

Image Classification Using Convolutional Neural Network

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ABSTRACT

In recent years, research related to images is a challenging task as there are very few techniques which can be used in processing and classification of images. Image classification is referred as Classification of the images from many predefined categories. Several researches took place to overcome the drawbacks in image classification, but the output was limited to the basic low-level picture. There are many deep neural network techniques used for image classification like Convolutional Neural Network, Deep Belief Network, and Machine Learning Algorithms like SVM, Random Forest and many. In this paper we want to implement image classification using CNN. CNN is a type of the deep neural networks, most frequently used for visual imaging analysis. CNN is implemented through multilayer perceptron that follows a hierarchical model that works on network building and finally delivers to fully connected layer. In this layer all the neurons are connected, and the output is processed.

Key words: Computer Vision, Supervised Classifier, Unsupervised Classifier, Image Classification

1.INTRODUCTION

Due to the spectacular growth in the digital world, image recognition and classification became one of the tough challenges in computer vision. Computer Vision (CV) is a computer science field that works in enabling computers to view, identify, and process images in the same manner as Human vision does, and then deliver appropriate output. In the time being the need of high accuracy in computer vision also increased. It took decades for the computer scientists to get where we are now.

Present computer vision is used in many fields like Vision biometrics, Object recognition, Social Media, Smart cars and many more. In many of these image recognition and classification plays a major role. In simpler terms, Image recognition is how well computer can recognize objects, writings, actions, places. And image classification is classification of images based on the contextual information in images.

In computer vision, most of the times the information is in the form of non-textual form, such as images.[1] Due to the presence such a huge number of images the image databases also increased.

As a result, we face complex task of organizing and accessing vast amounts of images that are available. Image classification helps in solving such tasks.

Decades before the image classification has done using hand-engineered features like SIFT [28], HoG.[2]

Among all the methods used in those days Bag-of-visual-words descriptor [3] achieved great success. Once the features are extracted learning algorithms like SVM are applied. As a result, the performance of the learned system is highly reliable on the features. But when the images are complex it is very difficult to extract features. To overcome these problems Some Machine Learning researchers proposed a model which contains a multiple layer of nonlinearity.

The learning algorithms can be of two types:

- Supervised Classifier
- Unsupervised Classifier

1.1Supervised Classifier

We identify instances of information classes of attention in the image through supervised classification. These are referred to as "training sites". The image processing technology scheme is then used to extend for each information category a numerical definition of the reflection. Some of the supervised Classification [27] algorithms are Support Vector Machines (SVM)[25], Naïve Bayes, Decision Trees[17] , K-Nearest Neighbours.

1.2 Unsupervised classifier

Unsupervised classifier is the way of observing a large number of unknown pixels and breaking them into a variety of modules based on the natural alliance present in the image values. Unlike supervised classification which requires training data, unsupervised classification do not require training data defined by the analyst. Some of the unsupervised classifier are K-means, Hidden Markov Model (HMM)[16]etc.,

1.3 Literature Survey Convolutional Neural Network for Image Classification [8]

Nadia Jmour[4], in their paper described about the learning approach to classify the traffic sign dataset using Convolutional neural networks (CNN). They have used Alex Net CNN Architecture. This CNN system basically used to classify the non-stop sign, stop sign, Green light, Red light. This system has acquired an accuracy of 93.33% using mini-batch size effect.

1.4Advertisement Image Classification Using Convolutional Neural Network [5]

An Tien Vo[5], Hai Son Tran[5], Thai Hoang Le[5] in their paper used a Convolutional Neural Network model with Two parameters (n,m) where m is the number of filters in Conv layer and n is the number of layers. They called this model as nLmF-CNN for classifying the Online

Advertisement. The input to this model is the online captured pictures. The output to this model is the Boolean values i.e., YES/NO. YES means the advertisements are displayed clearly and NO means the advertisements are not clear. Accuracy gained in this paper is 86%.

1.5 Comparative Study of Distinctive Image Classification Technique [6]

Rajesh Sharma R[6], in their paper discussed in detail about the different approaches in supervised and unsupervised classification of images. Among the various techniques like ANN, Decision Tree and Support Vector Machines(SVM) they concluded that system with Hybrid RGSA and SVM is best for classifying images.

1.6 Review of Deep Convolutional Neural Network in Image Classification [7]

Ahmed Ali Mohammed, their paper said that when a large dataset is used then CNN with more hidden layers are required due to which a complex architecture is formed. The authors in this paper first reviewed the rise of deep learning(DL) and CNN. Then reviewed the development of Convolutional Neural Network(CNN) based on the deep learning.

1.7 An Application of Pre-Trained CNN for Image Classification [8]

Abdullah, Mohammed S. Hasan [8] in their paper compared the performance of two supervised classifiers as well as two feature extraction techniques. The classifiers they used are Support Vector Machine(SVM) and Quadratic SVM. After training those classifiers they tested them with the features extracted[22] from Pre-Trained CNN and Bag of words. They concluded saying that high accuracy is obtained when the features are extracted from pre-Trained CNN.

2. PREVIOUS WORK

Computer vision (CV) is an interdisciplinary field of machine learning and artificial intelligence. It is about automatically capturing, analyzing, and interpreting valuable image data. With recent advancements of technology there is explosive growth in digital content regarding images and videos. In the field of CV understanding and analyzing the images is a crucial problem [18] by the computer as compared to human. So, the classification of images will be done with help of human intervention. Image classification is most widespread research area in deep learning, Computer Vision. The main task in image classification is extracting the features from image.

Feature Extraction is used to reduce the dimensionality of the image to make it easy for the classifier for classification. There are many methods used in the feature extraction like PCA, LDA, Histogram, Bag of Words and many. The input to the feature extractor is the Gray Scale image. And the Output is given to the Classifier for the classification. So, the Features extracted should be accurate for better and efficient Classification.

Image classification includes following steps [9]:

1. Image Processing: Performing operations on the image to get an enhanced image.
2. Image segmentation: Dividing the image into multiple parts or regions probably based on the characteristics of the pixels in the image.
3. Key Feature Extraction: Extracting features that are informative and non-redundant.
4. Matching Identification

To implement this image classification there are many traditional techniques used which many errors and queries had unanswered. But due to the emergence of deep learning [24] many problems from the traditional techniques are solved. There are many methods of deep learning used in the image classification which have their own functionality. Some of them are KNN used to group the images of same category.

2.1 Support Vector machines (SVM)

In SVM, a hyperplane is used for either classification or regression [29]. It is widely used as it attains high accuracy with less computational power. Due to its statistical learning approach [10] it is widely being used in handwriting digit, text classification and satellite image classification. SVM being non-parametric classifier, it is robust.

2.2 Bag of Features

It is a model Inspired by Bag of words. A BoW is a parameter that defines vocabulary frequency in a text document which is used in the fields of document classification (information documents).BoW model can also be used to classify image in computer vision. The features of the image are considered as words in that case. A picture is considered as a document with the use of the BoW model. We use three stages for the definition of "words" in images [11]: extraction of features, description of features, and generation of codebooks.

SURF(Speed Up Robust Features) is a technique used to extract features. In SURF, a 64-length descriptor vector is created using a histogram of gradient orientations in the local neighborhood around each key point [12].

Then K-Means is used to cluster is used to group them in N Clusters. Euclidean Distance is used while clustering CNN is the most used and robust algorithm for image classification. CNN has many layers such as Conv layers and the pooling layers is used for feature extraction and fully connected layers for connecting the output of previous layers.

3. PROPOSED METHOD

ANN is a Neural Network which is constructed based on the Biological Neural Network[26]. Its main idea is taken from the Cognitive science [13] where many simple Computational units are connected for intelligent behaviors. But due to its disadvantage of not having large computational power CNN is introduced. Image analysis is most common use of CNN.

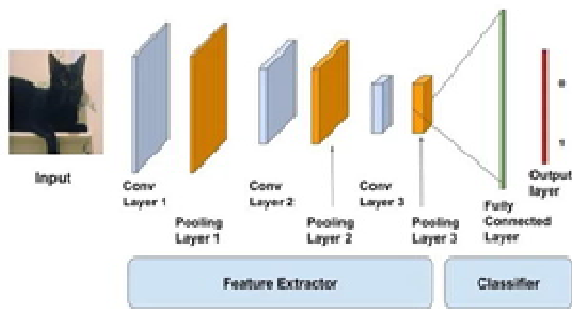


Figure 1: Convolutional Neural Network Architecture

Convolutional neural Network has hidden layers, Known as Convolutional layers which make CNN more effective for image analysis.

CNN layer types mainly include three types [14] as shown in the Figure 1:

- Convolutional layer
- Pooling layer
- Fully connected layer

When a computer sees image, it converts the image into an array of pixel values depending on the image resolution and size. Let's consider an image of type of jpg and size be 480 x 480. Then its converted to 480 x 480 x 3 image where the represents the RBG values[23]. To describe the intensity of the pixel [15], they are given numbering from 0 to 255. Further the array with numbers are given as input to the image classification.

3.1 Convolutional layer:

Convolutional Layer [30] is most important part of image classification. The main task in this layer is extracting features from the input image. Conv layer consists of many feature maps. The neuron of same feature map is used in extracting regional characteristics of various positions in the former surface[14]. But for single neuron, its extraction is regional feature of the same positions in the former separate feature map [14]. The results in the Conv layers are passed to nonlinear Activation function like sigmoid, tanh, ReLu[19]. Fig 2 shows how high-level image features are extracted from image using a kernel.

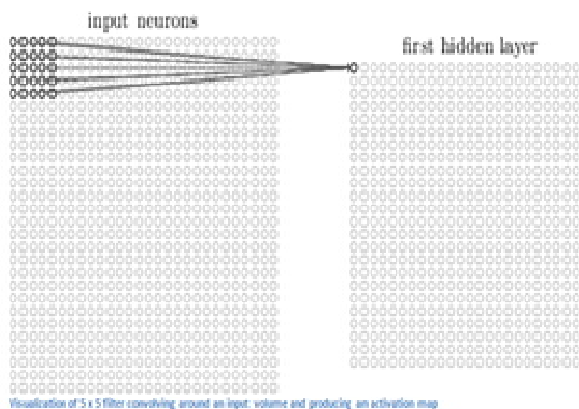


Figure 2: Convolutional Layer

3.2. Pooling layer

A problem with the output of the Conv layer is that they are sensitive to the location of the features in the input [20]. One idea to reduce the sensitivity is that we can decrease its dimensionality i.e., down sampling. Pooling layer is used to decrease the dimensions of the feature map. There are two types of common pooling techniques that can be used to decrease the dimensionality. They are max pooling and the average pooling. In max pooling, calculating the max value of each patch in the feature map. Whereas average pooling, finding the average of each patch in the feature map. Figure 3 is an example of max pooling.

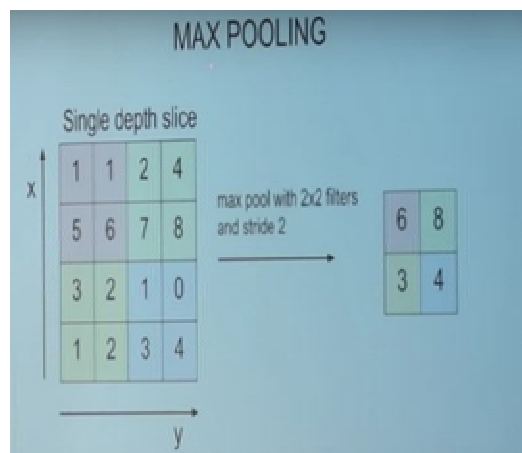


Figure 3: Max Pooling

3.3 Fully Connected layer

The task of the fully connected layer is to connect the output of the previous layer. There is no spatial arrangement [14] in this layer. There can be many fully connected layers where the last layer is connected to the output layer. One of the most commonly used method is soft regression because of its performance. Other methods like SVM can also be used with CNN to solve more complex task.

4. RESULTS

In this paper we used CIFAR-10 dataset. This dataset contains 60000 training images of size 32*32 in 10 classes likely airplanes, cats, cars, deer, birds, frogs, dogs, ships, horses and trucks[21]. Out of which 50000 are training images and the remaining 10000 are testing images. Figure 4 is the output of the CNN for Cifar-10 with Epoch size 2.

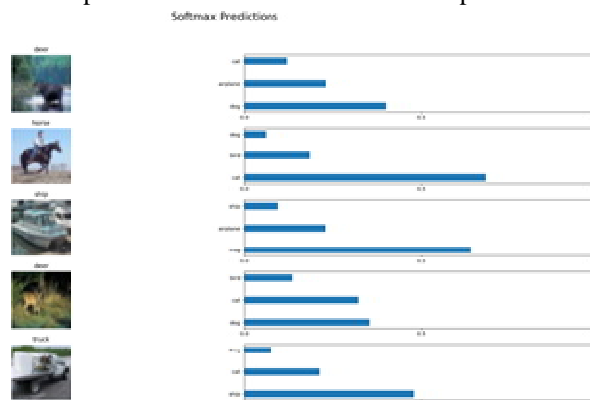


Figure 4: Output of the CNN

5. CONCLUSION

For image classification we need a system that itself can extract features efficiently and classify them. We used Convolutional Neural Network (CNN) for image classification which contains Convlayers to extract features and max pooling to decrease the size of image thus classifies the image accurately. Whereas for other techniques like SVM, K-Means Feature Extraction needed explicitly to be done. We implemented this using CIFAR-10 dataset in python.

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