Detection and Classification of Liver Cancer using CT Images

Abhay Krishan
1Electrical and Instrumentation Engineering Department, Thapar University, Patiala-147004, Punjab, India abhaykrishan44@gmail.com

Deepti Mittal
1Electrical and Instrumentation Engineering Department, Thapar University, Patiala-147004, Punjab, India deepti.mittal@thapar.edu

Abstract: This paper presents the enhancement of Computed tomography (CT) images using two different algorithms: Contrast Limited Adaptive Histogram Equalization (CLAHE) and Constrained Variable Histogram Equalization (CVHE). CLAHE enhanced the tumor region in a new look. CVHE enhanced with preserving the globalization of an image. The normal liver detection is done by the ox plot comparison in CLAHE. Primary liver cancer detection is done by CVHE. State vector machines (SVM) classifier works for the classification of CT liver images.

Keywords: Computed tomography (CT) images, Contrast Limited Adaptive Histogram Equalization (CLAHE), Constrained Variable Histogram Equalization (CVHE), CT enhanced images, Box plots, classification.

I. INTRODUCTION

Computed tomography (CT) or computerized axial tomography (CAT) produces the sequence of two dimensional image slices of a particular organ of the part of the human body by the process of rotation. CT scans may be single phase CT or multi phase CT. CT scanner has components: Gantry, X-ray tube, detector and Control console. Single phase CT is the process that the movement of x-ray beam through the detector. Multi phase CT is the processing of more than one CT scan, number of different modes is the number of phases. A computer compiles the multi images into complete, cross-sectional pictures (slices) of soft tissue, bone, and blood vessels. A CT scan obtains images of an organ that cannot be seen on a standard x-ray that result in earlier diagnosis, they use to further evaluate an abnormality seen on another test such as an X-ray or an ultrasound. CT scan used to the body in the cross section.

Liver cancers are the cancers that occur in the Liver organ. Liver cancer may be originates from the liver itself or may come from some other organs of the body. Cells are basic building blocks of the body and cancer is a particular type of disease of cells. Uncontrolled growth of liver cells may result in a lump called tumor. These tumors are appeared because of various causes and so they are treated in various ways. The medical image of tumor gives the information about the types of tumor. A tumor can be benign (non cancerous) or malignant (cancerous). A benign tumor does not spread to other parts of the body, whereas a malignant tumor is able to spread. Malignant tumors originate in liver, which grow inside the liver or on the surface. The cancer that first develops in a tissue or organ is called the primary cancer, and the tumors which originate from the liver itself are called primary cancer of the liver. Hepatocellular carcinoma (HCC) is the most common primary cancer of liver. They present symptomatically as an abdominal mass, abdominal pain, jaundice, nausea or liver dysfunction. Cancer cells can spread to other parts of the body by travelling through the blood stream or the lymphatic system. They may continue to grow into another tumor as a new site. This is called the secondary cancer or the metastases. Metastases are the secondary cancer of liver that originate from some other parts of the body.

The process of enhancement is done by using various algorithms. The enhancement algorithm results in enhanced images as the output from the original image. The enhanced images should result in better visualization, contrast and making the image more distinguishable with the tumor part and the other parts of the image. State vector machine (SVM) is use for the purpose of classifier of the types of CT images. It acts as the binary type of classifier. In this paper, there are two different algorithms used for the enhancement purpose that result in different images with their contrast, pixels and the parameter values. Their result makes a difference in the output result data of parameter values.

II. MATERIALS AND METHODS

The CT data is collected in the form of DICOM (Digital imaging and communications in medicine) images. Medical images generated using the procedure like CT, Ultrasound etc. that are stored in DICOM standard of image. It is used for handling, storing, printing and transmitting information in the medical domain. The CT data originally is the patient record of the normal liver, HCC and the metastases cancer. The data in the form of images is collected from the hospitals by using software, radiant DICOM viewer. The DICOM files exchange between the two entities that are capable of receiving image and patient data in its own format, following the interconnection and the interaction of the equipments and transfer the data. The images are then converted from the DICOM images to the .bmp form. The BMP form data is ready to perform the code on it. The DICOM images can be converted to many types of images, but for the purpose of medical domain and to do the image processing work, it is better to use .PNG image.

The CT data has three input types: CT normal liver, CT HCC and the CT Metastases. The image processing is the work that done on the liver portion of the CT image. In the normal liver of CT images, the whole liver portion works for the image processing. In the other cases of CT, the tumor portion that is the liver cancer presents in the CT images. The tumor portions have a different intensity in the CT image from the normal region in the portion of the liver region. In a particular record of one patient, the tumor begins from any particular slice number, it goes on...
increasing with next slice, it reaches the largest size and then goes on decreasing with may or may not continue till last slice. The tumor is not present in each slice of a particular series. The marking of tumor is done by an expert radiologist.

III. ENHANCEMENT

The CT normal liver, CT HCC and CT Metastases are the input images in this work. The input CT images are enhanced using two types of algorithms. The two algorithms are: Contrast Limited Adaptive Histogram Equalization (CLAHE) and Constrained Variable Histogram Equalization (CVHE). Histogram equalization is the processing use for the enhancement of Low contrast types of images. It has effective result on the enhanced image. The output image is the enhanced image.

CLAHE implement the histogram equalization to a contextual area where, every pixel in the degraded image is in its centre. CLAHE operates on small regions in the image, tiles not on the entire image. Each tile's contrast is enhanced, and then the histogram of the output region approximately matches the histogram using the 'Distribution' parameter. The neighbour tiles are then combined using bilinear interpolation that will eliminate the artificially induced boundaries. The contrast, especially in homogeneous areas, can be limited to avoid amplifying any noise that might be present in the image. CLAHE have robustness and reliability in the processing CT medical images. It has high flexibility in improvement, too many researchers work on it.

CVHE algorithm combines the advantages of the histogram equalization algorithm in contrast enhancement for gray level images with the preservation the global outlook of the image, extension of the variational definition of the histogram equalization by adding a constraint that would make the average brightness of the processed image as close to that of original image as close as possible. This algorithm preserves the appearance of the original image and reducing saturation and over-enhancement arti-facts.

These are the result of the enhanced images of CT normal liver, CT HCC and the CT Metastases by using both algorithms.
In these output enhanced images, the CLAHE enhanced images have tumor infected region give a new different look. The tumor region indicate clearly differ in these images by the different intensity. In CVHE enhanced images, there is preservation of the globalization of the original image.

IV. OBSERVATIONS

From the output enhanced CT images, the tumor infected region is for the purpose of further use. In the output enhanced image, an appropriate size of 25 X 20 pixels is cut out from the tumor region. This size give suitable number of pixels to get the statistical parameters values in a suitable range. For the purpose of desired amount in one particular record of these cut pieces, this size work efficiently. It gives the suitable amount of cut pieces size in all types of CT data patient records. In this size the boundary side of tumor is not taken, only the images that have a tumor size in such a way that this size clear with boundary, not containing the outside region of the tumor or the boundary region of the tumor.

Twenty features are calculated using Spatial Gray level dependency matrix (SGLDM) for the present paper. These are auto-correlation, contrast, correlation, cluster prominence, cluster shade, dissimilarity, energy of SGLDM, entropy of SGLDM, homogeneity, maximum probability, variance of SGLDM, sum average, sum variance, sum entropy, difference variance, difference entropy, information measure of correlation1, information measure of correlation2, inverse difference normalized and inverse difference moment normalized.

For each cut size of 25 X 20 pixels,

These 20 parameters are calculated and designed in such a manner that they are easily comparable from one type of record with another type of records and also with the images of the normal liver. These are output result parameter values of two normal liver images, one HCC and one Metastases of CT images, which are calculated using both CLAHE and CVHE algorithms.

<table>
<thead>
<tr>
<th>CLAHE</th>
<th>CVHE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norm1</td>
<td>Norm2</td>
</tr>
<tr>
<td>41.9200</td>
<td>24.4189</td>
</tr>
<tr>
<td>0.3747</td>
<td>0.3916</td>
</tr>
<tr>
<td>0.2604</td>
<td>0.1162</td>
</tr>
<tr>
<td>0.6859</td>
<td>0.9821</td>
</tr>
<tr>
<td>0.0308</td>
<td>-0.0275</td>
</tr>
<tr>
<td>0.3747</td>
<td>0.3621</td>
</tr>
<tr>
<td>0.2656</td>
<td>0.4012</td>
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<tr>
<td>1.3752</td>
<td>1.3547</td>
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<tr>
<td>0.8126</td>
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<tr>
<td>0.3389</td>
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<tr>
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<tr>
<td>1.1157</td>
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<td>0.3747</td>
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<tr>
<td>0.6614</td>
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</tr>
<tr>
<td>-0.0498</td>
<td>-0.0113</td>
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<td>0.1238</td>
</tr>
<tr>
<td>0.9584</td>
<td>0.9601</td>
</tr>
<tr>
<td>0.9942</td>
<td>0.9940</td>
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</table>
These 20 output parameters values are of one particular record of patient. The CLAHE and CVHE algorithms both output result parameters have a different class value of range in all three classes. The Norm1 and Norm2 are the output parameters results of CT Normal liver images data of two different records. They have a particular difference in all the parameters.

V. DISCUSSION

The output result parameters are designed in the form of box plots. They are designed separately using both the algorithms. These box plots are designed by normalization of data in all the classes from 150 best output parameter values.

Comparison of Box plots using both the algorithms, in these three parameters it is clear that in CLAHE, the CT normal data is detected from the abnormal data. Liver cancer disease is detected directly by this algorithm. CVHE works with the preservation of the globalization of an image, which will efficiently work in detecting the HCC.

Box plots using calculation of CLAHE and CVHE algorithm
VI. CLASSIFICATION

From the above box plots, CLAHE detecting the normal liver CT records, it classify as the Normal region of liver and the other as the abnormal region in the liver. From the direct application of CVHE algorithm, HCC, the primary liver cancer is detected directly from the complete records. The other records are of the CT normal liver and the secondary types of cancer.

For the purpose of classification, SVM classification is also done. The SVM will result in two values as the output. In case of matching the values with the data then it is true with classifier, otherwise false. By using CLAHE algorithm, the selected record of 150 CT data of all the twenty parameters, they give 100% accuracy results for the classification of normal liver. In case of abnormal liver, they give 98.66% accuracy results. Overall the result is 99.33% results for the complete data. Out of twenty parameters, four selected parameters output the overall result of 97% accuracy. In CVHE the complete classification is not possible due to some not defined parameter values.
VII. CONCLUSION AND FUTURE SCOPE

From this paper work, it is concluded that from CT normal liver, HCC and Metastases, it is possible to detect the normal liver and rest as abnormal liver, which is the tumor portion in the liver. CLAHE works mainly for extracting the useful result with visualization and in box plot it is clearly differentiates the normal liver region with abnormal tumor. They are easily comparable with the box plots using both the CLAHE and CVHE algorithms. CVHE works for detecting the HCC with the other records; it preserves the globalization of the input image in the output.

The SVM classification work efficiently for classify the normal liver and the abnormal liver.

For the future purpose reference, the more requirement of CT images, with the working of classification of these two tumors of liver cancer. The more CT image processing work will result in more accurate results of all parameters. For the 100% accuracy for all the classification, a large number of CT images are requiring. Some more different types of working parameters evaluation will result in more comparable form among these images.

REFERENCES
