Image Pixel Intensity and Artificial Neural Network based Method for Pattern Recognition

Dilip Singh Sisodia , Shrish Verma

***Abstract*—**In this paper, we propose a method for pattern recognition which is based on Multilayer Error Back propagation network trained with sigmoidal or any continuous and differentiable function with pixel intensity based technique. In this method of pattern recognition the system will be trained with sets of various patterns this set will contain number of same patterns. After training the network for the entire pattern set, it should be able to recognize the input patterns taken through already stored media file of patterns or directly from video capturing device like web camera. To show the application of proposed method here we consider the static hand gesture of any sign language as a input pattern and demonstrate the proposed method experimentally.

***Keywords*—**Pixel intensity, pattern sets, error back propagation, sigmoidal, continuous and differentiable.

I. Introduction

PATTERN recognition has become much important and interesting application to solve various problems from very long time. Pattern recognition is still active area of research. Here we are applying multilayer Back propagation neural network in combination with pixel intensity based skin color detection algorithms to recognize static hand Gestures of any sign languages. Sign language is one form of communication for the hearing and speech impaired. Similar to spoken language, there is no universal sign language. Sign language is itself a separate language with its own grammar and rules. Some signs are expressed as static gestures while others incorporate some dynamic hand movements. For static gestures, the prominent sign is captured within a specific time frame. For dynamic gestures, a sequence of finger and hand positions needs to be identified and analyzed in order to be recognized. The focus of this paper is to demonstrate the application of proposed pattern recognition algorithm on static gestures with a single hand. Here we present the application of neural network for pattern recognition in conjunction with other technique. In this paper we want to demonstrate two things:

1. To apply the concepts of an ANN for pattern recognition.

2. To improve the efficiency of pattern recognition by using ANN.

II. Related Work

A. Neural Network

Neural network possesses the capability of pattern recognition. Researchers have reported various neural network models capable of pattern recognition [2].

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The error back propagation algorithm has been a significant milestone in neural network research back-propagation training algorithm when applied to a feed forward multi-layer neural network is known as Back propagation neural network. Functional signals flows in forward direction and error signals propagate in backward direction. That's why it is Error Back-propagation network. The activation function that can be differentiated (such as sigmoidal activation function) is chosen for hidden and output layer computational neurons. The algorithm is based on error-correction rule [4].

B. Pattern Recognition

Pattern recognition is the study of how machines can observe the environment, learn to distinguish patterns of interest from their background, and make sound and reasonable decisions about the categories of the patterns. A pattern can be a image, a handwritten word, a human face, or a speech signal. Given a pattern, its recognition may consist one of the following two tasks: 1) supervised learning in which the input pattern is identified as a member of a predefined class, 2) unsupervised learning in which the pattern is assigned to a hitherto unknown class. The recognition problem here is being posed as a classification or categorization task, where the classes are either defined by the system designer or are learned based on the similarity of patterns The rapidly growing and available computing power, while enabling faster processing of huge data sets, has also facilitated the use of elaborate and diverse methods for data analysis and classification. At the same time, demands on automatic pattern recognition systems are rising enormously due to the availability of large databases and stringent performance requirements. The design of a pattern recognition system essentially involves the following three aspects: 1) data acquisition and preprocessing, 2) data representation, and 3) decision making. The problem domain dictates the choice of sensor(s), preprocessing technique, representation scheme, and the decision making model. It is generally agreed that a well-defined and sufficiently constrained recognition problem will lead to a compact pattern representation and a simple decision making strategy. Learning from a set of examples (training set) is an important and desired attribute of most pattern recognition systems. The four best known approaches for pattern recognition are: 1) template matching, 2) statistical classification, 3) syntactic or structural matching, and 4) neural networks.

C. Skin modeling

The final goal of skin color detection is to build a decision rule that will discriminate between skin and non-skin pixels. This is usually accomplished by introducing a metric, which measures distance (in general sense) of the pixel color to skin tone. The type of this metric is defined by the skin color modeling method .One method to build a skin classifier is to define explicitly (through a number of rules) the boundaries skin cluster in some color space.

(R, G, and B) is classified as skin if:
R > 95 and G > 40 and B > 20 and
Max{R, G, B} −min{R, G, B} > 15 and (10)
|R−G| > 15 and R > G and R > B

The simplicity of this method has attracted (and still does) many researchers. The obvious advantage of this method is simplicity of skin detection rules that leads to construction of a very rapid classifier. The main difficulty achieving high recognition rates with this method is the need to find both good color space and adequate decision rules empirically. Recently, there have been proposed a method that uses machine-learning algorithms to find both suitable color space and a simple decision rule that achieve high recognition rates. The authors start with a normalized RGB space and then apply a constructive induction algorithm create a number of new sets of three attributes being a superposition of r, g, b and a constant 1/3, constructed by basic arithmetic operations. A decision rule, similar to (10) that achieve the best possible recognition is estimated for each set of attributes [14].

D. Sign Language

Automatic sign recognition has been investigated since around1995 [16]. Researchers tried a variety of techniques, such as fuzzy logic, neural networks, and Hidden Markov Models (HMMs), mostly on small vocabularies. Vogler and Metaxas achieved a 96% recognition rate on a 22-word vocabulary using parallel HMMs. Chen reported a 92% success rate with whole-word HMMs for a 5113-word vocabulary. Both used instrumented gloves and magnetic trackers to capture their data. Zieren and Kraiss and Bowden use cameras to record signs. They achieve 98% recognition rates for a 152- and a 43-word vocabulary respectively.

Research on hand gestures can be broadly classified into two categories. The first category, glove-based analysis, employs sensors (mechanical or optical) attached to a glove that transduces finger flexions into electrical signals for determining the hand posture.

The second category, vision based analysis, is based on the way human beings perceive information about their surroundings, yet it is probably the most difficult to implement in a satisfactory way [21].

III. Proposed Method

The principal assumption of the proposed pattern recognition method is that the pattern includes exactly one hand. Furthermore, the arm is roughly vertical, the palm is facing the camera and the fingers are either raised or not. Finally, the pattern background is plain and uniform.

The proposed method consists of five main stages:

(a) The first thing for the program to do is to read the pattern (static hand image) database. A *for* loop is used to read an entire folder of images.
(b) To convert these patterns in to equivalent Binary patterns one by one
(c) Crop these digitized Binary patterns & again redraw for same positioning & Orientation
(d) Pass these digitized Binary patterns to back propagation Neural Network for Training of the network.
(e) After Successful completion of Training we can Test the network

Description of the method and analysis of these stages follows.In the proposed method the input pattern is converted in to Binary pattern with the help of pixel intensity based skin color detection algorithm, since color is a robust feature that performs highly even if the conditions of the environment are not exactly the requisite. First of all, color is invariant to rotation and scaling as well as to geometric variations of the hand. Secondly and importantly it allows a simple and fast processing of the input pattern. On the other hand, skin color varies quite dramatically. It is vulnerable to changing lighting conditions and it differs among people. The perceived variance, however, is really a variance in luminance due to the fairness or the darkness of the skin. We scan this pattern image from left to right and top to bottom and values of all pixels are stored. Skin color pixels are stored as 1 and non skin color pixels are stored as 0. The final digitized pattern image will be a two dimensional array of ‘0 ‘and ‘1 ‘and it will look like the following pixel vector. This array will be used as input to the neural network. This should be done to make it really fast recognizing scheme. Output, error and weight updating would be easy by this technique. For the common orientation and same positioning of all the Binary pattern images, we will crop the pattern images with the help of image filter, which extract a given rectangular region of an existing pattern mage and provide a source for a new image containing just the extracted region. This cropped Binary image will be passed to Input layer of Back propagation network for Further Training and testing of neural network.

For the experimental purpose of our project, we have selected and trained a multilayer Back propagation Network to recognize patterns of static hand gestures. The training data set (pattern images) we have used is obtained from a capturing device such as web camera. For example system should learn a static pose of numeric digits ‘1’ (see figure for Sign Language gesture for ‘1’). We are using a 32x32 resolution for an image.

IV. Experiment And Result Analysis

Here we are taking 24 different images of same pattern, so there are 48 images for training the network (24 for out put no. ‘0’ & 24 for out put no.’1’).

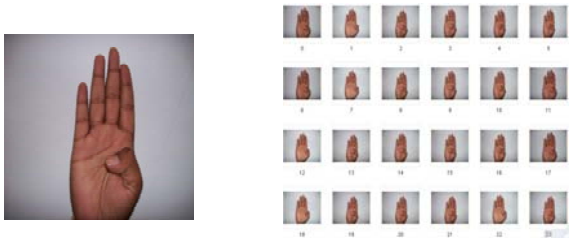

Fig. 1 Training data set for the output number ‘0’

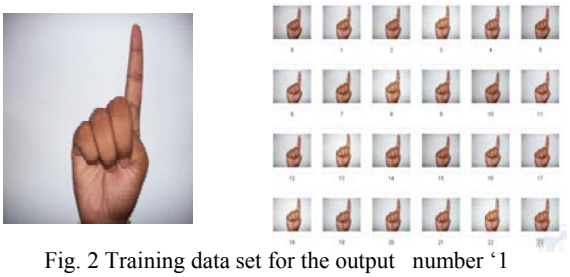

Fig. 2 Training data set for the output number '1

A. Training

Algorithm should train the network until output value of target neuron is greater than 0.80 and less than 0.20 for other output neurons. Initializing weight values to random values between – 1.0 to +1.0., Learning rate: 0.30, Number of neurons in Hidden layer: 40

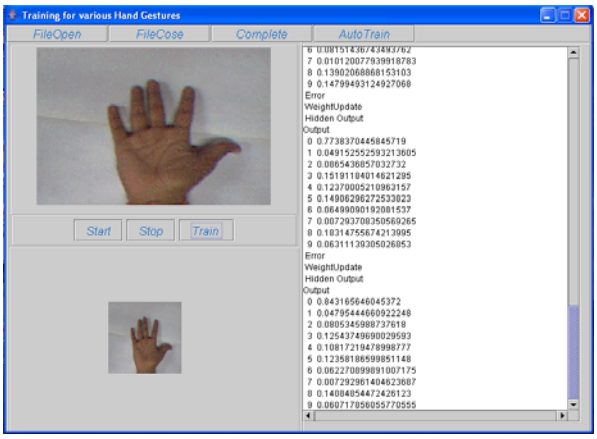

Fig. 3 Training Window showing the actual manual Training process

B. Testing

This network can be tested either by already stored media file (.avi) of various patterns or directly through any Video capturing device like Web camera. For testing it will read weight files which are saved during training process of the network (in this case W1.doc & W2.doc) on the basis of these weight values it will recognize the test gestures.

Test 1:

10.12264888891558096
0.7116607212375469 <<<
<<< It has higher value
Result: correctly recognized as output 1.

Fig. 4 testing pose – 1

Test 2:

0.6815143289197385<<<
<<<<< It has higher value
0.4492883078983879
Result: correctly recognized as output 0.

Fig. 5 testing pose - 2

If we select TESTING through a media file than FileOpen option. After opening a file, pressing Stop button should stop the player and then Test is to be pressed. one can see the output in the Text Area as shown below

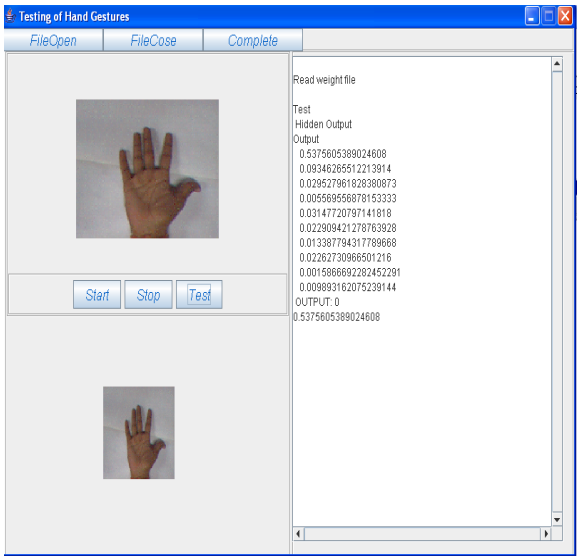

Fig. 7 testing with already stored .avi Media file

C. Training Time

Neural network Training time will depend on the size of the training data set and the no of images in training data set. We will analyze the training time by keeping no. of images constant for each pattern (i.e. 40 for each pattern) . There are four training data sets of different sizes training time for these data sets are shown in following chart.

Fig 8 Training time with training set size

V. Conclusion And Future Work

The Artificial Neural Network design in this paper has the ability to recognize the pattern of static hand gestures without affecting either by shift in position or by a small distortion in the shape of input pattern. It also has a function of

organization, which processes by means of "Learning with a teacher" (Supervised learning). If sets of input patterns are repeatedly presented to it, it gradually acquires the ability to recognize these patterns. It is not necessary to give any instructions about the categories to which the stimulus pattern should belong. The performance of the network has been demonstrated by simulating on a computer. I propose it as a working design for some neural mechanisms of static pattern recognition. This work can be extended to recognize the patterns of static hand gestures faster and more accurately using some robust skin color detection algorithms and performance optimization techniques of neural networks [8].

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