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Liver Tumor Segmentation and Classification Using Convolution Neural Network and Support Vector Machine

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ABSTRACT: Heptacellular caricinom a form of metastatic liver cancer making itselfs as the source of mass human death specifically in male than in female as liver stands as vital organ performing multiple functions in the human body. Hence, the need to figuring out the disease and providing appropriate treatment is necessary. Many advances have been made by deep learning in order to solve this. Multiple techniques related to neural network came into force but faliled in providing appropriate results. In this paper, we have used CNN and SVM as the classfication tecniques and U-Net as segmentation tecnique. To segment the liver from the abdomen is challenging task as it has may tissues sourrounding. Pre-processing techniques are used for enhancement of image. All the techniques used have shown better effenciency and accuracy.

KEYWORDS: Liver Cancer, Classification, Segmentation, CNN, SVM, U – Net, Pre-proessing. Filteration

I. INTRODUCTION

Advancement in machine Learning have opened may pathways for healthcare deveopements. The field of medicine stood as the prime acceptance for this facitlity namely medical imaging. CT scans of necessary organ is sent as input after completing all the process the end result is dervied. In this paper detection of Liver tumor from the abdomen Ct scan image is discussed.

Liver is considered to be the largest organ in the human body which have many vital functions ranging cleansing of blood to helping in metabolim any rapture or mishappening at this place is hazradous to the entire human body because of which people dying out of liver cancer are many. Cancer is refferend to abnormal growth of the cells which is sometimes unstoppable. The ubnormal growth of the cell with in the liver region is termed as liver tumor. It can be primary tumor or the secondary tumor. Primary tumor is the one that grows that developes with in the region and secondary referes to the one that has travelled to the liver from other region . Major secondary tumors are from colon or rectum, the metastases from this region move to liver taking its name as metastatic colon cancer or metastatic rectum cancer. Like every cancer early stage detection in this is hard as symptoms are hidden and unknown. The symptoms of Liver cancer ranges from abdomen pain, yellow skin, fatigue, vomitting, Abdominal swelling, upper abdominal pain, white chalky stools. Varios range of treatments are used like, Surgery, Radiotheraphy,Chemotheraphy, cyrosurgery, liver transpalnt, heptic artery chemoembolization, and surgical ressuruction are few options among other few.

To identify liver in the abdomen CT scan images is confusing and segmenting the liver from the abdomen CT scan is the tough task. It has many other organs sourrounding it like, bones, GI track,

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pancreas, kidneys, spleen, stomach, adrenal glands, lymph and blood nodes and bladder. Due to which finding the liver in this crowded place becaome a strenuous task. For whch many segmenting techniques have been introduced like CNN (Convolution Neural Network), FCN (Fully Connected Neural Network) and K means algoritm. Yet all these techniques failed to show the expected results. In this paper we have introduced U-Net segmentation technique, a architecture of CNN which have proven to give the better accuracy compare to al other techniques mentioned above. As detecting the liver cancer as a disease and finding its cure is neccessary many classifcation techniques have come into existence. But failed to prove the effieciency. The proposed system talks about Support Vector Machine (SVM) and Convolution Neural Network (CNN) as classification techniquees. A ROC curve is drawn comparing both the technique to judge which one has better accuracy.

II. METHODOLOGY

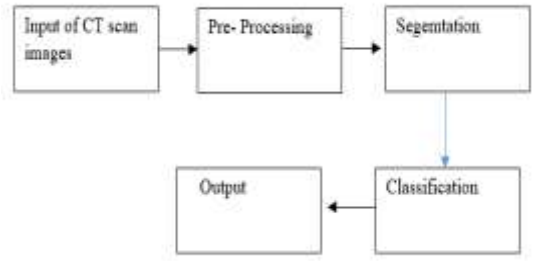

Figure 1: Methodology of Proposed System

Figure 1 shows the methodoly of the proposed system as shown the primary step after input of image is pre – processed by using different filtration techniques . Secondly, the pre – processed image is sent to segmentation . where the portion of image is segmented. Finally the image is classified into diseased or not. Further the stages are predicted. The steps are detailed below.

1. Pre- processing:
Grey scaling
Gaussian filter
Median filter
Binarization
2. Segmentation
3. Classification.

Pre-Processing.

Grey Scaling : In this step the RGB image is converted into grey scale. This is done in order to reduce computation and time complexity. The below formule is used to calculate

$$G' = ((0.3 * R) + (0.59 * G) + (0.11 * B))$$

The R , G and B here are Red , Green, Blue respectively.

Gaussian Filter : Filteration is done in order to remove the noise in the image. Gaussuain filter is used to remove the gaussian noise. A gaussian kernel is moved across the image. Below formulae is used to calculate the filter

$$g[i,j] = e^{\frac{-(i^2+j^2)}{2\sigma^2}}$$

Median Filter : Salt and pepper noise is removed Using this technique. Like gaussian filter here, kerenl is used. A window is coosed, pixel intensities are arranges in the ascending order and the middle on is choosen as value.

Formulae for median filter :

$$\text{Median Filter} = \frac{a\left(\frac{N}{2}\right) + a\left(\frac{N}{2}+1\right)}{2}$$

Binarization using thresholding:

Ostu thresholding is used as the process to covert the image into binary image. The maximum repeated pixel value is taken as threshold value the above and below is revalues as 0 and 1.

$$p(i) = \frac{\text{number}\{(r,c), \text{image}(r,c) = i\}}{R, C}$$

r and c are the index of rows and column respectively. R and C are values of rows and columns.

Segemtation

Segmentation is termed for extracting the desired regio. Here, the liver region is extracted from the abdomen CT scan image to identify the tumor. U – Net is the technique is used here. U Net is the architecture of CNN. Compared to many other techniques U – Net has performed well giving the expected accuracy.

Architecture of U-Net have two paths contracting path and expanding path.

Contracting path has layers like : Convolution, ReLU and Maxpooling.

Expanding Path : Upsampling , Convolution.

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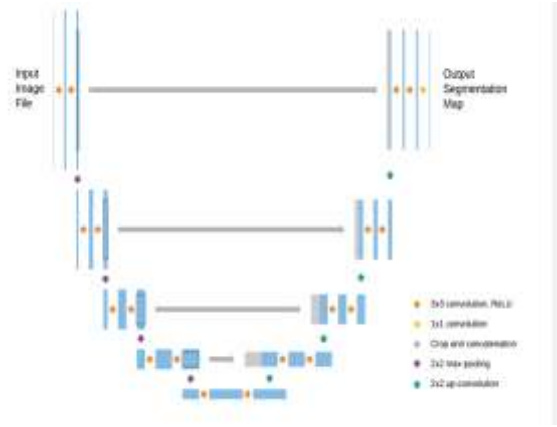

Figure 2 : Architecture of U-Net.

Figure 2 shows the U- Net architecture diagram. Both contracting and the expanding paths are represented in the above diagram. In convolution step, the image is convolued with the filter this happens three times with 3x3 kernel. In the next step ReLU activation function is used, where the negative values are made nullified. Pooling is applied to the image. Here, Max pooling is used in which the maximum pixel value in the selected window is choosen as pixel value for rest of the process. This process continues until further process in the image cannot be performed. It reaches to the point where the next process would be the expanding path. Where, upsampling takes palce where the image is rezied to the origional one. The end layer is convolued with the filter of size 1x1.

Energy function equaion :

$$E = \sum w(x) \log(p_{k(x)}(x))$$

Where, the pixel- wise Soft Max function is applied over final feaure max usingp^k.

$$p_k(x) = \frac{e^{a_k(x)}}{\sum_{k=1}^{k} e^{a_k(x)}}$$

Here, $a_k(x)$ = activation
k = channel.

Classification

The final step is classification, where the image is allowed to classified into normal and Stages of the cancer are displayed. CNN and SVM are the two techniques that are used and finally an ROC curve is drawn in comparision to both to check which one gives better accuracy.

CNN

The segmented image is taken as input CNN is subjected to it.

CNN has 4 stages, Convolution stage, Detector Stage, Pooling stage, Next Layer.

Convolution Stage : Image is convouled using a convolution mask of 3x3 or 5x5.

Detector stage : An activation function is added as per the requirement. The most commonly used activation function is ReLU. Where, all the non negative pixel intensities are replaced with zero.

Pooling Stage : Max pooling is performed here. By applying this operaton the image size is drastically reduced.

Next Layer : The next layer consists of flattening and the passing it to the sigmoid activation function where the wights are adjusted as per the desired outputs , through the process of back propogation

SVM

Support Vector Machine belongs to the class of supervised learning alogrithms. Here, the inputs are labelled as per the classes alter classified. SVM is used both in classification and regression.

At the beginning, from the segmented image a portion of necessary features in terms of numericals. These are labelled into different classes and are plotted in 2D plane. The support vectors choosen by calculating the distance between classes and two lines which are drawn over them are called marginal plane. Finally a hyper plane is found which seprates the classes. When a new point comes the classifier decides to which group does it belongs.

III. RESULTS AND DISCUSSION

To derive experimental results Abdomenal CT scan images have been used as inputs. Stage 1, stage 2 and stage 3 cancers have been identified and if no disease the a normal one is declared.

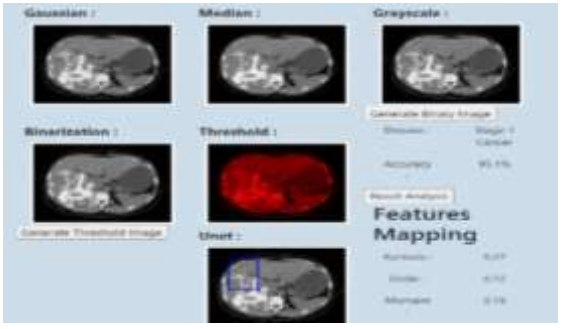

Figure 3 : Detection of liver tumor of stage 1.

Figure 3 shows the detection of liver tumor in stage 1. The primary step is included in pre processing. At first the image is uploaded. The loaded image is filtered at the beginning. The two

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filters used here are gaussian filter and median filter. Later the filtered image is grey scalled to easy the computation process. When " Generate biary image" is clicked the binarized image is displed which is the result of thresholding. When " generate thresholded image is clicked" then the thresholded image is displayed. The next image displayed is segmented one result of which the stage is displayed. The stage detected here is stage 1 with accuracy of 95.1%

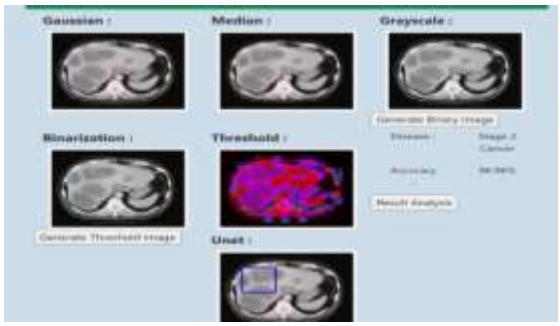

Figure 4 : Detection of liver tumor of stage 2.

Figure 4 shows the page where second stage liver tumor is detected. The above figure shows the prepocessing steps, segmentation step and then the stage of the cancer is detected. 96.96% accuracy is achived.

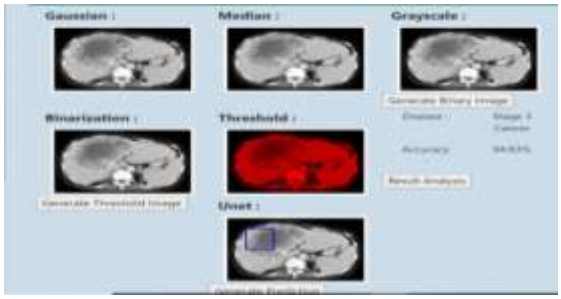

Figure 5 : Detection of liver tumor of stage 3.

Figure 5 shows the page of detecting the tumor at the thirs stage. The process is similar for all the stages. Filtering , Greyscaling, thresholding, binarization segmentation and finally classification. Accuracy of 94.83 is achived at this stage.

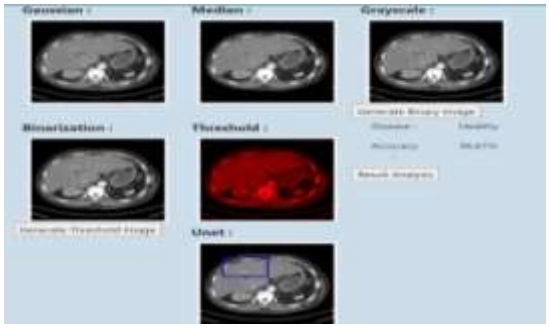

Figure 6 : Detection of healthy liver tumor.

Figure 6 depicts the image classified as heathy one. The image is extracted from the image set folder and uploaded. Preprocessing step is followed by segmentation and then finally image is classified as healthy with 96.61% accuracy.

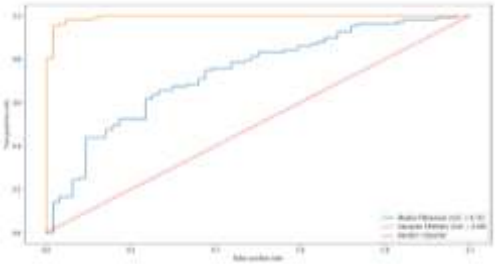

Figure 7 : ROC curve comparing gaussian and median filter.

Figure 7 depicts the ROC graph, The above graph briefs us abot the comparison between the models of gaussian and median filter. The graph is plotted as False positive rate at the X-axis and True positive rate at the Y-axis. Accuracy is directly porpotional to the space under the AUC. In this ROC curve, gaussian filter has higher accuracy compared to the median filter by giving the accuracy rate of 99%

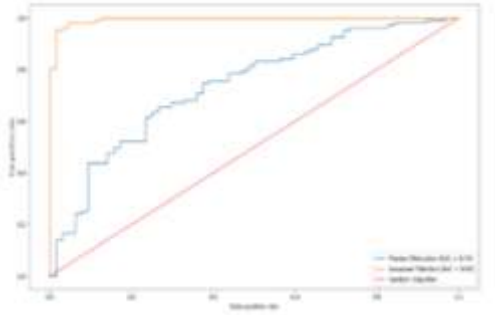

Figure 8 : comparative analysis of SVM and CNN.

Figure 8 shows the ROC curve between the convolution neural netwrok and the support vector machine. From the above graph we can conclude that the SVM is btter than CNN

IV. CONCLUSION

The necessity of detcting the liver disease at its earliest is evident as it's a wide spread problem. Many techniques in deep learning have introduced for the purpose of segmenting and classifying

Here, we have disscussed about U-Net for segmentation , CNN and SVM for classifiaction and gaussian and median filters for remvoing noises. By experimentation the above techniques have better accuracy compared to all other medical imaging techiques used prior.

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