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DETECTION OF GASTROINTESTINAL STROMAL CANCER CELLS USING HOMOMORPHIC FILTER AND REGION SPLITTING, MERGING SEGMENTATION TECHNIQUES

N.Chandra Prabha[1], Dr.Gandhimathi[2]
[1]B.E, M.E Communication systems, [2]Phd, Professor
Department of ECE, Parisutham Institute of Technology and Science, Thanjavur-613 006

ABSTRACT: Image processing plays a major role in biomedical applications in order to detect many diseases which affects human. It detects the gastrointestinal stromal cancer which affects the digestive system at the stomach. Image processing made it possible to detect, locate, provide the pre-state analysis of cancer and its stages. It uses image segmentation techniques such as threshold segmentation, clustering, edge detection, morphological operations and region based segmentation. Image segmentation process the PET scanned image according to the partitioning of images into its constituent regions or objects. It also uses homomorphic filter technique to highlight certain features of interest and to remove noises in an image. It is a subjective process which means that the human perception decides the best method from the obtained results. The approach of enhancement process involves the spatial domain and frequency domain methods. It also involves the region splitting and merging segmentation by processing an image in a region featured basis. The image can be functioned by considering several geometric properties based on the shape, structure and dimension of the cell. The results of this detection provides the accuracy in measurements and pre-state information of the cancerous cells.

Index terms: Gastro intestinal stromal cancer, Image segmentation, Noise removal, Homomorphic filter,Region split and merge segmentation, PET scan, Histogram estimation.

I. INTRODUCTION

Gastrointestinal stromal cancers are uncommon cancers which start in very early forms of Interstitial Cells of Cajal (ICCs). ICCs are the part of the nervous system which regulates the process of the digestion. It signals the muscles in order to contract to move the food and the liquid through the gastrointestinal tract in the digestive system. Not all the gastrointestinal tumor are cancerous. Some of them are benign which are non-cancerous and don’t grow into other areas or spread to other parts of the body.

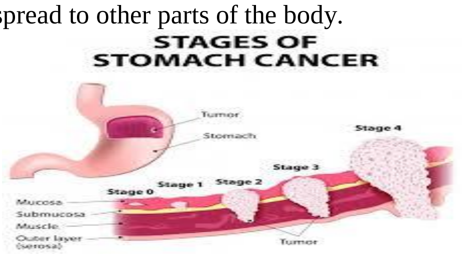

Fig.1. Stages of stomach cancer

There are various kinds of tumors in the gastrointestinal tract. Each cancer has a different prognosis and it is the challenging risk to detect the type which is cancerous, non-cancerous, and other types of cancers. About 70% of this cancer occurs in the stomach, 20% in the small intestine and less than 10% in the esophagus. When the cancer is not determined earlier it disseminate to the liver, omentum and peritoneal cavity. It rarely occurs in the abdominal organs.

II. THEORETICAL BACKGROUND

In the proposed system, it deals with the image segmentation process in which the PET scanned images are functioned by the partitioning of regions or an objects of an image. It also involves several techniques such as Noise removal, Segmentation, Morphological processing and Histogram likelihood estimation. To obtain high quality PET images from noisy projection data, many approaches have been explored. They can be coarsely divided into three categories: pre-processing methods, iterative reconstruction approaches and post-processing algorithms. Pre-processing methods restore the noise removal process by the use of Homomorphic filter mainly including nonlinear noise filters and statistic-based iterative de-noising methods.

Iterative reconstruction approaches treat the LDCT imaging as an ill-posed inverse problem, and solve the problem by minimizing an objective function, which often includes a data fidelity term and a regularization term. Image segmentation uses the Region based segementation techniques which provides high rate of accuracy in partitioning the pixels. In the proposed method, Region split and merging techniques are used. This method finds the boundaries between regions based on discontinuities in intensity levels. Thresholding methods segment an image using thresholds baser on the pixel properties like gray level values or color. Post-processing approaches are directly applied on LDCT images reconstructed by HF method to suppress noise and streak artifacts, ensuring that neither important tissue structures are lost nor false structures introduced.

Here the morphology is a broad set of image processing operations that process images based on shapes. It often takes a binary image and a structuring element as input and combine them using a set operator, creating an output image of same size. The histogram estimation are analyzed by means of histogram likelihood estimation technique.

III. MODULE DESCRIPTION

A. PET Scan Input Image

It is an imaging test uses special dye has radioactive tracers which is inserted into the human body in order to locate the disease or an abnormal areas. This dye can be inserted through the air inflow by which the tissue can absorb the tracer. It shows the problems at the cellular level and it detects how the cancer metabolizes, spread or metasized to the new areas. It is less exposure to harmful radiation and it gives the accurate clear imaging analysis than the CT scan image. It does not use the x-ray beams inside the body.

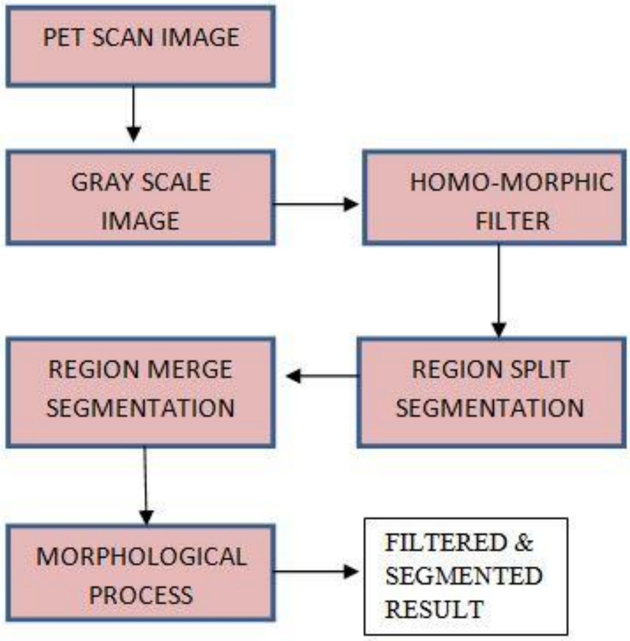

Fig.2. Block diagram of proposed system

B. Pre Processing

In the pre-processing step, the binary image is first converted to gray scale image. The illusion of gray shading in a black and white image is obtained by rendering the image as a grid of black dots on a white background (or vice versa), with the sizes of the individual dots determining the apparent lightness of the gray in their vicinity. A gray scale image can be specified by giving a large matrix whose entries are numbers between 0 and 255, with 0 corresponding to black and 255 corresponding to white. The homomorphic filter is used in this paper which reduces the noise content in a gray image by image enhancement technique.

1. Homomorphic Filter

Homomorphic filtering is the process of improving the appearance of an image by simultaneous gray-level range compression and contrast enhancement. It is based on the illumination-reflectance model.

A. Illumination-Reflectance model

This is a simple image formation model which states that an image can be written as a product of two components. They are,

Illumination component – This is the amount of source illumination incident on the scene being viewed; denoted as i(x, y).

Reflection component – This is the amount of illumination reflected by the objects in the scene; denoted as r(x, y).

Thus, an image f(x, y) is represented as,

$$f(x, y) = i(x, y).r(x, y),$$
$$0 < i(x, y) < \infty$$
$$0 < r(x, y) < 1 \quad \text{------ (3)}$$

B. Homomorphic filtering procedure

The method is based on a class of systems known as homomorphic systems.

- It will first convert the image to float.
- Convert the image next to the log domain
- Apply the High pass filtering in either the spatial domain or the frequency domain
- Apply inverse filter and retain the real part of the result
- Apply the exponential function to invert the log transform
- See the homomorphic filtered image using ifftshow () function

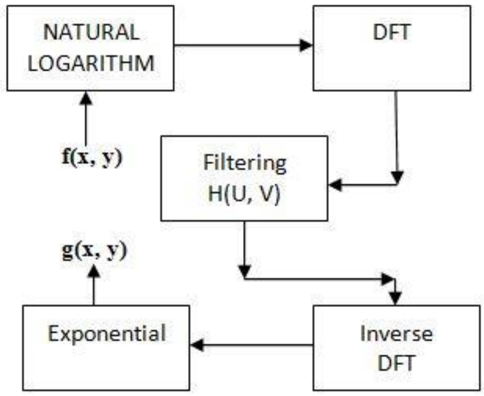

Fig.3. Block diagram of homomorphic filtering

Step 1: Define a new function with natural algorithms

$z (x, y) = \ell n\ f (x, y)$ ------ (2)

$z (x, y) = \ell n\ i (x, y) + r (x, y)$ ------ (3)

NOTE: FT of product of 2 functions is not separable. New function z (x,y) is needed.

Step 2: Compute DFT

$F [z (x, y)] = F [\ell n\ i (x, y)] + F [\ell n\ r (x, y)]$ ------ (4)

$Z (u, v) = F_i (u, v) + F_r (u, v)$ ------ (5)

Step 3: Multiply Z (u, v) by filter function H (u, v)

$S (u, v) = H (u, v) . Z (u, v)$ ------ (6)

$S (u, v) = H (u, v) F_i (u, v) + H (u, v) F_r (u, v)$ ------ (7)

Step 4: Compute Inverse DFT

$s (x, y) = F^{-1} [S (u, v)]$ ------ (8)

$s (x, y) = F^{-1} [H (u, v) .F_i (u, v)] + F^{-1} [H (u, v) . F_r (u, v)]$ ------ (9)

Step 5: Get the enhanced image by taking exponential

$s (x, y) = i (x, y) + r (x, y)$ ----- (10)

$g (x, y) = \exp (S(x, y)$ ----- (11)

$g (x,y)= \exp (i' (x, y).\exp (r' (x, y)$ ----- (12)

$g (x, y) = i_0 (x, y) . r_0 (x, y)$ ----- (12)

Homomorphic filtering provides good control over illumination and reflectance. The simultaneous dynamic range compression and contrast enhancement are achieved by reducing the contribution made by low frequencies (illumination) and amplifying the contribution made by high frequencies (reflectance).

2. Image Segmentation

Image segmentation is defined as the process of partitioning or subdividing an image into its constituent regions or objects. The inputs of segmentation are images, but unlike other image processing methods, the outputs of segmentation are attributes. The segmentation process should be stopped as soon as the objects or regions of interest are detected. The segmentation methods are based on discontinuities which divide an image depending on the abrupt unexpected changes in intensities like edges. Here, the boundaries of images are assumed to be different from the background. The another method is based on similarities partition an image into similar regions depending on a specified criteria.

A. Region splitting and merging model

Region splitting and merging is a segmentation process in which an image is initially subdivided into a set of arbitrary, disjoint regions and then the regions are merged and/or split to satisfy the basic conditions. This is an alternative method to the region growing approach.

Let R denotes the entire image region and P denotes a predicate. Region splitting has the following steps, starting with the entire region R.

- P(R) = FALSE, subdivide R into quadrant R_i; i=1,2,3,4
- P = FALSE for any quadrant, again subdivide that into sub quadrants
- Repeat until P (R_i) = TRUE for all sub regions R_i

Quadtree is a tree in which the nodes have exactly four descendants. The splitting technique can be represented using this quadtree.

Region merging is used because, if the process is stopped only with splitting, the result may have adjacent regions with identical properties. When the combined pixels of two adjacent regions satisfy the predicate P, they are merged if

P (R_i U R_j) = TRUE

B. Split and Merge Algorithm

- Split any region R_i into four disjoint quadrants where, P(R_i) = FALSE
- Merge any tow adjacents regions R_j and R_k if P (R_i U R_k) = TRUE
- Stop when no further merging or splitting is possible.

C .Post Processing

Morphology is a broad set of image processing operations that process images based on shapes. Structuring is an essential part of the morphological operations used to probe the input image. The center pixel of the structuring element, called the origin, identifies the pixel of interest. The pixels in the structuring elements containing 1's define the neighborhood of the structuring element.

Dilation adds pixels to the boundaries of objects in an image, the value of the output pixel is the maximum value of all the pixels in the input pixel's neighborhood. In a binary image, if any of the pixels is set to the value 1, the output pixel is set to 1. Erosion removes pixels on object boundaries, the value of the output pixel is the minimum value of all the pixels in the input pixel's neighborhood. In a binary image, if any of the pixels is set to 0, the output pixel is set to 0.

The histogram based likelihood estimation algorithm further increases the image segmentation, accuracy and the computation of deformed histogram of an image.

Input :img_x

Labelled image :img_i

1. Compute $i_i,\ i_x$ with quantization
2. Compute $H_i,\ H_x, H_{t,i}, t \in L$
3. With $H_i,\ H_x$, compute T_x^ix
4. With T_t^ixand $H_{t,i}$, compute deformed histogram
5. Pr_i(I(p)|f_p) = $H_{fp,i}$(I_x(p))

IV. CALCULATION

By evaluating multiple binary segmentation tasks, it also avoid the problem of specifying misclassification costs for trading false assignments in between, for example, edema and necrotic core structures or enhancing core and normal tissue, which cannot easily be solved in a global manner.

A. Performance Scores

For each of the three tumor regions ie obtained a binary map with algorithmic predictions P ∈ {0,1} and the experts' consensus truth T ∈ {0,1}, and it has been calculated the well-known Dice score,

$$\text{Dice (P, T)} = \frac{|P_1^{T_1}|}{(|P_1|+|T_1|)/2}$$

where^ is the logical AND operator,|.| is the size of the set (i.e., the number of voxels belonging to it), and and represent the set of voxels where and , respectively . The Dice score normalizes the number of true positives to the average size of the two segmented areas. It is identical to the F score (the harmonic mean of the precision recall curve) and can be transformed monotonously to the Jaccard score. It also calculated the so-called sensitivity (true positive rate)and specificity (true negative rate).

$$\text{Sens (P, T)} = \frac{|P_1^{T_1}|}{|T_1|)}$$

$$\text{Spec (P, T)} = \frac{|P_0^{T_0}|}{|T_0|)}$$

V. CONCLUSION

Image processing techniques helps to detect the stomach cancer accurately with a lot of new way of techniques. The noises are filtered finely by homomorphic filter and enhanced the cancer image. The image segmentation deals with the accurate location of the cancer cell using the Region splitting and merging approaches. Thus the image processing has been used to save the human lives from the cancer .

VI. FUTURE ENHANCEMENT

The image classification analysis can be developed at the prediction of tissue labels with advanced segmentation. The preprocessing techniques are improved at the Slice co-registration, Bias field and intensity and bone stripping. The Map reduce model for the Hidden Markov Model (HMM) has been obtained at the multilevel analysis of the segmented images.

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