Available online at www.sciencedirect.com

ScienceDirect

Materials Today: Proceedings PMME2016- EMT-397

www.materialstoday.com/proceedings

PMME 2016

Object and Character Recognition Using Spiking Neural Network*

Priyanka Bawane[a], Snehali Gadariye[b], S.Chaturvedi[c], A.A.Khurshid[d]

[a]*PG scholar,priyankabawanea@gmail.com,Nagpur, India*
[b]*PG scholar,snehalig22@gmail.com, Nagpur, India*
[c]*Asst. Profesor,soni2569@gmail.com, Nagpur, India*
[d]*profesor, aakhurshid@gmail.com, Nagpur, India*

Abstract

Artificial neural network have been well developed so far. First two generation of neural network, have had lot of successful application. Spiking Neural Network (SNN) often referred as third generation of neural network. Which have potential to solve problems related to biological stimulation. In today's world it is the gaining interest of active research with the areas of neural network. This paper depicts the study about classification and recognition of object and various handwritten characters using one of the popular model of SNN.Leaky integrate and fire model (LIF Model) for object recognition and two level network model for character recognition will be use. In object recognition, after applying image preprocessing operations the image is undergone through various operations for feature extraction. Here energy level of an image which is a low-level image feature and feature descriptor like Extended Histogram of Gradients (ExHoG) and Edge Detection using Extended Epanechnicov Function and Non maxima Repression are used to extract the features from an image. These feature vectors are then given to a classifier to classify an object. In character recognition, Segmentation of document imagesinto text lines and words is an important step for the document understanding however, unlike machine printed documents, the segmentation of the handwritten documents is still considered as the challenging problem due to irregular spacing between words and variation of writing style depending on the person. By developing an algorithm for characters, segmentation, feature extraction of the character and objects for classification of the given characters and object, this problem can be solved. For the evaluation of LIF and two level network model of SNN it is compared with SVM.

* Corresponding author:
*E-mail address:*priyankabawanea@gmail.com(Priyanka B), snehalig22@gmail.com(Snehali G), soni2569@gmail.com(S.Chaturvedi), aakhurshid@gmail.com(A. Khurshid)

Selection and Peer-review under responsibility of International Conference on Processing of Materials, Minerals and Energy (July 29th – 30th) 2016, Ongole, Andhra Pradesh, India.

Selection and Peer-review under responsibility of International Conference on Processing of Materials, Minerals and Energy (July 29th – 30th) 2016, Ongole, Andhra Pradesh, India.

Keywords:Artificial Neural network (ANN); Spiking Neural Network (SNN); Leaky Integrate and Fire (LIF) model;Two level network model;Support Vector Machine (SVM); Extended Histogram of Gradients (ExHoG);

1. Introduction

Human beings are recognizing object and characters through vision with great accuracy. Thousands of neurons are connected with each other and corporate to efficiently process incoming signals decides on action. A typical neuron sends its signal over 10,000 other neurons, it constantly receive input from environment. Brain process this information, recognize tree or danger or any object and take appropriate action. But recognizing object or character from an image is difficult task in computer vision. When preparing computer model to recognize an object, which is challenging theoretical problem such as how to model the visual appearance of the object/character. From last two decades, several models have been proposed that capture different mechanism within a neurons. There are many artificial neuron networks that successfully used in an image extraction and in recognition tasks. Artificial neural network (ANN) are broadly classified into three generation. The first generation model consist of restricted output signals to discrete binary values i.e. '0' and '1'.These network called as universal for digital computation. The second generation model uses continuous activation function and allows the output to take values between '0' and '1'.this mode suited for analog computation. The third generation model is more popular than other two models that is Spiking neural network (SNN) model. It highly inspired from natural computing in the brain and recent advancement in neuroscience, they derive their strength and interest from a perfect modeling of synaptic interactions between neurons, taking into account the time of spike firing. SNN's overcome the computational power of neural networks.In this paper we focus on a supervised learning algorithm called Support Vector Machine (SVM)

2. Spiking Neural Network

Over the last few decades, several models have been using the spiking mechanism within a neuron. Spiking neural network (SNN) is a class of ANN that are receiving an attention as both logically and computationally powerful. The neuron with sigmoidal activation functions, it is proved that the neuron that convey information by individual spike times are computationally more powerful.

The Hodgkin-Huxley model is one of the most accurate and biologically important models in SNN. It consist lots of parameters which contains membrane potential, activation of currents, and inactivation of current. This model take 120 flops for each 0.1 ms time and therefore 1200flops/1 ms But one of the main problems is that it is extremely expensive for large scale implementations. Thus, one can use the model only to implement a small number of neurons.

Izhikevich developed very simple and very computation efficient spiking neuron model. It has similar accuracy as the HH model. Izhikevich successfully reduced the complex HH model. Izhikevich's model needs only 13 flops per neuron update and still accurately reproduces a majority of neuronal properties. This model takes only 13 flops/1ms for neuronal dynamics update for the Izhikevich model.

Two layer network is one of the most popular model. Two layer model is easy to implement and gives a good computational speed. In proposed work this model is used for character recognition.

One of the most popular model of SNN which is used as a classifier in this context is the Leaky-Integrate and Fire (LIF) model. LIF model is easy to implement and have good computational efficiency. This model is used for object recognition in this study.

2.1. Leaky Integrate Fire (LIF) Model

LIF neuron is probably one of the simplest spiking neuron modelsand very popular due to the ease with which it can be analyzed and simulated. The model is basically based on, and can be explained in simple way by, the basic principles of electronics. Figure 1 shows a basic schematic model of Leaky Integrate and Fire neuron. If a spike

(short pulse) $\delta(t-t_i^f)$ moves through an axon then it is converted into a current pulse $I(t-t_i^f)$ by a low pass filter. This current pulse then charges the integrate and fire circuit and if the resulting voltage is increased above threshold value ϑ then a pulse is fired i.e., post-synaptic potential. As shown in figure 3, the driving current I(t) can be split into two components and can be mathematically written as,

$$I(t) = u(t) + C\frac{du}{dt} \quad \text{---1}$$

If equation 1 is multiplied by R, to introduce the time constant τ_m = RC of the 'leaky integrator'. Then equation 1 can rewritten as,

$$\tau m \frac{du}{dt} = -u(t) + RI(t) \quad \ldots 2$$

Where u(t) = membrane potential.

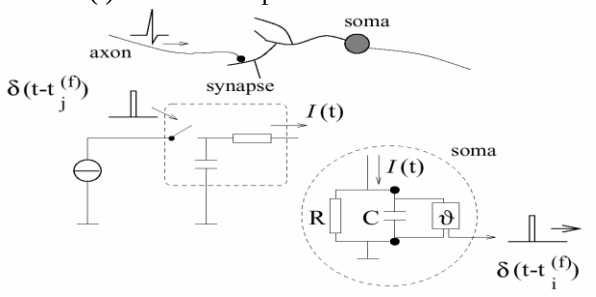

Figure 1: Schematic diagram of Integrate and Fire neuron

The neuron is considered as a leaky if there is decay in characteristic time constant is summed in contribution to membrane potential, when this "leak" is forfeit then the model is considered a perfect integrator. In the leaky integrate-and-fire model, the memory problem can be solved by adding a "leak" term to the membrane potential, reflecting the diffusion of ions that occurs through the membrane when some equilibrium is not reached in to the cell.In this paper, LIF model is used as a classifier, to classify the objects.

2.2. The two-level Network

The SNN network used in this study consist of two levels, the first level acts like collection of input neurons and the second level acts like a collection of output neurons. A binary input image is represented to the first level neurons, each image pixel belongs to a separate input neuron. The number of neurons present in output is equal to the number of training images. Each input neuron is connected to all of the output neurons as shown in fig below.

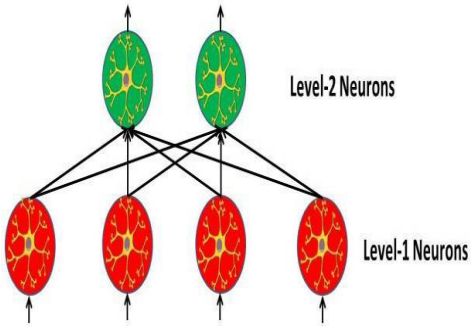

Figure 2: two level network

If a membrane potential crosses a certain threshold during a cycle, the neuron is considered as a fired. The input current is zero for level 1 neuron, if neurons corresponding to the pixel in the input image is 'off'. A constant current is supplied to the input neuron, if the pixel is 'on'. A level two neurons overall input current is the sum of all individual current received from the level 1 neuron connection.

3. Methodology

There are few steps through which classification and recognition of character could be done. The image undergoes through following four steps:-

3.1. Image Acquisition
3.2 Pre-processing
3.3. Feature extraction
3.4. Classification of Characters
3.5. Recognition.

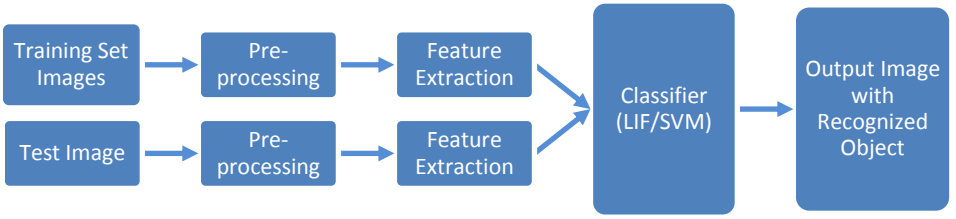

Figure 3: overall proposed system

3.1. Image Acquisition Process

Acquisition is the process of capturing the image from camera or printer. One can use the different images for character and object recognition. In this study the database for different handwritten characters and apple and grapes images is made. For the instance of 26 alphabetic characters.

3.2. Pre-processing

In pre-processing the image is scanned, that image can introduced noise which leads to decrease the quality of the image; this parameter may reduce the systems accuracy. Pre-processing occurring following steps:-
A) Converting the original image to Gray scale image
B) Use of filter to remove noise
C) Image enhancement

A) Converting original image into Gray scale:
The original scanned image is first converted into the gray level scale image. It makes the further processing easy and the intensity of image is equal throughout the image.

B) Reducing noise by using filter:
As the image is scanned its quality is reduced and noise can be inserted, to remove the noise we use Median filter it helps in model to removes the noise from the image.

C) Image enhancement:
It is the process of adjusting digital image to make it suitable for display of the image. It increase the brightness of the Image and makes it easy to identify the key features of that image.

3.2.1. Feature extraction for object recognition

Feature extraction is considered as process of converting the given data into classifier acceptable format. In object recognition process, the image is to be represented into relevant feature vector, so that the applied classifier can take these feature vectors as an input to recognize the object. In this paper, we have taken three different types feature, where each of them have different properties and extract unique features from an image for the object recognition process. Here we have taken Energy Level of an image [8], Extended Histogram of Gradients (ExHoG) [9] and Edge Detection using Extended Epanechnicov Function and Non maxima Repression [10], which are

combine together to exhibit promising performance and to increase the accuracy level to detect an object from any image.

Energy level feature of an image can be explained in a simple way that, it is a mean of the wavelet components of an image. Energy level of an image are calculated, by beginning with conversion of RGB image to Grayscale image and then calculating texture of that image using rangfilt command in Matlab. After this, decomposition of an image is done using single level 2-D wavelet transform by dwt2 matlab command. Haar wavelet is used to compute wavelet features, which transform the whole image into four sub-band image. In sub-band image only LL level is used for DWT computation. Output of the above procedure is a vector of features (e1, e2 and e3) containing energies of wavelet coefficients [8].

Edges are the most basic feature of images therefore plays an important role in image processing. Here to extract edge histogram features, Extended Epanechnicov Function and Non maxima Repression methods are used given in [10]. The third and the last important feature vector calculated is an Extended Histogram of Gradients (ExHoG), which is a type of feature descriptor. ExHoG is an extended version of Histogram of Gradients (HG) which are the histogram of gradients vectors. Gradient vectors are a measure of, change in the pixel values along x and y direction around each pixel. ExHoG is computed by following steps as, first of all HG is calculated with i as the bin of quantized gradient direction θ, L as the number of bins of HG and $h_y(i)$ is the bin value of HG. By adding $h_y(i)$ and $h_y(i+L/2)$, Histogram of Oriented Gradients (HOG) and by absolute difference between $h_y(i)$ and $h_y(i+L/2)$, histogram of difference gradient refer to as Diff HG are computed from HG. Now after concatenating Diff HG and HOG of L/2 bins each which form a histogram of L bins for each cell in the imagewindow called Extended Histogram of Gradients (ExHoG) [9].

3.2.2. Feature Extraction for character recognition

Feature extraction is considered as process of converting the given data into classifier acceptable format. It is the process of extracting the features of characters so that extracted character will be used in training of neural networks. These neural network can be used in recognition process by reference of trained neural network. Using two methods which are more effective in increasing the recognition rate of the handwritten characters, it involves row and column segmentation and extracting each character by its physical characteristics. By using row and column segmentation process we can count the number of black and white pixels in each row and column. It will help us to separate how many number of lines and words are there in a document. After separation of lines and words, each single character then detected by using the same process but this time the physical characteristics of the letter will be helpful for character recognition This method of extracting the feature of the character use to train the neural Network so that they can use in recognition process.

3.3. Classification and Recognition of object

In machine learning, classification is a problem of identifying to which set of categories a new observation set belongs and the algorithm which apply classification on sets is known as classifier. Here in our proposed method two types of classifier is used, first LIF model of SNN is used to classify between the objects for object recognition and two level network model of SNN is used to classify between characters and second SVM is used to compare the result of SNN.

4. SVM

Support vector machine are supervised learning models with the associated learning models with the associated learning algorithm that analyze data and recognize pattern. Algorithm has some memory requirements, it handle problems with thousands of support vector efficiently. SVM constructs a hyperplane in an infinite dimensional space, which is used for classification or other tasks. The maximum the margin the minimum the error of classifier. They follow the family of generalized linear classification. Minimizing the classification error and maximize the geometric margin at a time is the special property of SVM. SVM is also called as maximum margin classifier. Two parallel hyperplanes are constructed on each side that separate the data. The separating hyperplane is the hyperplane that maximize the distance between two parallel hyperplane. The larger the distance between these hyperplane the better the generalization error of classifier. The support vector machine (SVM) is superior to all machine algorithm which is based on statistical learning theory.

5. Result and Description

The proposed method was applied to the images from the dataset and some images are self-acquired.Dataset contain images of different types of fruits and character. It contains several original images and various types of computer generated images. Proposed algorithm was able to recognize different types of fruits as an object handwritten characters. The algorithm is implemented in MATLAB software. In figure 3, there are shown few output images computed by our proposed algorithm. Results have shown that proposed algorithm can recognize an object when the post-processing operations like rotation, scaling, JPEG compression are applied to an image. For character recognitionThe algorithm is implemented on MATLAB software. After that scan another image and give it to perform characterization using SNN, where the one document will get scanned then it will separate lines by line segmentation as shown in figure 6 then itwill separate out all characters as shown in figure 7 and in the end it will shows the decoded output as per the characters on each line on command window as shown in figure 8. All this process is shown in diagram below, different characters will be compare with data base and match with the output.

Figure 4:Output images of object recognition.

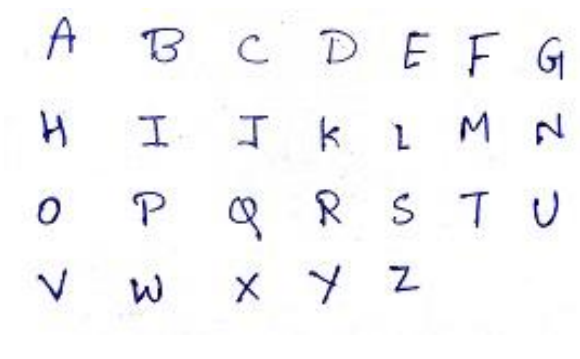

Figure 5: original image of handwritten document

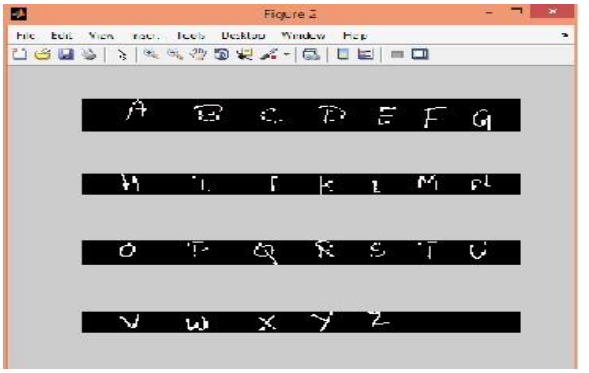

Figure 6: line segmentation of original document

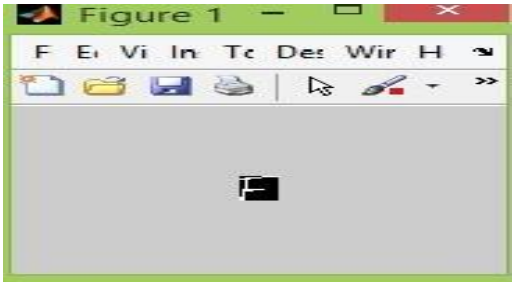

Figure 7: Character extracted from line

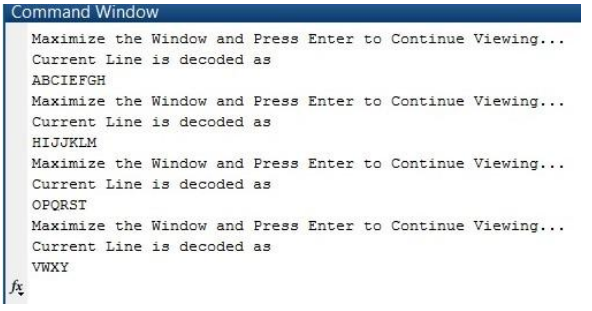

Figure 8: character decoded from each line

6. Conclusion

The proposed work aimed for,recognition of object and handwritten characters by applying a Spiking Neural Network (SNN's) Leaky Integrate Fire (LIF) model and two level Network. Study refers the Support Vector Machine (SVM) for classification of objects and characters. The work focused on the keys parameters: network architecture (number of sub-synapses, receptive fields, output neurons) and learning parameters (training step, size of the training data base, peak of the learning function). Study have shown that a careful setting of parameters is essential to obtain efficient results.

7. Refrences

[1] Mrs.S.Chaturvedi, Dr.A.A.Khurshid, " Comparison of Support Vector Machine and Leaky- Integrated & Fire SNN model for Object Recognition" ICAI-2014.
[2] Miss. ChinkiChandhok, Mrs. SoniChaturvedi. "Adaptation of Spiking Neural Networks for Image Clustering".International Journal of Video & Image Processing and Network Security IJVIPNS-IJENS Vol: 12 No: 03
[3]Boudjelal Meftah1, Olivier Lezoray, SoniChaturvedi, A.A.Khurshid and AbdelkaderBenyettou." Image Processing with Spiking Neuron Networks."
[4]Krishna Mohan Buddhiraju and Imdad Ali Rizvi, "Comparison of CBF, ANN and SVM Classifiers for Object based Classification of High Resolution Satellite Image", 978-1-4244-9566-5/10/$26.00 ©2010 IEEE.
[5] M. Pontil and A. Verri "Properties of Support Vector Machines", Neural Computation, vol. 10, pp.955 -974 1998.
[6] C. Cortes and V. Vapnik "Support-Vector Networks", Machine Learning, vol. 20, pp.1 -25 1995.
[7] J. Vreeken, "Spiking neural networks, an introduction,"Institute for Information and Computing Sciences, Utrecht University Technical Report UU-CS-2003-008,2002.
[8] Parag P. Gudadhe, Nikkoo N. Khalsa,"Features Affecting The classification of Images", International Journal of Recent Development in Engineering and Technology Volume 2, Issue 3, March 2014.
[9] AmitSatpathy, Xudong Jiang, How-Lung Eng, "Extended Histogram of Gradients with Asymmetric Principal Component and Discriminant Analyses for Human Detection".
[10] MeenakshiYadav , "Image Edge Detection using Extended Epanechnicov Function and Non maxima Repression", IJCSNS International Journal of Computer Science and Network Security, VOL.15 No.1, January 2015
[11] Ankur Gupta and Lyle N Long, "Character Recognition using Spiking Neural Networks". Presented at IEEE neural network Conference, Orlando, FL, Aug., 2007.
[12] S.Arivazhagan, R.NewlinShebiah, S.SelvaNidhyanandhan, L.Ganesan,"Fruit Recognition using Color and Texture Features"Journal of Emerging Trends in Computing and Information Sciences VOL. 1, NO. 2, Oct 2010