# Bone Sarcoma Detection using VGG16

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***Abstract*— Bone sarcoma, also known as bone cancer, is a rare form of cancer that refers to an irregular growth of tissue within the bone that has a high risk of spreading to other areas of the body. Kids, adolescents, and young adults are the most frequently affected. There are no known causes for bone cancer. As a result, only early diagnosis will increase the odds of surviving a bone sarcoma. The use of medical imaging modalities (like X-ray, MRI, and CT imaging) in combination with image processing techniques will increase the accuracy of bone tumor detection. The paper proposes a method for detection of tumor using VGG16 which gives good results.***

***Keywords*— VGG16, Bone Sarcoma, Canny Edge Detection, Smoothing Filter, Averaging Filter.***

## I. INTRODUCTION

When it comes to image processing science, medical imaging is the most important field to work in. The bone cancer disease subdivides the cells and grows widely, forming tumours and affects nearly whole human body parts. The bone tumor will grow numerously and spread the digestive system, nervous system, circulatory system and it will also enter into the hormones of the body, so that the body function will be changed. Because of the damage or the injury to DNA, cells will be considered as the cancer cells, when compared to the regular cell, the cell will upkeeps the damage and the cell dies if the DNA is damaged. It will results in making unnecessary new cells if the damaged DNA is not repaired.

The bone cancer is referred as metastasis when the bone cancer cells spread and when it moves to other parts of the body, so that it will begins to become tumours which will be positions in the tissues of the human body. Metastasis occurs when the cells of cancer spread from one part of the body to other areas like which may include the bones, breast cancer. Bone cancer and prostate cancer tend to spread to bones. This metastasis bone cancer have symptoms like bone pain and weakness of other forms of bone cancer, it also causes weight loss and fatigue.

The neoplastic growth of tissue in bone is a bone tumor. It can be benign that is non-cancerous or it can also be malignant which is cancerous due to the redundant growth found in the bone. The cancer is classified into two types “primary tumours” which will occur in the bone cells or tissues and the second type of cancer is “secondary tumours” which occurs in other sites and spread to the skeleton of the body. The cancer which occurs in the bone itself is called as primary tumours and the cancer which will be seen any parts of the body then it is called as secondary tumours. Primary tumours are again divided into benign tumours and cancers. The primary bone cancer is caused due to the heredity growth of cancer cells, this will start from the bone parts only. The sarcomas are the true or primary bone cancers. This sarcomas will move into the blood vessels of the nerves, muscles, bones, fat tissue present in the body and it can also spread to anywhere in the body. These primary tumours can also be called as benign tumours which may have abnormal tissue growth results in traumatic infections or inflammation caused into the bone. Metastasis bone cancer is called as secondary bone cancer.

The cancer cells in the bone due to which there will be a refashion of the bone. If the non-cancerous bone is affected by the bone cancer it will make the changes to the structure of the bone, or it will be broken and need to rebuild it. The bone will be affected by the cancer cells by the growth of new cells in the body, so bone cancer is a deadly and dangerous disease. To detect the bone cancer if the cancer cells are in the bone then there will be a difference in the structure of the bone it can result in the bone bent which will be at a maximum rate if it is observed with the perfect bone or healthy bone. The bone will produce the alkaline phosphates in the bone enlargement process and which is an important step in order to detect the increasing growth of the bone.

## II. LITERATURE SURVEY

Mokhled S. Al-Tarawneh [1] proposed an Image Processing Techniques-Based Lung Cancer Detection Strategy. To de-noise an image, this system used a Gabor filter. The Gabor filter produces the best results. Two segmentation technique are used to divide an image. The two equations are the threshold technique and marker-controlled watershed segmentation. When compared to a thresholding approach, a marker-controlled segmentation strategy produces better results. To recognise the disease, image features are extracted using binarization and concealing methods.

MaduriAvula [2] proposed the use of Mean pixel power to detect bone disease in MR images. To separate the tumor portion, the information MR image is de-noised and a K-Means clustering calculation is used. The total number of pixels is calculated from the divided tumor part, total of pixel force is determined for the removed tumor part to decide the mean pixel power. Mean pixel intensity is utilized to differentiate between benign and malignant development. It is called malignancy if the mean pixel intensity esteem is greater than the edge esteem.

Kishor Kumar Reddy [3] suggested a new method for determining tumour size and bone malignant growth organisation using a locale developing calculation. This process partitioned the area of interest using locale

developing calculation. The number of pixels in the extricated tumour portion determines the tumor's size. The disease scheme is accepted based on the absolute pixel value. The image is used to determine the seed point, and it is difficult to choose exactly.

Abdulmuhssin Binhssan [4], this proposed method describes a technique to identify enchondroma tumor. Using two-sided filter and normal filter information image gets denoised. Two-sided filter has several drawbacks. Denoising the image necessitates a larger expenditure. In comparison to the reciprocal filter, the regular filter produces better results. To section image, threshold segmentation is used, and morphological activities are linked to improve the tumour area.

## III. METHODOLOGY

Figure 1 depicts block diagram of detection of bone cancer using VGG16.

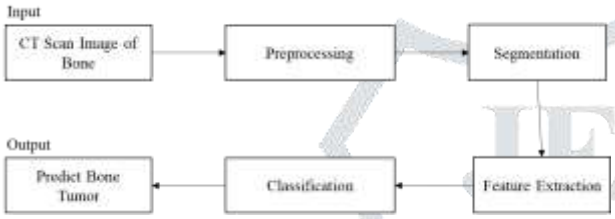


**Figure 1: Methodology of Proposed System**

**Preprocessing**

CT scan images are taken as input. Most of the times in the CT Scan Images there is a lot of noise which degrades quality of image, to extract the important data of image preprocessing is an important step.

First, the image is transformed to a grayscale image by using a function cv2.COLOR_BGR2GRAY, then a Smoothing filter with a 2D filter and Averaging filter is applied one after another to remove high frequency content from image which results in blurred edges when these filters are applied. The image after applying Averaging filter is then converted to Binary image which has pixels that have two colors black and white, the Binary image is then converted to Erode image. The basic concept of erosion is similar to that of soil erosion, except that it erodes the borders of foreground objects. The picture is slid through by the kernel (same as two-dimensional convolution). If all of the pixels under kernel are 1, a pixel in the original image (either 1 or 0) will be called 1, otherwise it will be made to zero. Depending on the kernel size, near the boundary all pixels will be discarded. As a result, the foreground object's thickness or height shrinks, or the image's white area shrinks. It can be used to remove tiny white noises, separate two associated objects, and so on.

If at least one pixel under the kernel is '1', a pixel element is '1'. As a result, the image's white region or the scale of the foreground object grows. In certain situations, such as noise reduction, erosion is accompanied by dilation. Since erosion reduces the size of the object when removing white noises. So it is dilated. They won't return because the noise is gone, but the object area grows. It can also be used to reassemble broken sections of an object. Finally, the edges are extracted using Canny Edge Detection.

Steps involved in Canny Edge Detection method are:

Step 1: Reduction of Noise

Since the discovery of edges is sensitive to image noise, the initial step is to eliminate the noise using the 5x5 Gaussian filter.

Step 2: Finding the Image's Intensity Gradient

The smoothed image is then filtered with a Sobel kernel in horizontal and vertical directions to obtain the first derivative for both the horizontal (Gx) and the vertical (Gy) directions. By using these two images edge gradient and direction for each pixel can be determined:

$$\text{Edge\_Gradient}(G) = \sqrt{G^2{}_x + G_y^2}$$

$$Angle(\theta) = \left(\frac{G_y}{G_x}\right)$$

The direction of the gradient is always perpendicular to the edges. It can be adjusted to one of the four angles: vertical, horizontal, and two diagonal.

Step 3: Non-maximum Suppression

After determining the gradient magnitude and the direction [5] a complete scanning of the image is performed to eliminate any unnecessary pixels that do not form the edge. For this, each one pixel is tested to see whether it is the local limit in its neighbourhood in the gradient direction. In short, the output got is the binary image with the thin edges.

Step 4: Hysteresis Thresholding

This stage establishes which edges are true and which are not. minVal and maxVal are the two threshold values needed. Edges with the intensity gradient greater than maxVal are certain to be the edges, and if the intensity gradient is less than the minVal they are certain to be non-edges, and are thus discarded. Based on their connectivity, those that fall in between these two levels are known as the edges or the non-edges. They are considered to be part of edges if they are bound to the "sure-edge" pixels. Otherwise, they are also discarded. On the premise that the edges are the long lines, and this stage also eliminates small pixel noises.

As a result, the image finally has solid edges.

**Classification**

The proposed system's final and most critical stage is Classification. 90% of data is used for training and 10% data is used for testing. The classifier distinguishes between benign and malignant tumours. The method used is VGG16. VGG16 is a convolutional neural network model whose architecture is depicted in Figure 2.

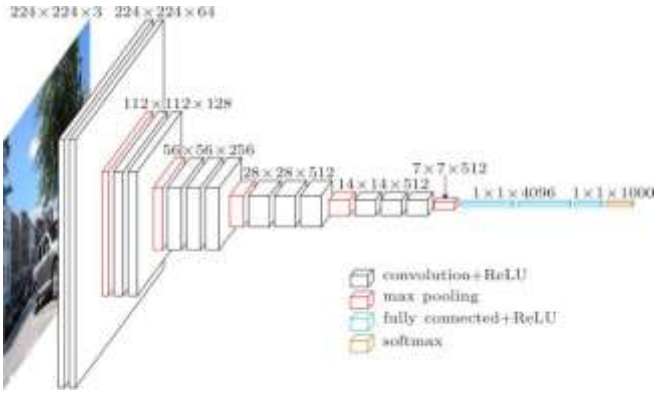


**Figure 2: VGG Architecture**

A 224 x 224 RGB image is used as input to the cov1 layer. The image is passed through a series of convolutional (conv.) layers with a limited receptive field: 3x3 (the smallest size that captures the concepts of left/right, up/down, and centre)., and spatial padding of convolution layer input is set to 1 pixel for the 3x3 convolution layers so that the spatial resolution is maintained after convolution. Spatial pooling is performed by five max-pooling layers that are applied after some of the convolution layers. Stride 2 is used to max-pool over a 2x2 pixel window.

Following three Fully-Connected (FC) layers are inserted after a stack of the convolutional layers. Each of the first two has 4096 channels, while the third uses 1000-way ILSVRC classification and thus has 1000 channels (one for each class). The soft-max layer comes last. The fully connected layers of all networks are set up in the same way.

The hidden layers exhibit the rectification (ReLU) non-linearity.

## IV. Results and Discussions

To conduct the experimental results City Scan images of Bone Cancer is considered with Stage 0 that is no cancer, Stage 1 that is first stage of bone cancer and Stage 2 means second stage of bone cancer.

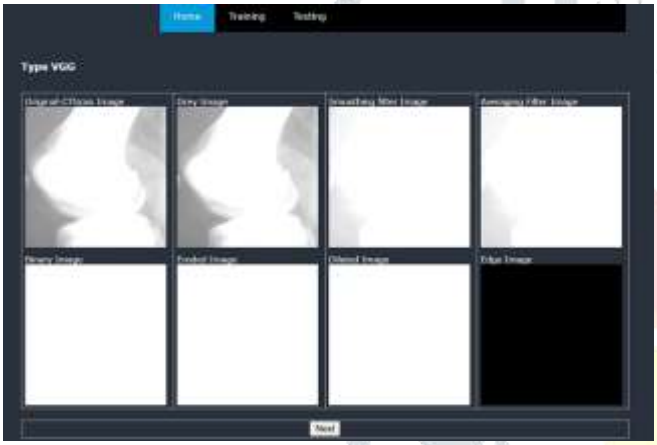


**Figure 3: Preprocessing steps for Stage 0**

Figure 3 shows the preprocessing steps of the CT Scan image selected. For the selected image the cancer is not detected and the accuracy for the prediction is 99.995%.


**Figure 4: Preprocessing steps for Stage 1 Bone Cancer**

Figure 4 shows the preprocessing steps for stage 1 Bone cancer. First the original CT Scan Image is converted to gray scale image, then smoothing and averaging filter is applied for the removal of the noise once the noise is removed the image is converted to binary image and the Eroded and dilated image is calculated and then the edges are extracted using canny edge detection method.


**Figure 5: Result of Stage 1**

Figure 5 shows the result for Stage 1 Bone Cancer. Once the preprocessing is completed the image is fed to VGG16 model for classification .The accuracy got is 99.97%. The affected area and perimeter is calculated. The area is 63619.5 and Perimeter is 1993.8.


**Figure 6: Preprocessing steps for Stage 2 Bone Cancer**

Figure 6 shows the preprocessing steps for Stage 2 bone cancer. For the original image Gray scale image is calculated and for removal of noise smoothing and averaging filter is used. Once the image is filtered Binary image is calculated. Binary image is taken input to calculate the Eroded image and from Eroded image Dilated image is calculated and finally the edges are extracted by using canny edge detection method.


**Figure 7: Result of Stage 2**

Figure 7 shows the result for Stage 2 Bone Cancer. After the preprocessing steps the image is given to the VGG16 model that is created by training the input images. The accuracy is 100% when the image is sent to VGG16 trained model. The affected area and perimeter is calculated. The area is 36108.5 and Perimeter is 1363.04.

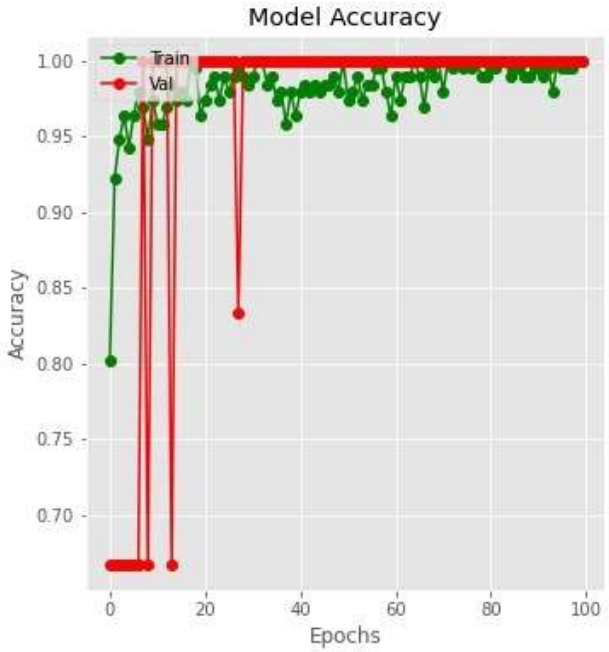


**Figure 8: VGG16 Accuracy Graph**

Figure 8 shows the model accuracy graph of VGG16. In X-axis the Epochs are taken and in the Y-axis Accuracy is taken. For the model 100 Epochs are takes and the accuracy of the system is 100%. The Training and validation accuracy is plotted in the graph. The validation set is used to test the model's results, while the training set is used to train it.

## CONCLUSION

Bone cancer is one of the most deadly disease where the symptoms cannot be notices in earlier stages. To prevent the deaths early detection of bone tumor is very much necessary.

In this system, VGG16 is the classification technique used to detect bone cancer for CT Scan images which gives good accuracy.

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