A Neural Network Model for Automatic Image Annotation Refinement

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***ABSTRACT* - In image retrieval techniques, automatic image annotation (AIA) is used to label image by set of semantic keywords automatically. Due to its potential impact on semantic based image retrieval, AIA has been an active research topic in recent year. AIA uses machine learning algorithm for classification of network, this network is use to automatically classify image content. However, the results generated by classification network are still far from satisfaction because it is very difficult to map low level visual features of image to high level semantic feature. Thus refinement of automatic image annotation is necessary. The purpose of refining image annotation is to reserve highly correlated annotations and remove weakly or irrelevant annotation. In this paper, a novel neural network based method is proposed to refine automatic image annotation. In this method correlation between keywords are identified by using neural network and final refined result can generate based on this correlation of keyword.**

***Index Terms* - Image retrieval (IR), Automatic image annotation (AIA), Annotation refinement**

I. INTRODUCTION

Nowadays, Information, in the form of digital images is increasing rapidly. We can also say that data in the form of image are as common as text data. To manage, store and retrieve such a large image, dataset is very difficult for human. Effective and efficient tool is needed to find visual information on demand. A large amount of research has been carried out on image retrieval system. Image retrieval system is mainly divided into three approaches. First is Content Based Image Retrieval (CBIR) in which image is retrieved based on low level visual feature such as color, texture, edges etc. of image. To retrieve image based on CBIR user needs to apply query image or low level visual feature in input of system. Based on applied query image, CBIR system gives set of visually related images to the query image. But it is very difficult for normal user to each time produce query image, and also low level visual feature does not describe high level semantic feature of image. So there is a semantic gap between low level visual feature and high level semantic feature. To bridge this semantic gap another method is introduced which is known as text based image retrieval. In text based image retrieval, image is retrieved such as text document retrieval. In such a system each image dataset has been labeled with set of keywords, based on this keyword image. But it is very difficult and time consuming for human to manually assign keywords to large set of images. So some automated system is needed which performs this task automatically. That's the reason, researcher is focusing on Automatic Image Annotation (AIA) System. In AIA, system image is annotated by metadata in the form of set keywords, automatically. Based on this keywords, image can be retrieved. Many classifiers have been proposed which perform AIA task. Classifier automatically gives set of keywords as a result for input image. These classifiers are trained using typical machine learning algorithm. The result generated by AIA is sometime noisy, means some annotated keywords of result are not related with image. So, it is necessary to refine result of AIA system.

Automatic Image Annotation (AIA) is a technique in which keywords are automatically assigned to image by using some machine learning techniques. The main concept of AIA is to automatically learn semantic concept model from large number of image database and use the concept model to label new images. Basically AIA techniques can be divided into two parts: (1) Visual feature extraction and (2) classification and Annotation. A survey on different AIA techniques is given in zhang et al[1] and hafidha et al[2] from various known techniques; to build a classification network for AIA. One method to learn semantic concept is using Artificial Neural Networks (ANN). ANNs are information processing system inspired by the ability of the human brain to learn from observation. ANN is a learning network which consists of multiple layers of interconnected nodes, which are also known as neurons or perceptrons. An ANN can learn from example and make decision for a new sample thus making it different from other common classifiers which usually learn one class at a time, ANN can learn multiple classes at a time.

Result obtained by classification network may not be satisfactory because it may contain noise i.e. keywords which are not related to the image. It is necessary to refine the current annotation result because many of annotation keywords are inappropriate for image

content. Many researchers have strived to invent novel algorithms of automatic annotation to improve the quality of annotation [3]. In this paper, a novel neural network based method is proposed to refine image annotation.

The rest of paper is organized as follows. In section II, related work of annotation refinement is described. A neural network model for automatic image annotation is presented in section III. Finally, conclusions and future work are given in Section IV.

II. RELATED WORK

In order to fully utilize the confidence scores of the candidate annotations, C. Wing et. al. [4] reformulates the image annotation refinement process as a graph ranking problem and solves it with random walk with restart. In this method graph is constructed for candidate annotation, in which each candidate annotation w_i is considered as a vertex of graph G. All vertexes are connected with proper edge weight based on co-occurrence similarity as follow:

$$sim(w_i, w_j) = \begin{cases} \frac{num(w_i, w_j)}{\min(num(w_i), num(w_j))} & num(w_i, w_j) > 0 \\ 0 & num(w_i, w_j) = 0 \end{cases}$$

Where, $num(w_i)$ is defined as the number of images annotated by annotation w_i , and $num(w_i, w_j)$ is defined as the number of images annotated by both w_i and w_j. After that, Random Walk with Restart (RWR) algorithm is applied to graph for re-ranking the candidate annotation. In RWR algorithm, the initial probability of all the keywords is considered as the restart vector $v(i)$. Starting from $v(i)$, at each time-tick there are two choices. One is to randomly choose an available edge to follow; the other choice is to jump to w_j with probability $c \times v(i)$, where c is the probability of restarting the random walk.

Yae cao et. al.[5] proposed a neural network based method to combine the measures of word to word semantic similarity for image annotation. In this model, candidate annotation is generated by max-min posterior pseudo probability (MMP) and this candidate annotation is refined using feed-forward neural network based method. Random walk with restart method is used to refine the annotation. Particle swarm optimization (PSO) is used to train a neural network for achieving the optimal annotation accuracy. The image annotation experimented on the corel5k dataset and results show that the proposed method is effective and promising. J. Liu et. al. [6] developed a novel method to estimate the word correlation based on the improved Nearest Spanning Chain (NSC). Using this enhanced word correlation, they utilized the graph ranking method to perform the annotation refinement.

III. PROPOSED TECHNIQUE FOR IMAGE ANNOTATION REFINEMENT

Automatic image annotation consists of two components: candidate annotation generation and annotation refinement. In our proposed scheme candidate annotation is identified by typical automatic image annotation methods and then annotation refinement is done by use of our neural network based refinement model.

CANDIDATE ANNOTATIONS IDENTIFICATION

In candidate annotation identification, set of keywords which describe image objects are generated by typical AIA model. Assuming set of semantically labeled, image samples are available and each image is represented with low level visual features. A machine learning algorithm can then be trained using this samples so that low level features maps to high level semantic features. Once trained, the annotation algorithm can be used to annotate new image samples. Since our main focus is to improve the annotation performance, by refining candidate annotation results through annotation refinement.

In our work we use neural network for image annotation and refinement. Many models have been proposed to train neural network for image annotation in the past. Chen et. al. [7, 8] proposed a neural network model with adaptive structure for image annotation. Pankaj savita et. al.[9], Yufeng zhao et. al.[10] proposed a novel technique to image annotation using neural network. In this work they have used a neural network with 2 hidden layer in which each hidden layer has 25 neuron. Mustapha Oujaoura et. al.[11] presented an image annotation system using region growing as image segmentation algorithm moments and Multilayer Neural Network. Fabio del et. al.[12] uses a neural network for automatic classification of high resolution satellite images.

IMAGE ANNOTATION REFINEMENT USING NEURAL NETWORK

The results of the state-of-art image annotation methods are often unsatisfactory. Therefore, it is necessary to refine the imprecise annotations obtained by existing annotation methods. To fully utilize the original information of candidate annotation and to remove noisy keywords from candidate annotation, we use neural network model to identify relation between each keywords of candidate annotation.

To refine image annotation, we have used three layers feed forward neural network. For input and output of neural network, we have taken keyword vector of training image dataset. Suppose, $K = (k_{i1}, k_{i2}, \dots, k_{in})$ is keyword vector of training image dataset where, n is a total number of keywords and $k_n$is keyword at nth position and ***i*** represent image number.

$$\begin{cases} k_{in} = 1 \; if \; keyword \; k_n \; present \; in \; image \; i \\ k_{in} = 0 \; if \; keyword \; k_n \; not \; present \; in \; image \; i \end{cases}$$

Figure 2 depicts the proposed architecture of neural network with one hidden layer. Input of neural network is candidate annotation generated by classification network. Each keyword of candidate annotation has value between 0 and 1 based on probability of keyword to identify image. The output of network is refined result, based on correlation of keyword which is estimated by neural network. For training neural network, target output of the model is same with the input as training. The aim of training a neural network is to find out relation among annotated keywords.

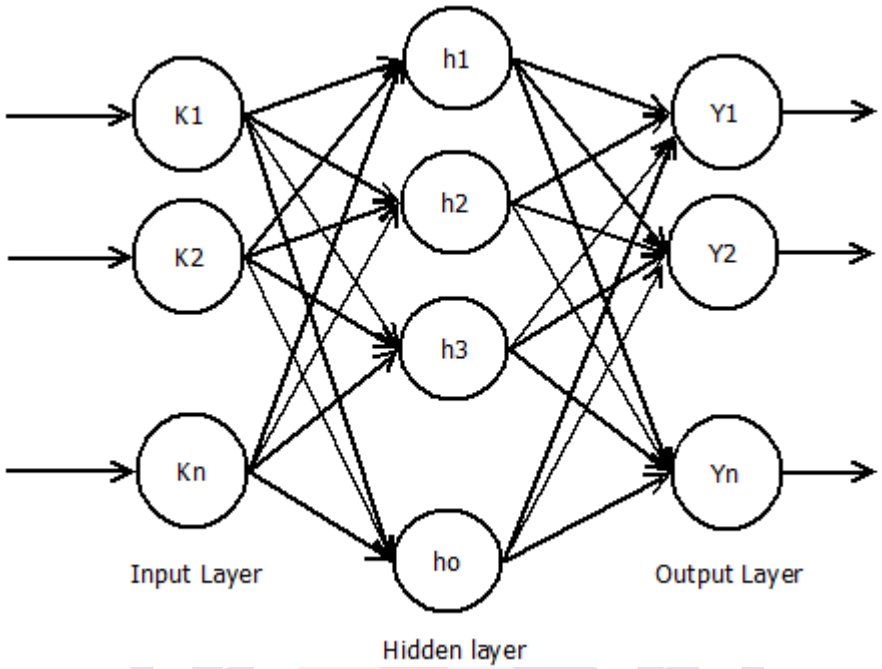

Figure 1: Neural network with one hidden layer

TRAINING ALGORITHM

In our approach, the neural network is trained by back-propagation (BP) algorithm. The parameters of neural network are shown in below table:

Input neuron	n (total number of keywords)
Output neuron	same as input neuron
Input and Output	K (keyword matrix)
Number of hidden layer	1
Transfer function	$f(x) = \frac{1}{1+e^{-ax}}$
Training Algorithm	back-propagation algorithm

Back-propagation algorithm for training neural network:

1. Initialize weight and thresholds

   Weight W_{ih} is weight matrix of input to hidden layer and W_{ho} is weight matrix of hidden to output layer.

2. Present input and desired output

   Input keyword vector $K = (k_{i1}, k_{i2}, \dots, k_{in})$ where n is number of input neuron. We take desired output same as K.

3. Calculate output of layers

$$oh = f(\mathrm{W_{ih}} * K + B_h)$$

$$O = f(\mathrm{W_{ho}} * oh + B_o)$$

Where oh, output of hidden layer and O is final output, B_h *and* B_o are bias vector of hidden layer and the output layer respectively.

4. Adapts weight

Starting from output, we now work backwards.

$$W_{ij}(t+1) = W_{ij}(t) + \eta \dot{p}_{pj} O_{pj}$$

Where $\tilde{n}$ is a gain term and $\dot{p}_{pj}$ is an error term for pattern p on node j.

For output units

$$\dot{p}_{pj} = kO_{pj}(1 - O_{pj})(t - O_{pj})$$

For hidden units

$$\dot{p}_{pj} = kO_{pj}(1 - O_{pj})[(\dot{p}_{p0} W_{j0} + \dot{p}_{p1} W_{j1} + .. + \dot{p}_{pk} W_{jk})]$$

Where the sum (in the [brackets]), is over the k nodes in the layer above node j.

IV. CONCLUSION

Annotation Refinement is very important task in AIA system. Candidate annotation generated by classification network is often unsatisfactory. So, with the use of refinement strategy we can remove noisy keywords. In this paper we proposed a neural network based refinement process which use back-propagation algorithm to train neural network. We tested proposed method in random dataset and result gives satisfactory performance. In the future, we will experiment proposed scheme on real dataset and apply it to different classification network.

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