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An Approach on Segmentation of Tumour and Tuberculosis in Hip-Joint Using Convolutional Neural Network

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ABSTRACT

Segmentation is a basic step in medical images analysis, often fundamental for computer-aided detection and diagnosis systems. The method based on a Convolutional neural network is presented, performing a semantic segmentation of the Computed Tomography (CT) scan images for identification of tumours and tuberculosis in hip-joint by Convolutional Neural Network (CNN) algorithm using MATLAB

KEY WORDS *Segmentation, Tumour, Tuberculosis, Convolutional Neural Networks, MATLAB.*

INTRODUCTION

Aging problems are now a days creating much difficulty, mainly in joints. The subject of the paper is primarily based on image segmentation. Image segmentation in simple terms can be described from low-level processing of an image as the initial step transforming a greyscale or colour image into one or more other images to high-level image description in terms of features, objects, and moving elements. Segmentation divides an image to definite portions containing each of the pixel with indistinguishable attributes. The ultimate goal of segmentation is finding the meaning from an image whether it is to identify an object, understand interactions, etc. resulting to make everything easier than finding meaning from pixels. While focusing on defects namely: tuberculosis and tumour in hip-joints by segmentation, modified techniques for its faster detection are also been focused.

Tuberculosis (TB) of the hip is next to spine; hence a good count of cases is paying a visit to the medical facilities every year. Many among them present in the forwarded stage of the disease due to delay in diagnosis. In early stages of TB of human hip-joint, when plain X-rays are negative, there was a diagnostic dilemma. In the present time, diagnostic modalities in compare to the days when diagnosis was based essentially on clinicoradiological presentation alone have improved. Tuberculosis of hip-joint constitutes 15-20% of the musculoskeletal system (1). The majority of cases of hip TB are presenting as painful, restricted movements of the hip and there comes, the dilemma of accurate diagnosis as several pathologies may mimic this presentation. Input images which are been used for segmenting are Computed Topography (CT) scanned images as because they gives better result in compare to MRI and X-Ray images.

Tumour in hip-joint is also a commonly caused disease in patients which can also be diagnosed by the convolutional neural networks. When cells divide uncontrollably and abnormally, they can form a mass or lump of tissue. This mass is called a tumour. As tumour getting more strength, abnormal tissue can supplant healthy tissue.

Image classification is one among the foundational issues in computer point of view. It forms basis for many other computer vision tasks such as object recognition, image segmentation and object detection. The task of categorizing images into one of several predefined classes is called image classification. Though the task of classifying images is easy for human beings, it is very difficult for an automated system. By using machine learning techniques, images can be classified. These machine learning algorithms falls under the category of deep learning. Deep learning is a of neural network algorithm type where each layer is responsible for extracting one or more features of the image.

Image classification can be done using both supervised and unsupervised classification algorithms. Supervised classification uses training data along with human intervention whereas in unsupervised classification intervention of human is not required as it is fully computer operated. The supervised classification has two phases namely classification phase and training phase. In training phase, the classifier is given information about classes. This is the phase where learning of a model takes place. In classification phase it uses the information provided by the training data and classifies the image into one of the predefined classes. Various algorithms such as minimum distance algorithm, K-Nearest neighbour algorithm, Nearest Clustering algorithm, Fuzzy C - Means algorithm, Maximum likelihood algorithm, Watershed Algorithm are used for the classification of images. Convolutional Neural Networks (CNNs) have become the standard for image classification (2).

Convolutional neural network based image classifier will identify and separate the defective images from that of normal hip joint along with identification of the defect.

Traditional neural networks like Alex Net, Inception which are very good at doing image classification need GPU (Graphics Processing Unit) and take few hours of training time. In compare to that, a very small CNN of six layers is build, consuming less of the time giving modified output as well.

CONVOLUTIONAL NEURAL NETWORK

One of the most popular algorithms for deep learning, is convolutional neural network is which can be defined as a type of machine learning where a user learns to perform classification tasks from pictures, sound , video or text. CNN is mainly useful for finding designs in images to identify faces, objects, and motion pictures as in **Figure1.**

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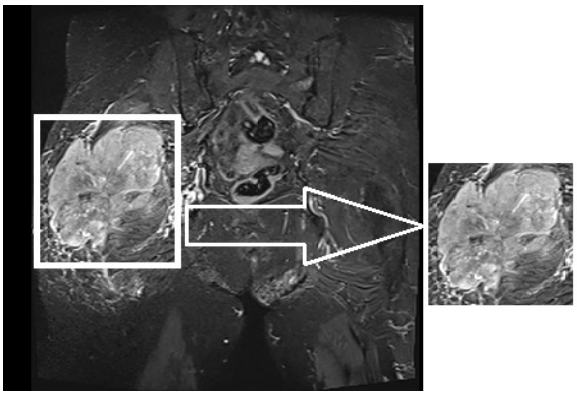

Figure 1.identification of tumour in hip joint

CNN provides architecture optimal for pattern detection image identification. For instance, thousands of pathology reports to visually detect tumours, cancer cells, fractures and various other diseases are examined by deep learning applications using CNN. As shown in **Figure1**, it is used for identification of tumour in hip joint. Using Convolutional neural network is more beneficial in medical field as it can particularly visualise the defects and damage in any particular area.

III.COMPONENTS OF CONVOLUTIONAL NEURAL NETWORK

A Convolutional neural network consists of various layers amongst them each of which learns to detect different image features. To each training image at different resolutions, filters are applied and when it is moving to next layer the convolved output image is used as the new input image. The features can be very simple, such as increase in complexity, brightness and edges, to focus on the uniquely defined object.

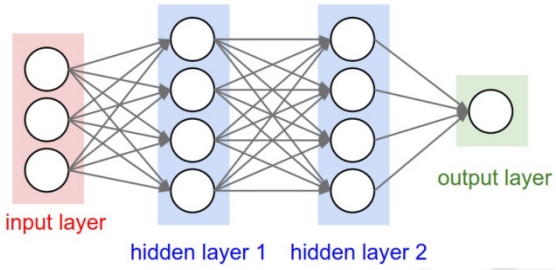

Figure 2.Hidden layers in a Neural Network

Unlike other neural networks, a CNN is composed of an input and output layers, along with many hidden layers in between as shown in **Figure2.** Performing operations, these layers are altering the data with the aim of learning features specific to the given data. Three of the most common layers are: **convolution**, **activation** and **pooling** as shown in **Figure3**.

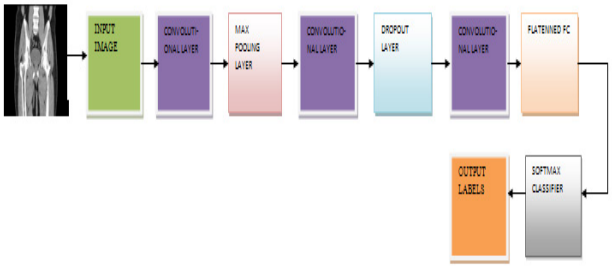

Figure 3. A flowchart of the convolutional neural network architecture. .

i) Input Layer:
This layer carries the undone pixel values of the input image (colored as green in **Figure 3**).

ii) Convolutional Layer:
This layer is highlighted in violet boxes in **Figure 3** is collection of enormous maps along the dimensional depth, each of which is correlating to a different convolution filter. This facilitates capturing imaging characteristics of wide variety. The layer depth means the numerous amounts of convolution filters. Each input receptive field can be extracted from the number of features. In a feature map each neuron is sharing absolutely the same load, which defines the convolution filter. The number of load is allowed to reduce, hence increasing the notion of the architecture (3)

iii) Activation Layer:
It is viewed often as layer along with the convolutional layer, as in **Figure 3**, it applies to the output of each neuron a threshold function in the previous layer. In this network, a rectified linear unit (RELU) activation is used, where RELU(x) = max (0,x), meaning it shows the thresholds at zero also the real value of the output. It simply puts back "0" with the negative values(3).

iv) Pooling Layer:
It is particularly settled after activation layer, which along spatial dimensions down-samples (purple box in **Figure 3**), it selects the uniform features of imaging by reducing the structural extent of the convolution layer. Max pooling is used maximum times, which selects the maximum value of four of its inputs as the output, thus protecting the most important responses of filters.

v) Fully Connected Layer:
This layer joins all neurons in the foregoing layer with a weight for each connection (Shown as green in **Figure 3**). In the output layer, each of the output nodes represents the "score" for each class.

To ease the relationships is to learning the compounds; deep architecture of nonlinear transformations is formed by combining multiple convolutional-pooling layers. It is helped to represent a ladder of an image. Compound features are allowed to learn for image classification by using predictive power (3).

IV. RESULTS AND DISCUSSIONS

As shown in **Figure4**, three pre-processed images of tumour in hip joint have been chosen and each of them gets an output image in

two interations (Prediction and Ground tooth). The implementation of Convolutional Neural Network for segmenting the defect in the image helps in having more accurate output.

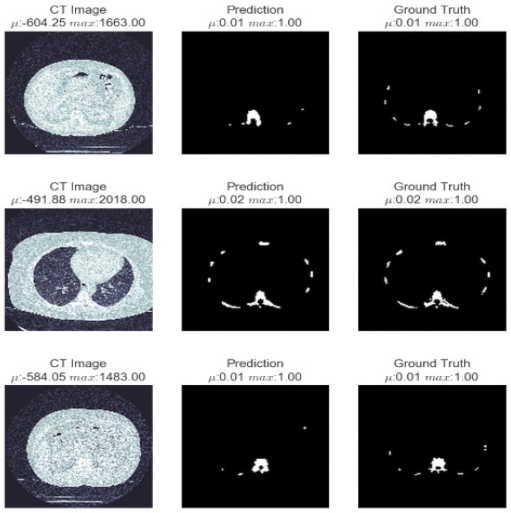

Figure 4.Output of the input CT image of tumour in hip-joint

The prediction level predicts the defect of the image partially which may not give the desired output. The Ground Tooth level is training the pre-processed image to more accurate level and gives the output

A robust non- invasive method is presented to predict the presence of tumour and pus in hip-joint, a common precursor to cancer and Tuberculosis, from CT scan images of hip joints. A major advantage of this approach is that it allows developing solutions to complex problems. From the results of our training using Convolutional Neural Network algorithm, we were able to achieve sensitivity, specificity, accuracy. Among CT scan images, x-ray images and MRI images, CT scan images are been chosen as because for detection of defects in bones, they can give better results. The result of this paper is obtained by using MATLAB software 2012 version, giving an output of identified defective portion in hip joint.

CONCLUSION

The tumour segmentation techniques on CT scan images are based on intensity, density and texture that are simple to implement, minimum number of points required to classify the object as dense or not. Thus CT scan images are chosen so that it can be easily identified by using the CNN algorithm. The TB of hip is still a common condition in developing countries. Early presentations are pain around hip and limp. Later the patient presents with deformities, shortening of limb and restriction of movements. The constitutional symptoms may or may not be present in all the cases. Diagnosis is mainly clinicoradiological; however, supportive blood investigations and imaging modalities like USG, CT scan and MRI are helpful. Histological proof may not be necessary in all the cases in the endemic zones for TB. The management depends upon the stage of clinical presentation and the severity of destruction as visible radiologically.

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