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Semantic Assisted Convolutional Neural Networks in Face Recognition

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Abstract – *In today's age of automation; face recognition is a vital component for authorization and security. The principal aim of facial analysis is to extract valuable information from face images, such as its position in the image, facial characteristics, facial expressions, the person's gender or identity It has received substantial attention from researchers in various fields of science such as biometrics and computer vision. A convolutional neural network is a deep learning algorithm that is used in object recognition. The philosophy of a CNN is to train the network, the same way as a human learns things. The proposed system is a new framework to efficiently and accurately match face images that are automatically acquired under less-constrained environments. Our framework, referred to as semantics-assisted convolutional neural networks (SCNNs), incorporates explicit semantic information to automatically recover comprehensive face features. The proposed system is a new framework to efficiently and accurately match face images that are automatically acquired under less-constrained environments. The paper refers to semantics-assisted convolutional neural networks (SCNNs), incorporates explicit semantic information to automatically recover comprehensive face features.*

Key Words: **Face Recognition, Artificial Neural Neuron Architecture, Neural Network, CNN, SCNN**

1. INTRODUCTION

Face recognition is one of the most relevant applications of image analysis. Face recognition is a very challenging research area in computer vision and pattern recognition due to variations in facial expressions, poses and illumination. Several emerging applications, from law enforcement to commercial tasks, demand the industry to develop efficient and automated face recognition systems. It's a true challenge to build an automated system which equals human ability to recognize faces. Face recognition is a visual pattern recognition problem. Face recognition system with the input of an arbitrary image will search in database to output people's identification in the input image. Face recognition is one of the biometric methods that to have the merits of both high accuracy and low intrusiveness. F ace recognition is an interesting and successful application of Pattern recognition and Image analysis. Facial images are essential for intelligent vision-based human computer interaction. Face processing is based on the fact that the information about a user's identity can be extracted from the images and the computers can act accordingly. It is also useful in human computer communication, computer operated reality, database retrieval, multimedia, computer entertainment, information security - operating system, medical records, online banking. Biometric – personal identification - passports, driver licenses, automated identity verification – border controls, law enforcement - video surveillances, investigation, personal security – driver monitoring system, home video surveillance system. A face recognition system generally consists of four modules as detection, alignment, feature extraction, and matching

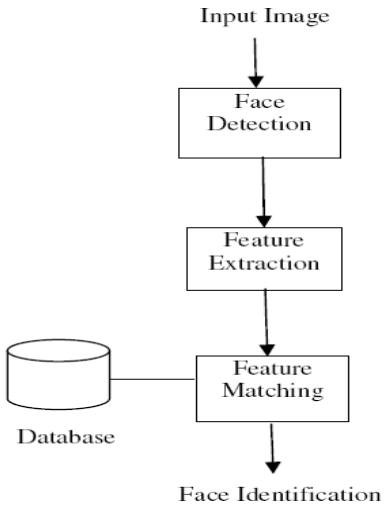

Fig-1: Flowchart of Face Recognition system

2. NEURAL NETWORKS

Many pattern recognition problems like object recognition, character recognition, etc. have been faced successfully by neural networks. These systems can be used in face detection in different ways.

The simplest definition of a neural network, more properly referred to as an 'artificial' neural network (ANN), is provided by the inventor of one of the first neurocomputers, Dr. Robert Hecht-Nielsen. He defines a neural network as:

"...a computing system made up of a number of simple, highly interconnected processing elements, which process information by their dynamic state response to external inputs."

Motivated right from its inception by the recognition a machine that is designed to model the way in which the brain performs a particular task. A massively parallel distributed processor.

Resembles the brain in two respects:

1. Knowledge is acquired through a learning process.
2. Synaptic weights, are used to store the acquired knowledge

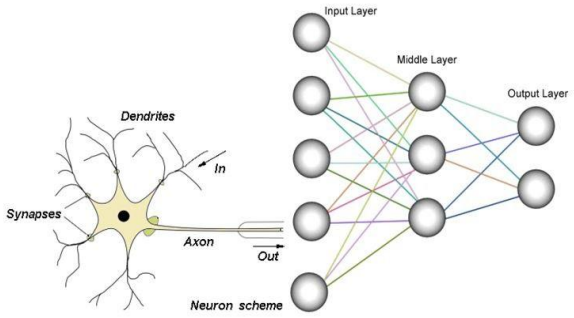

Fig-2: Human brain Neuron resembles Artificial Neuron

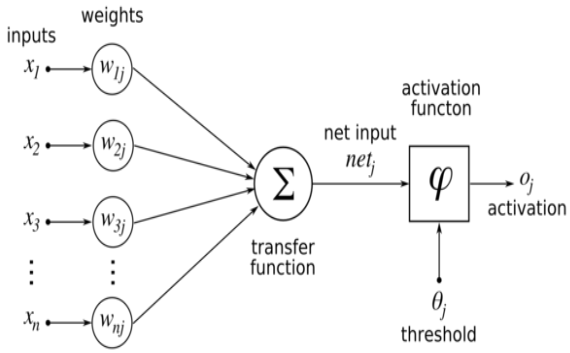

Fig-3: Architecture of Artificial Neuron

3. CONVOLUTIONAL NEURAL NETWORKS

Different approaches have been investigated and proposed for this task. The learning algorithms that are used in deep learning are based on how a human learns things. A convolutional neural network is a deep learning algorithm that is used in object recognition. CNNs show to be a powerful and flexible feature extraction and classification technique which has been successfully applied in other contexts, i.e. hand-written character recognition, and which is very appropriate for face analysis problems.

Convolutional neural networks (CNNs) are composed of a hierarchy of units containing a convolutional, pooling (e.g. max or sum) and non-linear layer (e.g. ReLU max(0,x)).

In particular, unlike a regular Neural Network, the layers of a ConvNet have neurons arranged in 3 dimensions: **width, height, depth**. (Note that the word *depth* here refers to the third dimension of an activation volume, not to the depth of a full Neural Network, which can refer to the total number of layers in a network.)

The three basic components to define a basic convolutional network:

1. The convolutional layer
2. The Pooling layer
3. The output layer

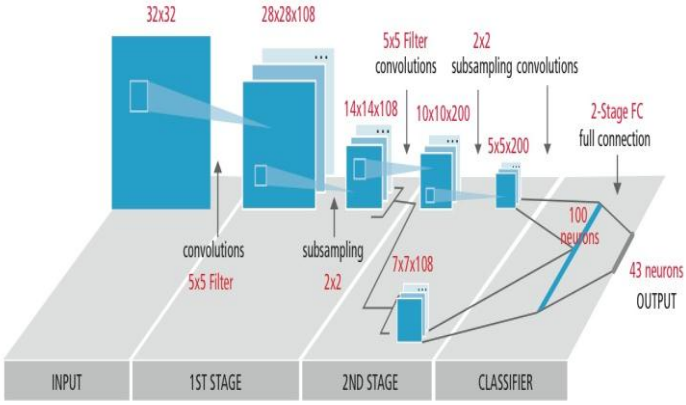

Fig-4: Architecture of CNN

Convolutional Layer: The convolution operation extracts different features of the input. The first convolution layer extracts low-level features like edges, lines, and corners. Higher-level layers extract higher-level features.

Pooling or Sub-Sampling Layer: The pooling/sub-sampling layer reduces the resolution of the features. It makes the features robust against noise and distortion. There are two ways to do pooling: max pooling and average pooling. In both cases, the input is divided into non-overlapping two-dimensional spaces.

4. SEMANTIC ASSISTED CONVOLUTIONAL NEURAL NETWORKS

In addition to successfully investigating the strengths of CNN for the less-constrained face recognition, our system introduces the **Semantics-Assisted CNN (SCNN)** architecture to fully exploit the discriminative information within limited number of training samples. The approach to the proposed system is as follows:

1. The SCNN is trained with one database and tested on totally independent/separate databases.
2. Can also enable recovery of more comprehensive face features from the limited training samples.

4.1 Limitations of Contemporary CNN

- To achieve superior performance using CNN based methods, a common way is to add more layers to make the network deeper and more comprehensive,

and/or devote more labeled training data because CNN is usually trained in a supervised manner.

- Hard to afford to train such deep networks due to the lack of enough
- The network goes deeper; the need for training data grows accordingly computational power.
- It is difficult to acquire enough labeled training samples.
- For instance, where the developed CNN is not very deep (nine layers), a total of ~200,000 face images from more than 10,000 people were used for training to achieve superior performance.

Therefore, we are motivated to improve the performance of existing CNN based architecture in another way - to enhance CNN with supervision from explicit semantic information

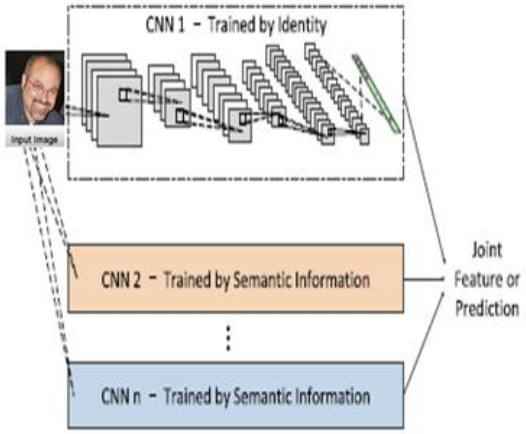

Fig-5: Architecture of SCNN for Face Recognition

As from above Figure, we simply add a branch, which is also a CNN, to the existing CNN. The attached CNN is not trained using the identity of the training data but the semantic groups. For example, we could train CNN2 using the gender information of the training sample, i.e., let the CNN2 be able to estimate the gender instead of identity, and train CNN3 using the ethnicity information. After the CNNs are trained, we can combine the output of each CNN in the way of feature fusion. We refer to such extended structure of the CNN as Semantics-Assisted CNN (SCNN for short).

4.2 Benefits of SCNN over CNN and NN

- Very helpful for identification task
- The training scheme for SCNN can reuse the same set of training data but just labeled in another way than the simple identities.
- The SCNN architecture and training scheme is naturally compatible.
- This technique approach is better in performance over other techniques due to high accuracy rate for complex face recognition, adaptive learning as well as better tolerance factor.
- SCNN is capable of recovering more comprehensive features from the images and therefore achieve superior performance.

CONCLUSION

Face recognition might be a very easy task for human beings, but it is extremely difficult to make a machine detect and recognize human faces. In this work it has been shown that if a facial image of a person is given then the network can able to recognize the face of the person. The whole work is completed through the following steps: Facial image of a person has been collected by taking three different samples of the person for the experiment

In this research a CNN-based face detector is used to look if the size of the training data is of impact on the performance of a CNN-based face detector. In particular, we proposed a robust and more accurate framework for the face recognition using the semantics-assisted convolutional neural network (SCNN). By training one or more branches of CNNs with semantically information corresponding to training data, the SCNN is capable of recovering more comprehensive features from the images and therefore achieve superior performance.

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