Liver Cancer Detection Using Image Processing

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ABSTRACT

Image processing is a processing technique with the help of mathematical operations. It uses any of the form of signal processing. Here the input is an image or video and the output is also an image or a set of images. This technique is also used in medical applications for various detection and treatment. In this project, it has been used to detect cancer cell of the liver. Here Otsu's method is used for enhancing the MRI image and Marker controlled watershed segmentation method is used to segment the cancer cell from the image. Active contour model was added to identify all the unique segments in the input MRI. Dice similarity score (Dice coefficient) were calculated for both segmented image and image after applying contour model and are compared.

KEY WORDS: IMAGE PROCESSING, OTSU'S, WATERSHED METHOD, MRI IMAGE, CONTOUR MODEL.

INTRODUCTION

Worldwide cancer is the fifth reason for death therefore detection and treatment of cancer having great significance because of widespread episodes of diseases, recurrence after treatment and high death rate. There are different types of cancer in which liver cancer is at third position for death factor. This cancer is also known as hepatic cancer (Sharma & Kaur 2013).

1.1 Problem Definition: Liver cancer starts from the liver and then grows further if not diagnosed early. The cancer which is started from some other organ and travels to liver is not treated as liver cancer. Liver cancer is consisting of the malignant hepatic growths called tumors over liver or inside liver. Therefore, early detection of liver cancer is challenging task in practical radiology. There are number of computer aided diagnostic methods designed using image processing terminologies for early detection accurately. Early stage detection of liver cancer helps to prevent it completely through the proper treatment.

1.2 Existing System: There are some already existing models for Liver cancer detection using image processing.

But in every model, there is only some sort of segmentation technique being used for tumor identification in the liver which was giving less accuracy. Image enhancement must be done before segmentation to get rid of noises in the image. Superimposing the identified image must also be done to identify the tumor clearly.

1.3 Proposed System: Otsu's method is used for image enhancement i.e. to remove noises in the image. Marker controlled Watershed segmentation algorithm is used to segment the Liver MRI image. Active contour model is added to segmented image that finds all the unique segments in the input MRI and labels them with green circles. Dice similarity score is calculated for both the segmented image and image after applying contour model and are compared (Haluska et al., 2004).

The proposed system consists of the following advantages:

Advantages:

- It is easy to implement.
- It is easily interpretable.
- It is very efficient.
- Good accuracy and precision.
- Help doctors to detect liver cancer

MATERIAL AND METHODS

Liver MRI image is taken as input. Image enhancement is done to remove the noise on the image using Otsu's method. Later, image segmentation is done using Marker

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controlled watershed segmentation method to segment the image. Active contour model is used to improve the segmented image (Kaye et al., 2004).

2.1 Otsu's method: Otsu's method uses clustering based technique. In other words, it converts greyscale image into binary image. It assumes that the image contains two levels of pixel which are foreground pixel and background pixel (bi-modal histogram). It calculates the optimum threshold by separating two classes. The result gives minimum combined-spread and maximum inter-class variance. The Otsu's method can roughly be said to be one-dimensional method. The Otsu's method searches for the threshold which minimizes the inter class variance.

2.2 Image segmentation: It is an important process for many tasks in image processing. Many of the important techniques like image description and image recognition depend on the image segmentation. The process of segmentation divides an image into region or object. The objective of the process of segmentation is to make the image more useful by changing the representation and simplifying the image due to which it will be easier to analyze the image. This process is used for detecting the boundaries and objects of an image.

2.2.1 Marker Controlled Watershed Segmentation: Marker-Controlled Watershed Segmentation process enhances the region which indicates the presence of the required object. The locations which are extracted by this process are then set to the minimum position within the same topological surface. The watershed algorithm is applied afterwards. Separating objects of an image is one of the difficult methods which watershed segmentation makes it easier. Watershed Segmentation Approach is of two types: External associated with Background and Internal associated with the object of interest.

2.3 Active contour model: Active contour models are used in various image processing applications specifically in medical image processing. In medical imaging, active contours are used in segmentation of regions from different medical images such as Liver MRI images, MRI images of different organs, cardiac images and different images of regions in the human body. Active contour model is added is used to enhance the segmented image. Contour models describe the boundaries of shapes in an image. Features like area of liver tumor, shape of liver tumor etc are extracted from this. Here it finds all the unique segments and represents them with green circles (Mitha & Jayasree 2015).

2.4 System Architecture: The system basically uses Jupyter notebook which sets the path to take the image input. Image enhancement is done on the input image to remove noise using Otsu's method. Later, image is segmented using marker controlled watershed segmentation algorithm. Watershed algorithm is applied using Opencv and further MATLAB, to segment the image easily. This algorithm marks the boundaries of all objects using a red label. Active contour model is added to segmented image that finds all the unique segments

in the input MRI and labels them with green circles. Dice similarity score is calculated for both the segmented image and image after applying contour model and are compared (Kekre et al., 2016).

Figure 2.1: The system architecture of the proposed Liver cancer detection using image processing

The above figure 2.1 shows the system architecture of liver cancer MRI showing the sequence of actions of image enhancement, image segmentation and active contour model applied. Dice similarity score is calculated as shown for the enhanced images and are compared.

RESULTS AND DISCUSSION

Dice Coefficient: Dice similarity coefficient is a spatial overlap index and a reproducibility validation metric. It was also called the proportion of specific agreement by Fleiss. The value of a DSC ranges from 0, indicating no spatial overlap between two sets of binary segmentation results, to 1, indicating complete overlap.

Dice similarity Score = $2 * \frac{\text{Area of Overlap}}{\text{Total number of pixels in both images}}$

Figure 3.1: Otsu's histogram of Liver cancer detection using image processing

Dice similarity score of contour model image with original image:

Dice similarity score = 0.00019607138058098448

Dice similarity score of contour model image with original image:

Dice similarity score= 0.0002464599353843849

Output Screens: The following are the screenshots of proposed system:

The above figure 3.1 shows the graph drawn between pixel count on x-axis and pixel intensity on y-axis. It gives optimal threshold value that is used to divide the image into two classes of foreground and background.

Figure 3.2: Otsu's transformation for Liver cancer detection using image processing.

Figure 3.3: watershed segmentation for Liver cancer detection using image processing.

The above figure 3.2 shows the Otsu's transformation of Liver MRI with two classes foreground and background shown with two different colors. Otsu's method is applied for image enhancement to remove the noise in the image (Nelofar et al., 2016)

The above figure 3.3 shows the boundaries drawn with red line for each object in the foreground image. On comparing with the healthy liver MRI, the white part in the liver are detected as cancer cells. Other white colored cells even though they appear to be cancer cell, they are actually fatty cells at the borders. The white cell outside of the liver is actually a body part and not our region of interest since it is outside of liver.

The above figure 3.4 shows the healthy liver MRI which is having the fatty cells at the boundaries of foreground image and also the larger white part outside of the liver which is common in all Liver MRI's. So it can be clearly known that in the image 3.3, the cancer cell is white part in the Liver (Namrata et al., 2017).

Figure 3.4: Healthy Liver MRI for Liver cancer detection using image processing

Figure 3.5: Liver MRI after applying active contour model for Liver cancer detection using image processing

The above figure 3.5 shows the MRI image after applying active contour model. It finds all the unique segments and represents them with green circles. Here it finds 29 unique segments represented with green circles.

The above figure 3.6 shows the output screen of dice similarity score of segmented image related to original image which gives 0.00196071 (Anisha 2015; Saranya 2016).

The above figure 3.7 shows the output screen of dice similarity score after applying active contour model related with original image which gives 0.0002464599353843849 (Yamini 2014).

On comparing the dice similarity scores, active contour model increases the dice similarity score from 0.00019607138058098448 to 0.0002464599353843849.

Figure 3.6: Dice similarity score of segmented image for liver cancer detection using image processing

```
import numpy as np
import cv2
from PIL import Image
k=1

# segmentation
seg = Image.open('../Result/Test/segmentation.jpg').convert("L")
seg = np.asarray(seg)

# ground truth
gt = Image.open('../Dataset/Test/gt.jpg').convert("L")
gt = np.asarray(seg)

dice = np.sum(seg[gt==k])*2.0 / (np.sum(seg) + np.sum(gt))

print("Dice similarity score is {}".format(dice))

Dice similarity score is 0.00019607138058098448
```

Figure 3.7: Dice similarity score of contour model image for liver cancer detection using image processing

```
import numpy as np
import cv2
from PIL import Image
k=1

# segmentation
seg = Image.open('../Result/Test/contour.jpg').convert("L")
seg = np.asarray(seg)

# ground truth
gt = Image.open('../Dataset/Test/gt.jpg').convert("L")
gt = np.asarray(seg)

dice = np.sum(seg[gt==k])*2.0 / (np.sum(seg) + np.sum(gt))

print("Dice similarity score is {}".format(dice))

Dice similarity score is 0.0002464599353843849
```

CONCLUSION

Different MRI Images were acquired from the internet; basic Otsu preprocessing technique was used for preprocessing the input MRI image for image enhancement and denoising. For segmentation, Marker-Controlled Watershed segmentation was used and it was observed that segmentation was done properly and the areas were identified accurately for most of the images. Dice similarity score was nearly 0.19 for segmented image with original image. In Accuracy viewpoint, for the base paper, the accuracy obtained comes out to be 74.93 %. On adding the active contour model in which all unique segments were found, the accuracy comes out to be 85.99% and also dice similarity score increased to 0.24 .

Future Scope: The current project can be converted into a proper GUI based application. It can be either an android or a web application, so that it is handy for any normal user to detect liver cancers. So that the human expertise of finding the tumor region in liver MRI image can be

changed to automatic detection of liver cancer saying yes or no when a particular MRI image is given as input to the application.

REFERENCES

- Akanksha Sharma, Parminder Kaur. (2013). "An optimized Liver Tumor detection and segmentation using neural network". International Journal of Recent Technology and Engineering (IJRTE) .
- F. G. Haluska, D. N. Louis, D. C. Christiani, J. Settleman, D. A. Haber, (2004). "Activating mutations in the epidermal growth factor receptor underlying responsiveness of non-small-cell lung cancer to gefitinib", New England J. Med., vol. 350, no. 21, pp. 2129-2139.
- F. J. Kaye, N. Lindeman, T. J. Boggon, K. Naoki, H. Sasaki, Y. Fujii, M. J., W. R. Sellers, B. E. Johnson, M. Meyerson, (2004). "EGFR mutations in lung cancer: Correlation with clinical response to gefitinib therapy", Science, vol. 304, no. 5676, pp. 1497-1500, Jun.
- H. B. Kekre, A. Bild, E. S. Iversen, A. T. Huang, J. R. Nevins, M. West, (2016). "Integrated modeling of clinical and gene expression information for personalized prediction of disease outcomes", Proc. Nat. Acad. Sci. vol. 101, no. 22, pp. 8431-8436, 2004
- Dhomse Kanchan B., M.K.M..
- Mitha Raj ,Jayasree M , (2015) . "Automated Liver Tumor Detection Using Markov Random Field Segmentation ", International Conference on Emerging Trends in Engineering, Science and Technology.
- Namrata Ghuse, Yogita Deore, Amol Potgantwar (2017). "Efficient Image Processing Based Liver Cancer Detection Method " , International Journal of Scientific Research in Network Security and Communication.
- Nelofar Kureshi, Syed Sibte Raza Abidi, (2016). "A Predictive Model for Personalized Therapeutic Interventions in Non-small Cell Lung Cancer", IEEE Journal of Health Informatics Vol. 20, No.1.
- PR Anisha, CKK Reddy, LVN Prasad, (2015). "A pragmatic approach for detecting liver cancer using image processing and data mining techniques", International Conference on Signal Processing And Communication Engineering Systems (SPACES), India, pp.1-6.
- Saranya , Dr. M. Pushpa Rani , (2016). " Liver tumor detection for CT images using image processing techniques", International Journal of Current Research.
- Yamini Upadhyay , Vikas Wasson , (2014). "Analysis of Liver MR Images for Cancer Detection using Genetic Algorithm", International Journal of Engineering Research and General Science.