MNIST [1] dataset for Kannada digits. The said data set is a collection of sixty thousand images. The dataset symbols provide variations in representation of the kannada digit symbols for training purposes to accommodate different styles of writing. The dimensions of the images are 28028 and digits are from zero to nine. A sample of Kannada digit representation as in Kannada-MNIST dataset is provided in Fig 1.

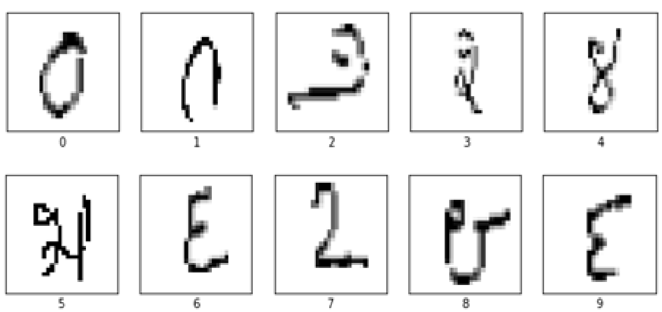

Fig 1: Sample Kannada digits

This paper proposes a neural network architecture to classify Kannada digits. There is always a need to enhance image classification accuracy for Neural Network architecture. Researchers have adopted many ways to achieve this goal including fine tuning training parameters of neural network, number of epochs and learning rates. A situation which is to be avoided in deep learning is data over fitting. Data over fitting decrease the accuracy of predictions for a new unseen input instance. One way to avoid data over fitting is to provide more data for training. Generative Adversarial Network (GAN) is a good option to generate new training data with diverse coverage of possible new instances. This experiment demonstrates the impact of GAN generated data on classification accuracy in the context of epoch values.

The paper proposes a hybrid system where GAN produces sixty thousand additional images to train a neural network and its impact on classification accuracy is measured. This paper explores the GAN and subsequent Convolution Neural

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Network (CNN) network setup, behaviour of setup with different epoch values of GAN and CNN, size of additional data set generated by GAN and a discussion on classification accuracy. The contributions of this paper are as follows:

1. A neural network architecture to recognize and classify Kannada language digits.
2. Design of Generative Adversarial Network for data augmentation of Kannada digits samples.
3. Analysis of classification accuracy corresponding to epoch values and augmented data.

II. LITERATURE SURVEY

CNN design involves N dimension convolution layer, pooling strategy, and drop out nodes. 1D convolution is applied for a matrix input with either one row or one column. For example, an image matrix attended for output dense layer accepts 1D matrix input .2D convolution is applied on a matrix with row and column.

For example, MNIST dataset images have dimensions 28028. 3D convolution is applied for three dimensional matrices. It can be imagined as a stack of three 2D matrices. For example, RGB images represent three dimensional matrices. Batch normalization is employed to bind the values in the CNN layers within a range. This increases computational efficiency of the layers [6]. Pooling layer captures the features for image classification [2]. Max pooling is employed in this experiment which selects the maximum value in 202 pool windows. Pooling keeps the size of the matrix in check after every layer of convolution. Application areas of CNN include Radio imaging [13], Cartography [14], Radar imaging [11] and imaging applications on resource constrained platforms [4].

GAN have a generator and a discriminator. During training, the generator becomes more efficient in generating new images and discriminator becomes efficient in rejecting the generated image as fake by comparing it with real image [5]. At the end of training, the generator will be capable of producing images which discriminator cannot recognize it as different from real image. An overview of GAN is shown in Figure 2. GAN can produce additional datasets for training a neural network. Improving the resolution of images, synthesis of images from textual descriptions, medical researchers are few applications of GAN [3].

III. DEEP LEARNING ARCHITECTURE

This experiment explores the idea of using GAN and CNN introduced in section 2.1 and 2.2 for producing additional data, supplementing MNIST data employed for CNN training. Data augmentation is a matured approach for ensemble of CNNs, classification of astronomical bodies [9], etc.

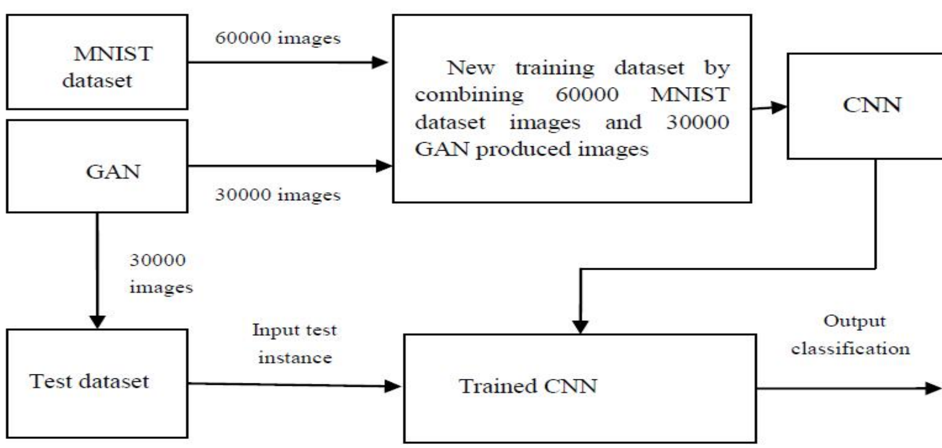

Fig. 2 Deep learning architecture for recognizing Kannada digits

Strategy to split the data into train and test set is required. We propose a 50:50 ratio split up of GAN generated data for each class of image. First half earmarked as train set will be merged with primary MNIST dataset. Other half is to be used as test set. Two rationales encouraged us to arrive at this arrangement for dataset; Introduction of new data into primary dataset with the aim of achievingbetter parameter tuning for a wide range of input variations [12]. GAN generated test set will provide new instances to the trained CNN. An overview of experimental setup is given in Fig 2.

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Generative Adversarial Network produces additional data set of 60000 images. Newly created dataset is split into train and test set in 50:50 ratios. 30000 images are combined with Kannada MNIST dataset for training purposes. Remaining 30000 will be deployed as test set. The accuracy of classification compared to a CNN in combination with variation of epochs in training. NVDIA RTX 2080Ti hardware platform is employed for training the model.

IV. RESULTS

CNN presented in Section 3 is trained and tested on Kannada-MNIST dataset. Performance observed is tabulated in Table 4. Value of epoch should be in between 10000 to 15000 for good performance. Above these epoch values, accuracy decrease due to overfitting. CNN when augmented with GAN data for training is resilient to over fitting.

Table 4. Accuracy Versus number of epochs by CNN with standard and augmented dataset

Epochs	Accuracy of CNN with standard dataset(%)	Accuracy of CNN with GAN augmented dataset (%)
5000	94.25	95.35
10000	97.40	98.75
15000	97.75	99.05
20000	95.85	98.55
25000	94.75	98.25

We propose that the additional GAN produced data should be at least fifty percent of original dataset to have an impact on CNN training. Below forty percent, the impact is marginal. A graphical representation of increase in accuracy achieved by the proposed GAN augmented training in comparison with standard dataset is provided in Fig 3.

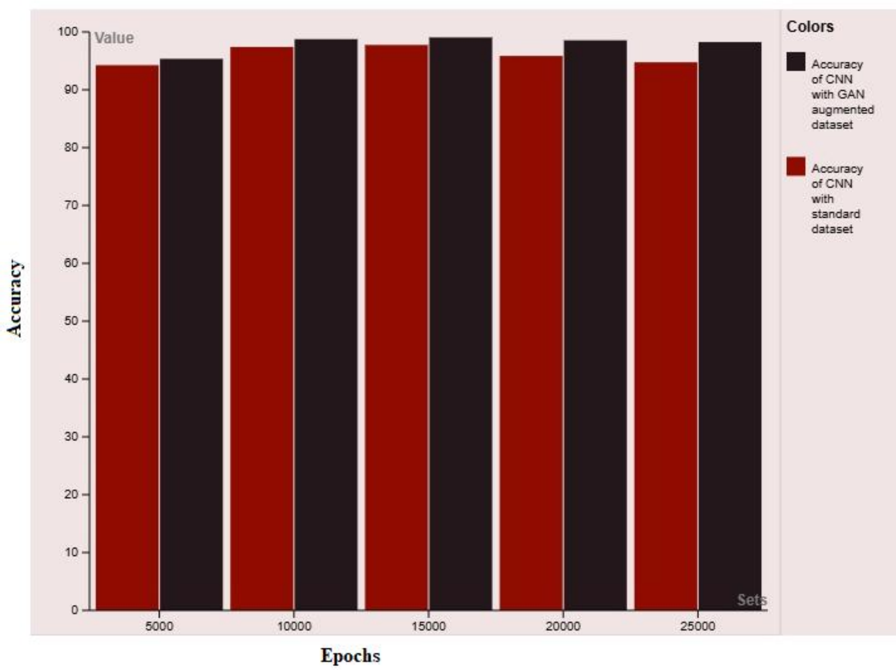

Fig. 3 Accuracy Chart

V. CONCLUSION

CNN can be used for classifying kannada language digits. This paper proposes a CNN design to achieve the same. The experiment explores the possibility of additional data generation using GAN for training and testing purpose. Accuracy of Convolution Neural Network increases with number of training instances available. Data collection and dataset creation requires resources. Therefore, there is a need for techniques to generate additional data to train and test the

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CNN models. A large dataset created by combining data collected through sources and augmentation techniques is an attractive approach to improve performance of CNN. Our experiment split the GAN generated data into train and test sets in 50:50 ratios.

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