Comparaison of Support Vector Machine and Leaky-Integrate & Fire SNN model for Object Recognition

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Abstract *- Classification is récursive an impulse décision making tasks of human quickness. In today's world it is the gaining interest of active research with the areas of neural network. Classification and recognition of objects plays a vital role in computer vision research. In Neural Network, Spiking Neural networks are found to be exquisitely beneficial in impregnable. Classification of data. In this paper we will classify and recognise the object using Support Vector Machine (SVM) and one of the most popular model of SNN which is the Leaky-Integrate and Fire (LIF) model. SVM are supervised learning models that are used for classification of images. SNNs incorporate the concept of time into their operating model. LIF model is easy to implement have good computational efficiency. This paper depicts comparison of SVM and SNN model LIF for object classification and recognition. .*

Keywords: Support Vector Machine (SVM), Spiking Neural Network (SNN), Leaky Integrate and Fire Neuron Model.

1 Introduction

Over the last decades many theories have been developed on how human can recognise. Most of them are based on logical reasoning and on clear abstractions, and sound very plausible. From human object recognition to computerized object recognition is a large rung of ladder. There are various theories on human object recognition which do not touch on the lower plane of vision processing, i.e. assuming that extracting an object from its surroundings is given, and that decomposition of this object into different entities happens naturally.

Humans easily possess the ability to classify the objects. With a simple glance of an object, humans are able to tell its identity or category despite of the appearance variation due to change in pose, illumination, texture, deformation, and under occlusion.

Existing image storing systems limit classification mechanism to describing an image based on metadata such as colour histograms, texture, or shape features. The ability of these systems to retrieve relevant documents based on search criteria could be greatly increased if they were able to provide an accurate description of an image based on the image's content. By using a neural network we can recognise objects from an image.

The difficulties of object recognition are extensive. To avoid too general a discussion we will mainly look at them here in a light that makes sense when working with neural systems. Shapes can differ in appearance for several reasons. The most important reason is the difference in perspective we can have on a shape, i.e. shapes can be viewed from different angles and positions possibly making the shape appear bigger, upside down, tilted etc. In this paper we focus on a supervised learning algorithm called Support Vector Machine (SVM) and Leaky Integrate and Fire neuron model (LIF) which is a well known SNN model for classification of objects.

2 Support Vector Machine (SVM)

Support Vector Machine (SVM) was proposed by Vapnik and has since gained attention a high degree of interest in the machine learning research community. SVM method does not have any limitations of data dimensionality and limited samples. The support vectors, which are critical for classification, are obtained by learning from the training samples.

Support vector machines are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification and regression analysis. The algorithm has scalable memory requirements and can handle problems with many thousands of support vectors efficiently. The SVM constructs a hyper plane or set of hyper planes in a high-or infinite-dimensional space, which is used for classification, regression, or other tasks. Instinctive, a good separation is gained by the hyper plane which has the maximum distance to the nearest training data point of any class, in general the maximum the margin the minimum the generalization error of the classifier.

They belong to a family of generalized linear classification. A special property of SVM is that it simultaneously minimizes the empirical classification error and maximizes the geometric margin. So SVM called Maximum Margin Classifiers. SVM is based on the Structural risk Minimization (SRM). SVM map input vector to a higher dimensional space where a maximal separating hyper plane is constructed. Two parallel hyperplanes are constructed on each side of the hyperplane that separate the data. The separating hyperplane is the hyperplane that maximize the distance between the two parallel hyperplanes. An assumption is made that the larger the margin or distance between these parallel hyperplanes the better the generalization error of the classifier. The support

vector machine (SVM) is superior to all machine learning algorithms which are based on statistical learning theory. There are a number of publications detailing the mathematical formulation and algorithm development of the SVM [6] [7]. The inductive principle behind SVM is structural risk minimization (SRM), which constructs a hyper-plane between two classes, such that the distance between supports vectors to the hyper-plane would be maximum.

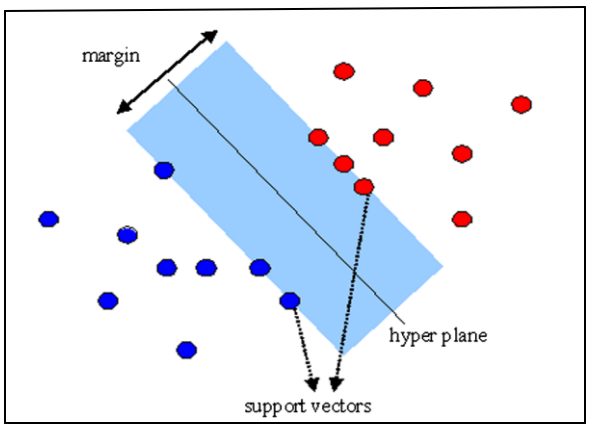


Figure 1. Concept of SVM

The principle of an SVM is to map the input data onto a higher dimensional feature space nonlinearly related to the input space and determine a separating hyperplane with maximum margin between the two classes in the feature space.

3 Leaky Integrate Fire neuron Model

LIF neuron is probably one of the simplest spiking neuron models, but it is still very popular due to the ease with which it can be analyzed and simulated. The LIF model is a popular SNN model which falls into the third generation of neural network models, increasing the level of realism in a neural simulation. SNNs incorporate the concept of time into their operating model.

In this paper, LIF model is used to recognise the objects. LIF model is popular for its simplicity and ease to implement with minimum computational cost. The neuron is called or considered leaky if there is decay in characteristic time constant is summed in contribution to membrane potential when this “leak” is forfeit then he model is considered a perfect integrator. The LIF model is used in computational neuroscience. The leaky integrate-and-fire (LIF) neuron is probably one of the simplest spiking neuron models, but it is still very popular due to the ease with which it can be analyzed and simulated.

The basic circuit of an integrate-and-fire model consists of a capacitor C in parallel with a resistor R driven by a current $I(t)$; The driving current can be split into two components, $I(t) = I_R + I_C$. The first component is the resistive current I_R which passes through the linear resistor R. It can be calculated from Ohm's law as $I_R = u/R$ where u is the voltage across the resistor. The second component I_C charges the capacitor C. From the definition of the capacity as $C = q/u$ (where q is the charge and u the voltage), we find a capacitive current $I_C = C\,\mathrm{d}u/\mathrm{d}t$.

In the leaky integrate-and-fire model, the memory problem is 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 the cell.

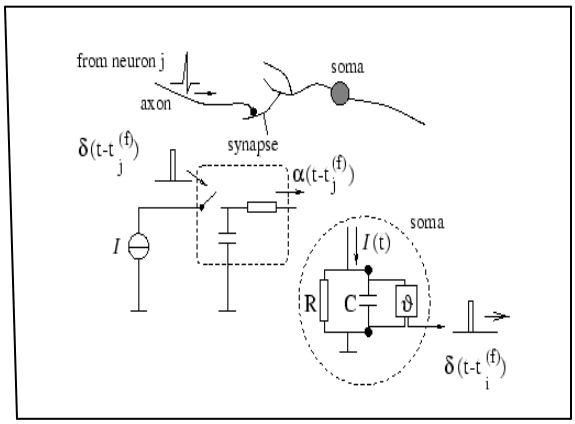


Figure 2. Concept of LIF

4) Steps involved for classification of object

The image of object is scanned which degrades the quality of the image. To enhance or improve the quality of the image, the image undergoes four steps:-

4.1) Pre-processing
4.2) Feature extraction
4.3) Classification of object using SVM
4.4) Object Recognition.

4.1) Pre-processing:

In pre-processing the image is scanned, due to which noise is introduced which leads to degradation of the quality of the image; this parameter can reduce the systems accuracy.

Pre-processing involves following steps:-

4.1.1) Converting the original image to Gray scale image
4.1.2) Use of filter to remove noise
4.1.3) Image enhancement
4.1.4) Segmentation (Thresholding and Edge Detection)

The scanned input image of an object a mug is as shown below:

4.1.1) Converting original image into Gray scale:

The original scanned image is converted to the gray scale. It makes the further processing easy and the image intensity is equal throughout the image.

4.1.2) Reducing noise by using filter

As the image is scanned its quality is reduced and noise is inserted, to remove the noise we use Median filter. It removes the noise from the image.

4.1.3) Image enhancement

It is the process of adjusting digital image for suitable display of the image. It sharpens or brighten the image and makes easy to identify the key features of the image.

4.1.4) Segmentation

Segmentation plays important role in pre-processing, it is the predominant stage in the demonstration. Segmentation involves Thresholding and Edge Detection. Thresholding converts gray scale image to binary image. It extracts the object from the background by selecting certain threshold value. Edge detection detects meaningful discontinuities in intensity value which helps reduce the data to be processed. Edge detection also preserves the efficient properties of the object to be recognized.

4.2) Feature Extraction

The most vital role in classification of object is to extraction of feature. It represents the feature vector which is used for classification purpose. We extract various features from the object such as texture, shape distribution and pair point feature etc. After extracting feature values we get feature vector which is used for the further classification of various objects.

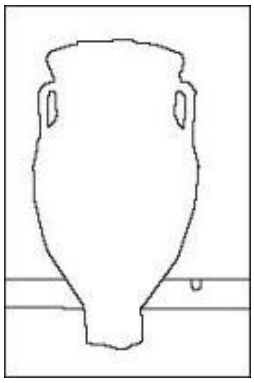
4.3) Classification/Recognition of object

SVM is a supervised learning technique in which the output and input is known.SVM classify efficiently with almost accurate results. We also use LIF model for classification and recognition of object. Among SVM and LIF which classifier technique is accurate and efficient will study by comparing its results.

a)

b)

c)

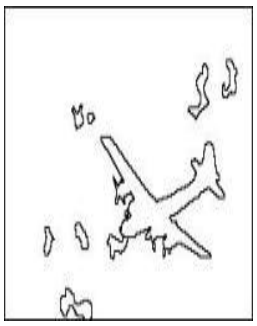


d)

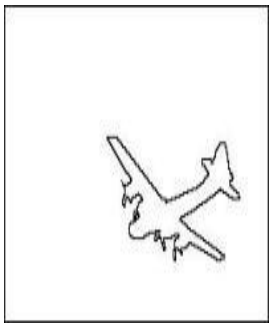
Figure 3. a) Original image b) c) d) Edge detection

a)

b)



c)



d)

Figure 4. a) Original Image b) c) d) Edge Detection

5) SVM Classifier Vs Neural Classifier model

Flexibility of training: The Neural Network classifiers parameters can be adjusted by gradient descent training which aims the global performance. The neural classifier is embedded layout recognizer for object recognition. SVMs can only be trained at the level of holistic patterns.

Complexity of training: Neural classifiers generally adjust their parameters by various algorithms such as Gradient Descent. By giving the training samples a fixed number of sweeps, the training time is proportional with the number of samples. S VMs are trained by quadratic programming (QP), and the training time is generally proportional to the square of number of samples.

Classification accuracy: According to the researchers SVMs has superior classification accuracies to Spiking Neural Classifiers in many experiments.

Storage and execution complexity*:* SVM learning of SVM by QP gives a large number of SVs, which are to be stored and computed in classification. As compared to SVM, Neural classifiers have very less parameters, and the number of parameters is very ease in controlling. In other words, neural classifiers consume less storage and computation than SVMs.

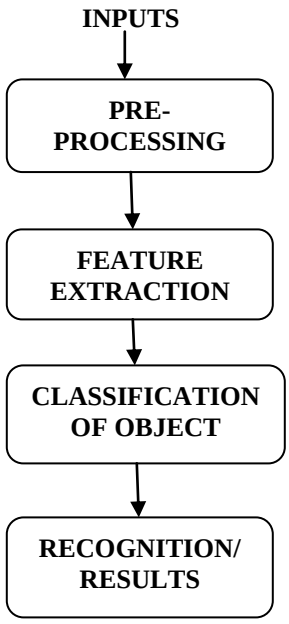


Figure 5. Flowchart of Object Recognition

6) Conclusion

In this paper we will study how to classify object using SVM and recognize using SNN model, Leaky- Integrate fire neuron model (LIF). According to the research, SVM is a good and efficient classifier with high accuracy and better classification as compared to SNN. The LIF model is popular because of its computational efficiency.

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