Efficient Real – Time Analysis for Sequence of Medical Images using Support Vector Machine

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Abstract- The objective of the proposed work is to develop an automatic system which is capable of determining the stage of the ongoing surgical operation by analyzing the video sequence obtained from an endoscope during surgery. The system is designed such that, they are: 1. capable of distinguishing between different organs on the image obtained from an endoscope 2. Capable of making real-time decisions when working with video stream. This paper uses Support Vector Machine (SVM) which is used as a classifier.

Keywords: Endoscope, Support Vector Machine (SVM), Neural Network, Processing Elements, Nodes, Principal Component Analysis method(PCA).

I. INTRODUCTION

The term neural network was traditionally used to refer to a network or circuit of biological neurons. The modern usage of the term often refers to artificial neural networks, which are composed of artificial neurons or nodes. Thus the term has two distinct usages. Biological neural networks are made up of real biological neurons that are connected or functionally related in a nervous system. In the field of neuroscience, they are often identified as groups of neurons that perform a specific physiological function in laboratory analysis. Artificial neural networks are composed of interconnecting artificial neurons (programming constructs that mimic the properties of biological neurons).

Artificial neural networks may either be used to gain an understanding of biological neural networks, or for solving artificial intelligence problems without necessarily creating a model of a real biological system. The real, biological nervous system is highly complex: artificial neural network algorithms attempt to abstract this complexity and focus on what may hypothetically matter most from an information processing point of view.

Good performance (e.g. as measured by good predictive ability, low generalization error), or performance mimicking animal or human error patterns, can then be used as one source of evidence towards supporting the hypothesis that the abstraction really captured something important from the point of view of information processing in the brain. Another incentive for these abstractions is to reduce the amount of computation required to simulate artificial neural networks, so as to allow one to experiment with larger networks and train them on larger data sets.

An artificial neural network (ANN), usually called neural network (NN), is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks.

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A neural network consists of an interconnected group of artificial neurons, and it processes information using a connectionist approach to computation. In most cases an ANN is an adaptive system that changes its structure based on external or internal information that flows through the network during the learning phase. Modern neural networks are non-linear statistical data modeling tools. They are usually used to model complex relationships between inputs and outputs or to find patterns in data.

The original inspiration for the term Artificial Neural Network came from examination of central nervous systems and their neurons, axons, dendrites, and synapses, which constitute the processing elements of biological neural networks investigated by neuroscience. In an artificial neural network, simple artificial nodes, variously called "neurons", "neurodes", "processing elements" (PEs) or "units", are connected together to form a network of nodes mimicking the biological neural networks — hence the term "artificial neural network".

Because neuroscience is still full of unanswered questions, and since there are many levels of abstraction and therefore many ways to take inspiration from the brain, there is no single formal definition of what an artificial neural network is. Generally, it involves a network of simple processing elements that exhibit complex global behavior determined by connections between processing elements and element parameters. While an artificial neural network does not have to be adaptive per se, its practical use comes with algorithms designed to alter the strength (weights) of the connections in the network to produce a desired signal flow.

These networks are also similar to the biological neural networks in the sense that functions are performed collectively and in parallel by the units, rather than there being a clear delineation of subtasks to which various units are assigned (see also connectionism). Currently, the term Artificial Neural Network (ANN) tends to refer mostly to neural network models employed in statistics, cognitive psychology and artificial intelligence. Neural network models designed with emulation of the central nervous system (CNS) in mind are a subject of theoretical neuroscience and computational neuroscience.

In modern software implementations of artificial neural networks, the approach inspired by biology has been largely abandoned for a more practical approach based on statistics and signal processing. In some of these systems, neural networks or parts of neural networks (such as artificial neurons) are used as components in larger systems that combine both adaptive and non-adaptive elements. While the more general approach of such adaptive systems is more suitable for real-world problem solving, it has far less to do with the traditional artificial intelligence connectionist models. What they do have in common, however, is the principle of non-linear, distributed, parallel and local processing and adaptation.

The real life applications are Function approximation, or regression analysis, including time series prediction, fitness approximation and modeling, Classification, including pattern and sequence recognition, novelty detection and sequential decision making, Data processing, including filtering, clustering, blind source separation and compression, Robotics, including directing manipulators, Computer numerical control.

Application areas include system identification and control (vehicle control, process control), quantum chemistry, game-playing and decision making (backgammon, chess, poker), pattern recognition (radar systems, face identification, object recognition and more), sequence recognition (gesture, speech, handwritten text recognition), medical diagnosis, financial applications (automated trading systems), data mining (or knowledge discovery in databases, "KDD"), visualization and e-mail spam filtering.

II. PROPOSED MODEL

To identify the organs during surgery, one Support Vector Machine system is designed for each organ so that each of this system analyzes if corresponding organ (or group of internal organs) is visible or not visible on examined image and then combines results from each of systems to receive a final decision.

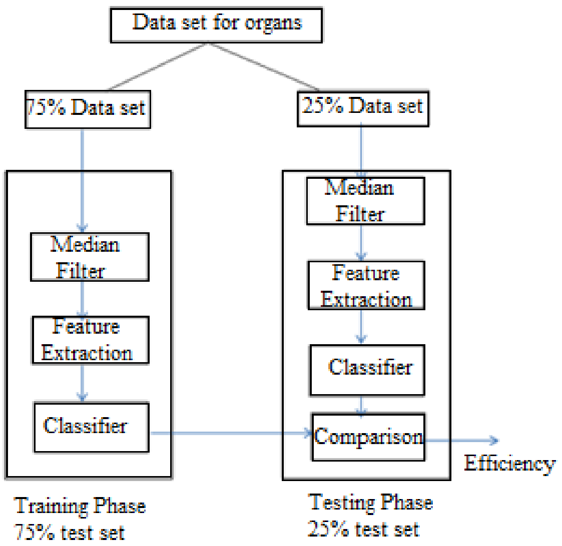

Fig. 1 Algorithm

This approach work with more complicated data like several internal organs present in the same image at the same time. The system is easily extendable by adding new modules corresponding to new organs that are required to recognize.

In this proposed work, the data set consists of images of different organs to be identified. The noise is removed from the image set by using filters. Features are extracted by using structural, spectral and statistical approach. These features set which is extracted from all the images are stored in a data base. Since the features play an important role for efficient classification, only the features, which contribute to the classification, are identified by using Principal Component Analysis method (PCA).

Support Vector Machine (SVM) is used as a classifier. The polynomial kernel is used for Support Vector Machine. Support Vector Machines have high approximation capability and much faster convergence. The support vector machine operates on two mathematical operations:

(1) Nonlinear mapping of an input vector into a high-dimensional feature space that is hidden from both the input and output.

(2) Construction of an optimal hyper plane for separating the features discovered in step 1.

The data set is divided into two parts of 75% and 25% data set. 75% of the image set is used for training the SVM and 25% is used for testing the SVM. Efficiency of the proposed system is calculated in both training phase and testing phase. The data set is divided into two groups, one set consisting of 75% of the data set which is used to train individual module of SVM to determine the corresponding organ. The remaining 25% is used as a test set.

The useful features of the image can be obtained from the histogram are mean, variance, skewness, kurtosis, energy and entropy. Mean is the average value of the intensity of the image. Variance tells the intensity variation around the mean. Skewness is the measure which tells the symmetriness of the histogram around the mean. Kurtosis is the flatness of the histogram. Uniformaty of the histogram is represented by the entropy.

The features are given mathematically as

$$Mean: \mu = \sum_{i=0}^{G-1} ip(i) \quad (1)$$

$$Variance: \sigma^2 = \sum_{i=0}^{G-1} (i-\mu)^2 p(i) \quad (2)$$

$$Skewness: \mu_3 = \sigma^{-3} \sum_{i=0}^{G-1} (i-\mu)^3 p(i) \quad (3)$$

$$Kurtosis: \mu_3 = \sigma^{-4} \sum_{i=0}^{G-1} (i-\mu)^4 p(i) - 3 \quad (4)$$

$$Energy: E = \sum_{i=0}^{G-1} [p(i)]^2 \quad (5)$$

$$Entropy: H = \sum_{i=0}^{G-1} p(i) log_2 [p(i)] \quad (6)$$

Where, G is the total gray level of the image. Efficiency of the proposed system is calculated in both training phase and testing phase.

III. CONCLUSION

The proposed algorithm is used to analyze sequence of medical images. Image of Gall bladder and Liver is shown in Figure 2. The image is read from endoscopy. SVM is used to identify the organ present in the image. This is used for real time analysis of endoscopic images.

The proposed architecture is tested with a sequence of biomedical images and it effectively identifies the organ that is visible in the endoscopic image.

Fig. 2 Image of Gallbladder and Liver

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