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Effective Intelligent Learning Mechanisms for Intra-modal and Multi modal Deep Convolutional Neural Network based on Wavelet for Data Analytics

Vinit Gupta [1,*], Santosh Pawar[2] Aditya Mandloi[3]

1Electronics Engineering Department, Medi-Caps University, Indore, INDIA.

[2] Faculty of Engineering, Dr APJ kalam University, Indore, INDIA.

3 Electronics Engineering Department, Medi-Caps University, Indore, INDIA

Email: Vinit@medicaps.ac.in

Abstract

In the era of technical advancement, so many intelligent learning frameworks and technologies are effectively proposed for system identification, image/video recognition and data analytics. They are enhanced versions of conventional machine learning approach in the sense of training and prediction. Such frameworks are basically based on conventional neural networks. This paper presents a novel architecture of multi modal and intra modal convolution neural network that uses wavelet as activation function so as to attain better learning characteristics in intra as well multi mode feature extraction approach. In this work, CIFAR, SNAE2, and dataset are used for evaluating the performances of proposed Wavelet based Deep Convolutional Neural Network (WDCNN).The effectiveness of theoretical implementation is verified through simulation analysis.

Keywords: Machine Learning; Deep Learning; Convolutional Neural Networks; Wavelet, Data Analytics

Introduction

In recent years the E-commerce, Wireless Sensor Networks (WSN), Internet of Things (IoT) and other cloud based technologies producing, a massive amount of data. The processing and analyzing such data for new information and prediction is a vital process. The processing of such data required an effective and advanced learning system for prediction and control. These advanced structures/ architectures are suitable for providing a better solution in various applications like intelligent transportation, artificial intelligence (AI) based devices and applications, smart city, smart agriculture, smart medical as well as industrial control. [1-2]

At the present time, Internet of Things (IoT) has attained more consideration for researchers and engineers. In various applications like intelligent transportation, smart city, smart agriculture, smart medical as well as industrial control, this IoT is involved through a high value of producing industrial information. These big data are usually heterogeneous. [3]

Unfortunately, such amount of big data contains a very high level of multi-modality. For example, in smart city project a traffic surveillance video with sensors for weather, humidity, location and temperature produces a large amount of complex data with multi –modality. Therefore, an advanced methodology and technologies are needed for analyzing to such a huge amount of data. In addition, numerous deep learning forecasting implementation and controlling models are developed for such applications [3-5].

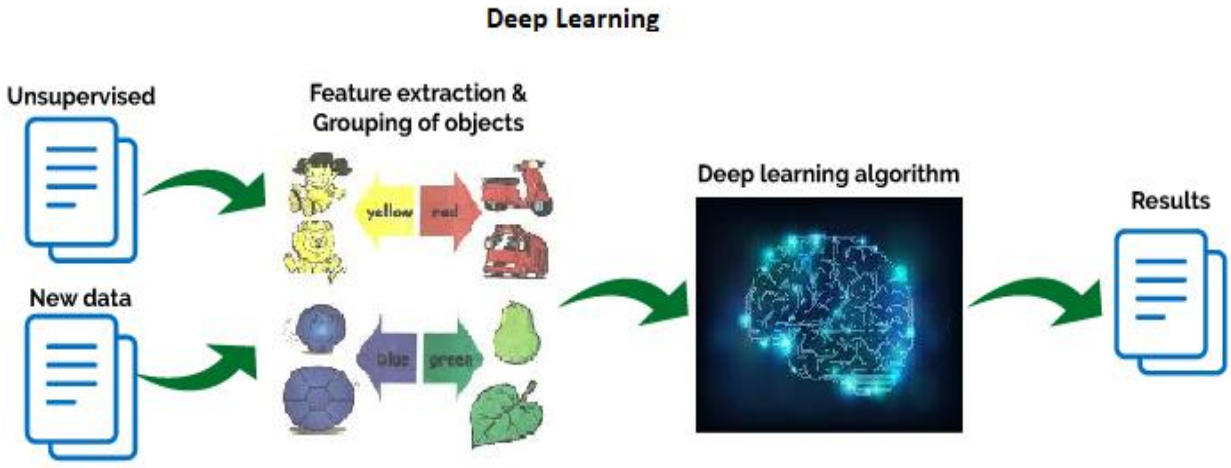
Many researchers have proposed and tried to develop the effective structures for high level of predictions, identification as well the control through the liberalized mathematical framework. The available data contains a very high level of complexity and variability even in single applications. Most of the Several advanced machine learning architectures are like Deep Learning (DL),

Convolutional Neural Networks (CNN), Reinforcement Learning (RL), Hopfield Networks (HN), Markov Chain (MC), Kohonen Networks (KN), Deep Belief Networks (DBN), Recurrent Neural Network (RNN), Long Short Term Memory (LSTM), Variational Auto Encoders (VAE), Restricted Boltzmann Machine (RBM), Extreme Learning Machine (ELM), etc, have also been presented to solve the problem of such complex data processing but the performance and effectiveness was subjected to the computational cost is always be there. [6-10]

Deep Framework

Deep learning is a subset of artificial intelligence and machine learning. It emulates the way humans gain certain types of knowledge. The conventional neural networks are based on mathematical modelling of human biological nervous systems. Figure 1 shows the basic structure of deep learning modal.

Figure 1. Deep learning framework



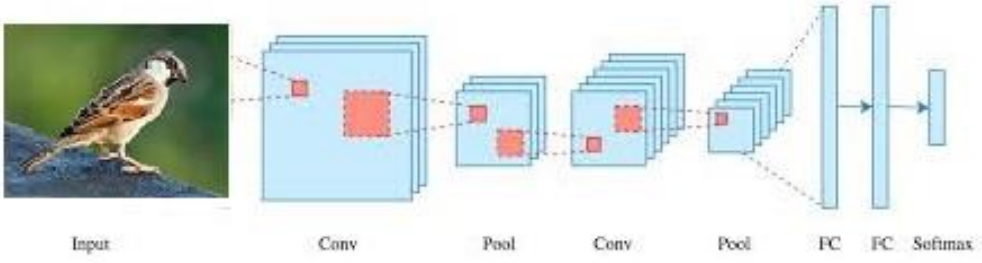
Deep learning is basically inspired from the human brain learning approach. In deep learning we try to improve the learning performance as the data size is increased, whereas in classical neural networks the performance was saturated at a particular point.

Wavelet based Deep Convolutional Neural Network Framework

The recent expansions in the field of machine learning exert a pull on to developed new architectures and methods. The conventional convolution neural network is the one of the effective framework since last decade and efficiently applies on data classification and object detection. CNN architecture contains multiple layers and in most of cases each layer provides a non-linear response to next layer.

Wavelet based Convolutional neural network is a modified version of Convolutional neural network where the activation function is replaced by a fast decaying wavelet. It has been utilized as building block for function approximation in the proposed work. The learning capabilities of this deep leaning framework are significantly improved by using the dialed and translated versions of the mother wavelet function. It results into a nonzero mean and offers an incredible estimation performance for the image data sets [10-11]. Figure 2 shows the basic structure of deep convolution neural network model.

Figure 1. Basic Structure of Deep Convolutional Neural Network.



Results and Discussion

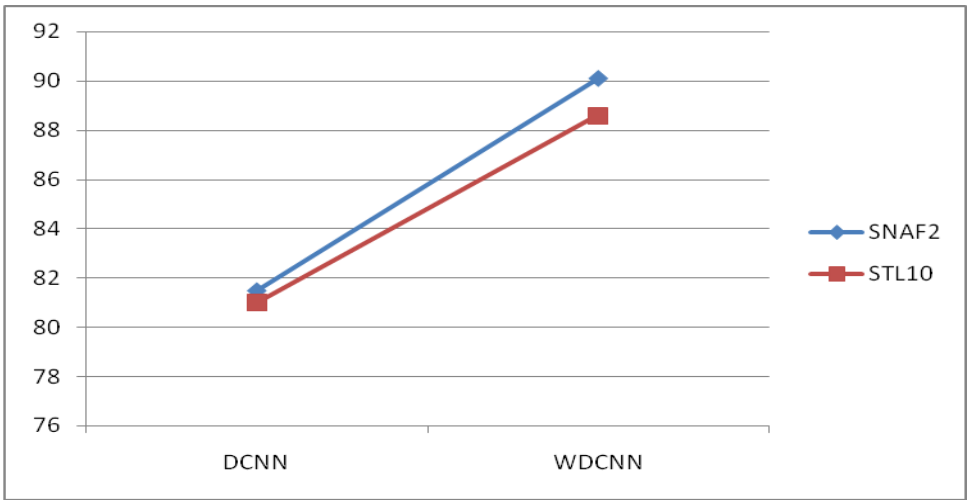
In this section, experimental analysis is carried out on both models wavelet based DCNN and conventional DCNN. The two datasets such as SNAF2 and STL-10 are conducted to evaluate the performance of proposed wavelet based DCNN and conventional DCNN in terms of the performance metrics such as accuracy and computational cost.

A detail simulation analysis has been performed to evaluate the effectiveness of proposed intra and multi modal wavelet based DCNN and Conventional DCNN. The accuracy analysis for different data sets are calculated and reflected in Table 1 and in Figure.2 respectively. The Figure 2 shows the accuracy analysis for wavelet based DCNN as well the conventional DCNN.

Table 1. Accuracy for different data sets

	DCNN	WDCNN
SNAF2	81.5	90.1
STL10	81.7	88.6

Figure 1. Accuracy analyses



Conclusion

The paper presented an effective Intra modal wavelet based DCNN for hierarchical feature learning on available data i.e. STL10 and SNAE2. The feature reduction was performed using wavelet transform. It is observed that the redundancy in data datasets was significantly removed. The proposed method has a convolutional layer, pooling layers and the fully connected layer for training the images from various datasets. Stochastic gradient descent (SGD) with back-propagation algorithm is utilized for training the data. Delta rule is applied for the weight updation of DCNN.

Our proposed model has more accuracy than the conventional DCNN model with less number of iterations during training of the data. The computation cost was significantly reduced. Moreover, our

proposed intra model wavelet based DCNN model spends less time learning the features when compared to conventional DCNN.

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