Bone Tumor Detection from MRI Images Using Machine Learning

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Abstract - *In the field of bio-medical, tumor detection in early stages is the trending research topic as most of the tumors indicates the early stages of cancer. A lot of work have been done on the tumor detection and identification. So, the point of discussion is to find out the identification and detection system which is fast and reliable. In this paper an approach of tumor detection using machine learning have been discussed and the data set for the performance analysis is MRI images. This paper specifically dedicated for the bone tumor detection. Also the algorithm have been implemented in openCV so as to make the system more fast and convenient.*

***Key Words*: Tumor detection, cancer, machine learning, MRI, openCV.**

1.INTRODUCTION

Bone is the supporting skeleton of body and is hollow. The outer part of bones is a arrangement of tough tissue called matrix against calcium salts are laid down. The hard out layer is made with cortical bone, it covers trabecular bone inside, outside of bone covered with periosteum. Some bones are hallow and space is called medullary cavity which contains the soft tissue called bone marrow. Endosteum is act as a tissue lining. At each end of the bone is a region of a softer shape of bone-like tissue called cartilage, it is softer than bone that is made of fibrous tissue matrix assorted with a gel-like stuff that does not enclose much calcium. Most bones get going out as cartilage. The body then put downs calcium onto the cartilage to form bone. After the bone formation, some cartilage may stay at the ends to act as a bolster between bones. This cartilage, along with ligaments and some other tissues join bones to form a joint. Bone itself is very stiff and muscular. Bone is able to hold up as much as 12,000 pounds per square inch. It takes as much as 1,200 to 1,800 pounds of pressure to break the thigh bone. The bone contains 2 kinds of cells. The osteoclast is the cell that form new bone, and the osteoclast is the cell that softens old bone. some bones the marrow is greasy tissue. The marrow in other bones is a concoction of fat cells and blood-forming cells. The blood-forming cells fabricate red blood cells, white blood cells, and blood platelets. Other cells in the marrow include plasma cells, fibroblasts, and reticuloendothelial cells.

Cancer, which makes unfettered cell growth, will subdivide the cells and grow wildly, forming malevolent tumors, and assault nearby parts of the body. This tumor can grow and impede the digestive, nervous, and circulatory systems and they can liberate hormones that amend body function. Cells treated as cancer cells because of injure to DNA. In a regular cell, when DNA damaged the cell upkeep the damage or the cell dies. If the damaged DNA isnt repaired, and die that damaged DNA causes to making unnecessary new cells. Cancer cells often moves to other parts of the body, and begin to produce tumors that reinstate to regular tissue. This process is called metastasis. After that cancer cells get into the bloodstream or lymph vessels of human body.There are different types of cancer that are detected in human body. If the tumor is directly affected to bone then that type of disease is known as Bone cancer. bone cancers are called sarcomas. Sarcomas are initiate in muscle, bone, fibrous tissue, blood vessels, fat tissue, as well as some other tissues. They can expand anyplace in the body. Bone refashion activity is only due to Cancer cells in the Bone. Normal bone is indefatigably being amended, or conked out and rebuilt. Cancer cells offend the balance for growth and formation of cell in bone. If cancer cells are in the bones, then the structure of bone is bent at a higher rate when compared to normal bone rate. Mostly bone cancer will be of primary or secondary . Primary bone cancer occurs in the bone. Whereas secondary bone cancer happens anywhere in the Body.

2. METHODOLOGY

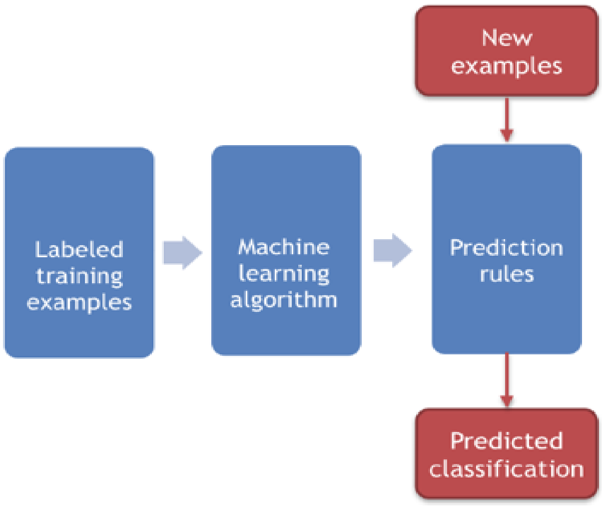

Fig. 1 Supervised Learning Problem

It is useful to characterize learning problems according to the type of data they use. This is a great help when encountering new challenges, since quite often problems on similar data types can be solved with very similar techniques. For instance natural language processing and bioinformatics use very similar tools for strings of natural language text and for DNA sequences. Vectors constitute the most basic entity we might encounter in our work. For instance, a life insurance company might be interesting in obtaining the vector of variables (blood pressure, heart rate, height, weight, cholesterol level, smoker, gender) to infer the life expectancy of a potential customer. A farmer might be interested in determining the ripeness of fruit based on (size, weight, spectral data). An engineer might want to find dependencies in (voltage, current) pairs. Likewise one might want to represent documents by a vector of counts which describe the occurrence of words. The latter is commonly referred to as bag of words features. One of the challenges in dealing with vectors is that the scales and units of different coordinates may vary widely. For instance, we could measure the height in kilograms, pounds, grams, tons, stones, all of which would amount to multiplicative changes. 2. Unsupervised learning In other pattern recognition problems, the training data consists of a set of input vectors x without any corresponding target values. The goal in such unsupervised learning problems may be to discover groups of similar examples within the data: it is called clustering.

Machine learning covers these areas:
1.Classification assign a category to each object (OCR, text classification, speech recognition).

2.Regression predict a real value for each object (prices, stock values, economic variables,
ratings).

3.Clustering partition data into homogeneous groups (analysis of very large data sets).

4.Ranking order objects according to some criterion (relevant web pages returned by a
search engine).

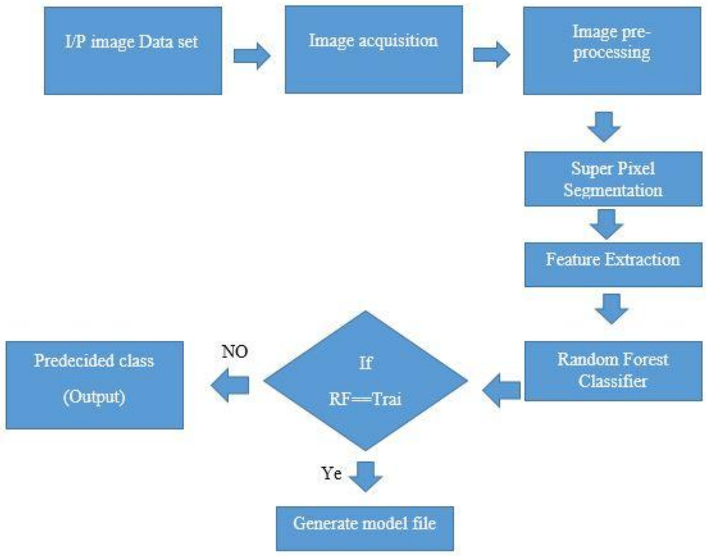

Fig. 2 Proposed Model

In this paper a method is introduced to detect bone cancer by using machine learning algorithm. The main objective is to detect the tumor present in the bone, but most of the times happens that in methods of tumor detection the images obtained comes up with the greater noise factor which restrict the area to operate as it doesn't give the exact location of tumor and the affected tissues. Hence in this paper a novel approach have been proposed which will comprised of the number of stages which will ultimately lead to the proper detection of enchondroma tumor i.e. bone tumor. A simple flow chart for the proposed system as follows:

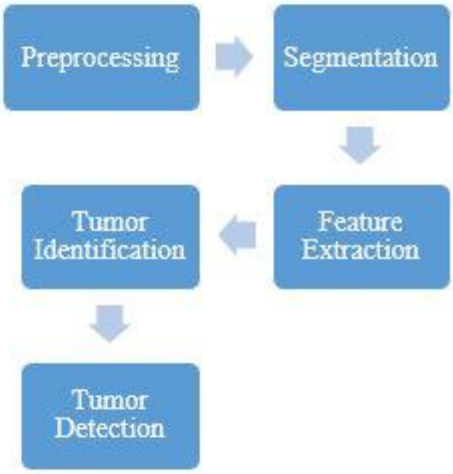

Fig. 3 Flow Chart

Preprocessing

As most of the times the captured images are degraded with the noise leads to poor quality hence to extract exact and important information from the image preprocessing is very much important. Preprocessing is done by denoising the image. Main steps in preprocessing are:

- RGB to Grayscale Conversion
- Bilateral Filtering

The filtering operation can be mathematically formulated as follows:

$$I_b(x,y) = \frac{\sum_{n=-N}^{N}\sum_{m=-N}^{N} W(x,y,n,m)\, I_g(x-n,y-m)}{\sum_{n=-N}^{N}\sum_{m=-N}^{N} W(x,y,n,m)}$$

Where,

$I_g(x,y)$ is a grayscale image ranging values in the range [0,1].

$I_b(x,y)$ will be a bilateral filtered version of $I_g(x,y)$ [1]

Segmentation

Image segmentation is the process of dividing the image into the partitions on the basis of regions with similarities. In this paper the use of K-Means clustering algorithm and the Fuzzy C-Means algorithm have been proposed.

K-means Clustering algorithm:

Basically the clustering can be defined as the grouping pixels of an image such that pixels possessing similarities belongs to the same cluster.

Mathematically,

$$M = \frac{\sum_{I:c(i)=k} x_i}{N_k}$$,k=1,2,.....k

Where M is a specific cluster. [2]

Fuzzy C-Means Segmentation algorithm.

Fuzzy stands for the probabilistic logic or a multi-values logic. In fizzy C-means the main prime features are: Support, Boundary and the core. They are varied in the cluster membership as the support is non-membership value of the set whereas the boundary is the intermediate membership with value ranging from[0,1] and the core is fully member of the fuzzy set.

Fuzzy C-Means is the clustering algorithm which allows one piece of data to be the part of another cluster.

It is based on the reducing the following function:

$$J_m = \sum_{i=1}^{n}\sum_{j=1}^{c} u_{ij}^{m} \left|\left|x_i - C_j\right|\right|^2$$

Where, m>1,

U_{ij} is the deree of membership of x_i in the cluster j, x_i is the *i*th of d-dimensional measured data, c_j is the d-dimensional center of the cluster, and ||*|| is any norm expressing the similarity between any measured data and centre. [2]

Super-Pixel Segmentation

Superpixels provide a convenient primitive from which to compute local image features. They capture redundancy in the image and greatly reduce the complexity of subsequent image processing tasks. They have proved increasingly useful for applications such as depth estimation, image segmentation, skeletonization , body model estimation , and object localization. For superpixels to be useful they must be fast, easy to use, and produce high quality segmentations. Unfortunately, most state-of-the-art superpixel methods do not meet all these requirements. As we will demonstrate, they often super from a high computational cost, poor quality segmentation, inconsistent size and shape, or contain multiple difficult-to-tune parameters. The approach we advocate in this work, while strikingly simple, addresses these issues and produces high quality, compact, nearly uniform superpixels more efficiently than state-of-the-art methods.

Feature Extraction

The feature extraction from the captured images can be carried out with the number of techniques available. In this paper we are going to use the machine learning algorithm so as to make the system more robust. In machine learning algorithm there are several algorithms which are classified based on their performance. Specifically in supervised learning the Random forest and the nearest neighbor algorithm are worth useful, as these algorithms generates a function that maps inputs to desired outputs.

Tumor Identification

The bone tumor is identified by simply calculating the mean pixel intensity of segmented image.

Mathematically, the mean pixel intensity can be calculated as:

$$Mean\ pixel\ intensity = \frac{\sum intensities\ for\ extracted\ tumor\ part(s)}{No.\ of\ pixels\ for\ extracted\ tumor\ part(N)}$$

Tumor Detection

After the tumor identification process it is last step to detect the tumor which can be carried out by using the MATLAB function for connected components which will simply select out the area with maximum connected component and the remaining area will be discarded.

3. RESULTS

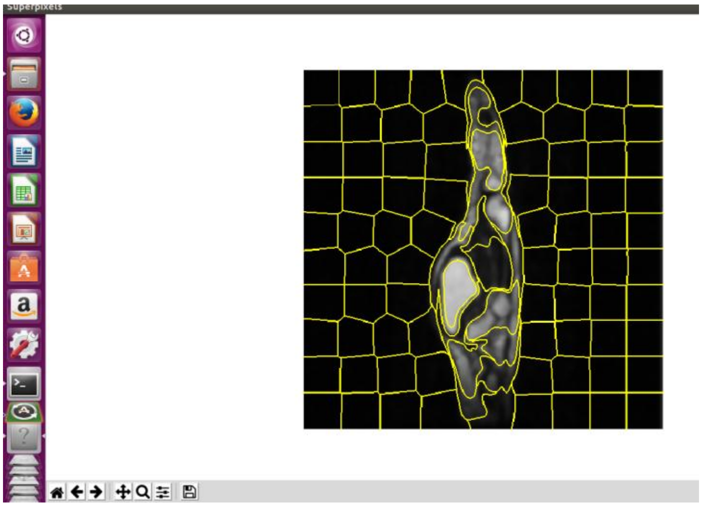

Fig. 4 Segmented Image

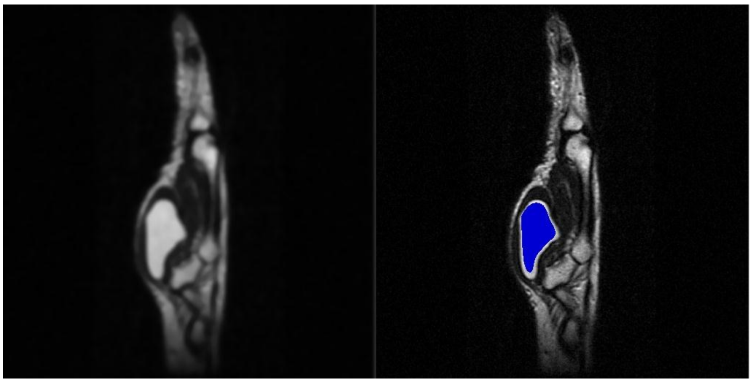

Fig. 5 Output Image

3. CONCLUSIONS

The proposed system of bone tumor detection with superpixel segmentation is implemented using python. Also the detection of brain cancer is carried out with the given set of images. The proposed system is specially dedicated for brain tumor detection . The same system can be further extended to identifying the stages of cancer.

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