An Accurate Approach for Satellite Image Classification using NeuroEvolutionary Method

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Abstract— Image classification is the growing need for the researchers and analysts who are dealing with huge number of satellite images in their everyday life. Deep Learning has shown quite impressive work in image classification field, but still gaining good accuracy is always an issue with this technique. NeuroEvolutionary Method appears as a solution for this problem. In this paper we present a neuro-evolutionary method called Enhanced HyperNEAT (E-HyperNEAT) which will be used to perform image classification and has shown better accuracy than the other existing methods. E-HyperNEAT has two main features that (1) it will evolve the network as well as the weights, and (2) it will remove the weak links in the network to manage with the processing time. So, E-HyperNEAT is more accurate and efficient method for image classification.

Key words: NeuroEvolutionary Methods, Classification Techniques, NEAT, Neural Network, HyperNEAT

I. INTRODUCTION

Image classification is the procedure of ordering all pixels in a picture or crude remotely detected satellite information to get a given arrangement of names. There are two expansive sorts of classification methodology, one is supervised classification and the other one is unsupervised classification. Unsupervised picture classification is a technique in which the picture translating programming isolates countless pixels in a picture in view of their reflectance values into classes or bunches with no course from the examiner. Then again, supervised classification is a strategy in which the examiner characterizes little regions called preparing destinations on the picture and allots earlier classes to the inspecting units. Picture arrangement is a critical and testing assignment in different application spaces, and satellite remote detecting [1] is one among them. Satellite remote detecting advances gather information/pictures at customary interims. The volumes of information get at server farms is colossal and it is becoming exponentially as the innovation is developing at quick speed as convenient and information volumes have been developing at an exponential rate. There is a solid need of powerful and proficient instruments to separate and translate significant data from gigantic satellite pictures. Satellite picture classification is an effective method to concentrate data from immense number of satellite pictures.

Artificial neural network (ANN) have long held guarantee in the fields of machine learning and counterfeit consciousness. Natural neural systems were delivered through a developmental procedure [2]. The advancement roused calculations are called evolutionary algorithms (EA), a subset is called genetic algorithms. The blend of ANN and EA is called NeuroEvolution (NE), where advancement develops a populace of ANN. There are numerous neuro-transformative algorithms. One basic refinement is whether calculations advance just the associated weights for an altered system topology or on the off chance that they develop both the topology of the system and its weights. Another refinement is whether every component of the developed system is straightforwardly encoded as a different quality, called an direct encoding, or whether there is quality reuse through which one quality may encode numerous system components, called an indirect encoding [3]. In the direct encoding plots the genotype specifically maps to the phenotype. Hence every neuron, association and weight in the neural system is determined straightforwardly and expressly in the genotype. Conversely, in the indirect encoding plots the genotype determines in a roundabout way how that system ought to be produced. The NE has appreciated accomplishment in numerous sorts of undertakings. Most remarkably it has been effectively connected to assignments where the accurate target yields or arrangement are obscure, and just a scalar assessment sign is accessible.

The proposed system is more applicable for the scientists, researchers and analysts, as automated image classification will give vision to computer systems and reduce the work load of scientists. It will be helpful in the field survey, change analysis and management field also. It can also assists planners and engineers by providing a base map for reference.

II. BACKGROUND

The NeuroEvolution of Augmenting Topologies (NEAT) [4] is a neuro-evolutionary algorithm for the advancement of artificial neural networks. This technique does not require a human experimenter to characterize the structure of the ANN it rather advances it independent from anyone else. Amid the development it changes weights of associations between the neurons and the structure of the system trying to locate the fittest individual and in addition keep up differing qualities in the populace. Every neuron yields estimation of the sigmoid capacity over its inputs as in the standard ANN. The technique applies three fundamental methods to accomplish its objective: it tracks qualities with advancement number to keep up the similarity between various topologies, it creates topologies incrementally from basic structures to the unpredictable ones and it safeguards the speciation (development of various species) so as to give the opportunity to complex structures to advance.

Hypercube-based NEAT (HyperNEAT) is an indirect encoding that develops the artificial neural systems with the standards of the broadly utilized NEAT method. It is a novel method for developing extensive scale neural systems using the geometric regularities of the assignment space. The viability of the geometry-based learning in the HyperNEAT [5] has been shown in the various spaces and representations, for example, the checkers [6], the multi-
In this way the element enactments of the RBM give a reflection of the information to prepare the RBM above it. This recursive technique is connected until adequate layers are delivered.

<table>
<thead>
<tr>
<th>Existing System</th>
<th>Definition</th>
<th>Related Works</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuzzy Neural Network</td>
<td>Method concentrated on the discriminant capacity era assignment</td>
<td>N. K. Kasabov S.I. Israel B.J. Woodford</td>
</tr>
<tr>
<td>Convolution Neural Network</td>
<td>Expand the training set by adding a new form of distorted data.</td>
<td>Simard, P. Y. Steinkraus D. Platt J</td>
</tr>
<tr>
<td>Support Vector Machine</td>
<td>SVM is more successful and more viable.</td>
<td>Farid Melgani Lorenzo Bruzzone</td>
</tr>
</tbody>
</table>

Table 1: Comparisons of Existing Systems

**IV. PROPOSED SYSTEM**

The exploratory test is performed on gathered an arrangement of satellite pictures (Google Inc.) from Google Earth. It contains the 12 classes of the physical scenes in the satellite symbolism, including Airport, Bridge, Pond, Parking, Port, Viaduct, River, Forest, etc. For every class, there are 50 images. For training the network, we have used 35 images from the dataset and the rest 15 images have been considered for the testing purpose.

The Figure 1 shows the system architecture of the proposed system.

**An image classification task can be divided into four phases -**

1) **Image Pre-Processing**
2) **Image Vectorization**
3) **Feature Detection**
4) **Classification**

**A. Image Pre-Processing:**
Color image is given to the system by specifying the image path. The system has to pre-process the given input image before performing the actual classification. Pre-processing...
will reduce the pixel size of the input image to the required pixel size. Initially, the system has to get trained over the images of a particular class. So, the input will contain the image path as well as the class, the image belongs to. The system will read the input file path and the class of the given images and store it in the list. After storing the particular image details, system will downs-sample the image, to get the required 16x16 pixel size.

B. Image Vectorization:
After performing pre-processing, the system will have the color image of 16x16 pixel size. The system will extract the Red, Green and Blue value of each pixel and store these values serially as image vector to perform the further processing.

C. Feature Detection:
The system will have the image vector as input and the system will extract the features from the image vector using E-HyperNEAT method. E-HyperNEAT algorithm works on the substrate i.e. grid of neurons. It will divide the image vector into equal number of substrate and then generates the neural network for learning the features. Each Neural Network Node is initialized with random gene value. Gene population can be generated based on the similarities of the different pixel value. The best fit gene will be assigned to the ANN node. A threshold function is included at each neuron which will control the generation of subpopulation of chromosomes during evolution. While generating the subpopulation of chromosome, weak connections are identified (lesser weight) and removed. Thus, generating lesser combination of chromosomes and makes the network less complex.

D. Classification:
The outputs of substrate ANNs will be feed to the Classifier ANN for performing the classification. This is Neural Network based classifier which gets trained by the features detected by the E-HyperNEAT. It will have multiple input nodes which are the features detected and 12 output nodes which are the class labels.

1) Algorithm:
Image classification using E-HyperNEAT algorithm
Input: Satellite images
Output: Classification of input images
Step 1: Input the training satellite image path and the class definition as input.
Step 2: Down-sample the images to the required pixel level
Step 3: Vectorize the RGB pixel values of the images in the array, to feed it to the neural network.
Step 4: Generate substrates to process the image.
Step 5: Analyze the genome encoding.
Step 6: Remove the weak links from the network based on the threshold value.
Step 7: Feed the new test images for the classification to the trained network.

V. RESULTS
The experiments are carried out on satellite dataset, which is collected from Google Earth. Table 2 shows comparison between different methods based on the number of iterations, error % and the accuracy.

<table>
<thead>
<tr>
<th>Comparison Result</th>
<th>Iterations</th>
<th>Error %</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neural Network Algorithm</td>
<td>1,463</td>
<td>0.24209</td>
<td>54%</td>
</tr>
<tr>
<td>NEAT Algorithm</td>
<td>3,430</td>
<td>0.99615</td>
<td>49%</td>
</tr>
<tr>
<td>E-HyperNEAT Algorithm</td>
<td>404</td>
<td>0.24299</td>
<td>63%</td>
</tr>
</tbody>
</table>

VI. CONCLUSION
In this paper we have proposed an algorithm which will perform the image classification and gives better accuracy than the existing methods. We had compared the accuracy of the two neuro-evolutionary methods as well, for the task of image classification. The accuracy can be increased to even more extent, if large number of training dataset is provided to the E-HyperNEAT method.

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REFERENCES