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Comparative analysis of active contour random walker and watershed algorithms in segmentation of ovarian cancer

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***Abstract* – In the recent era, Image processing has been one of the most commonly used domain in the field of medical science that includes different kinds of procedures namely extraction, image gaining, detection, surgical planning and presentation which indeed helps in giving effective treatment to the patient and using all those techniques, the disease could also be detected at a early stage. When it comes to the case of ovarian cancer, it could be treated successfully when detected at an early stage.**

As per the following statistics, it is very much important to identify the cancer in the ovaries at the starting stage. Today, there are many algorithms that are being implemented in order to detect the cancer i.e. by segmentation. Here are the three algorithms Random Walker, Active Contour and Watershed that are being implemented in order to segment the ovarian cancer. Finally, a comparative analysis is being performed to identify which gives a better result among the three algorithms.

Index Terms - Segmentation, ovaries, image boundary

I. INTRODUCTION

Cancer in the ovary is a kind of cancer that would be formed in the ovary, within no matter of time cancer spreads fastly and enlarge to other parts of the body. The multiplicity and the development of this cancer would lead to the continuous production of tumors.

One of the most fearful and concerning health problems in the world is ovarian cancer. There have been many reasons for the cause of ovarian cancer some of them are diabetes, high cholesterol, and obesity in the body.[7] That is mainly caused due to unhealthy lifestyle. The average age group of females who get affected by this condition is of the age 44.

The need for females to get awareness regarding this disease and take necessary precautions is very much important. As the treatment would become successful only if it gets detected at the early stages. As soon as the woman gets aged she is more prone to ovarian cancer. Ovarian cancer would usually go undetected at the initial stages and they would hardly show any symptoms during these starting days. As and when it gets complicated, some of the symptoms such as abdominal pain, severe kidney pain, loss of appetite, and loss of weight come into the picture. At times, it would also lead to a state of losing a life. In today's world, one of the leading and most common causes of death is due to ovarian cancer.

There are a lot of cases where either the cancer is detected at the last stage or further treatment would not produce the required results. To date, the doctors could not find a way to prevent ovarian cancer, but at the same time based on multiple research work over several years they have come up with different ways to keep cancer under control and take precautionary steps to follow to overcome ovarian cancer.

The paper has been arranged as mentioned below. Section II inculcates the Literature survey, Section III gives the details about the Methodology, Section IV tells about the Results and Discussions and Section V concludes the paper

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II. LITERATURE SURVEY

Jiwen Dong et al.[1] implemented an automatic segmentation method for immunohistochemical images based on the characteristics of ovarian cancerous tumours. The Otsu method was used to get objects that are different and are separated automatically according to the YUV colour space in difference with negative cells, positive cells, and their backgrounds. Later, the results were very efficient, reasonable, and simple with the algorithm. Devesh D. Nawgaje et al.[2] used the OTSU principle for image segmentation. In this Otsu method, the threshold was calculated without pretreatment of the histogram. The algorithm gave a unique and simple method to select the threshold. Andrew Janowczyk et al.[3] presented an accurate system by quantifying the stain on a vascular biomarker of tissue with microarrays. A supervised algorithm was used, i.e. hierarchical normalized cuts (HNCuts) to solve a problem of ovarian cancerous tissue of microarrays. HNCut was used to represent the structure of the data which also allows the merging of two algorithms of image segmentation which were powerful, they are weighted frequency normalized cut algorithms and mean shift algorithm. cuts were fastly used to traverse the hierarchy pyramid that was generated with the input image of various resolution colours that we're enabling the analysis of large images. Jianfei Liu et al.[4] has come with a TSMF (tumour sensitive matching flow), a unique methodology for identifying and matching the metastasis roles and classifying the framework of PDE. It includes the augments of TSMF by integrating an approach with the indexed shape to measure the deformation caused by metastasis, a Gaussian mixture to describe the model of intensity distribution caused by metastasis, and a TV flow which is a total variation to make the regions more enhanced that is caused by metastasis and TSMF vector controls the amount of propagation of level-set that are displaced.

K.Srilatha et al.[5] proposed a work of ovarian tumour segmentation with ultrasound images with a synchronous find of methodology with segmentation and pre-processing. Coming to the stage of pre-processing, Speckle Noise, Contrast Limited Adaptive Histogram Equalization (CLAHE), and Adaptive Anisotropic Diffusion Filter was used to improvise the adjustment of contrast ultrasound tumour images. In the next step of segmentation, tumours were segmented using FL-SNN Model and GrabCut algorithm. Later, for extraction of features from tumour images of ultrasound, a statistical feature of GLCM (Gray Level Co-occurrence Matrix) was used. Weight and Bias were the parameters that played a vital role in the segmentation of the ovaries.

Jiwen Dong,Jing Li et al.[6] presented the characteristics of the immunohistochemical images of ovarian cancer and used automatic segmentation. Initially, positive cells in an image were roughly brown or tan, and negative cells were purple or blue and had white colour as the background. The part of the image is cross-regional with colour space of R, G, and B and has the result of segmentation which is very crucial. Later RGB needed to be selected as a complete part which led to time- consuming computing that was large enough to be considered. Therefore, the image was divided into two categories along with the criteria of chromaticity.

Later, the ISODATA clustering algorithm was applied to the two different images that were new to extract or segment the area containing negative and positive cells.

III. METHODOLOGY

A. Materials and Methods

During this research work, in the images are being procured from SDM College of Medical Sciences and Hospital, Dharwad. A total of 350 images of benign CT images were used in this research work. The patients are priorly intimated about the study protocols and their consent was taken. The ethical committee has also approved the entire study and the place where this research was being carried out.
The images of patient who was suffering from ovarian cancer at the initial stage and the images of the patient who was suffering from final stage of ovarian cancer were taken into the research work.

B. Architecture of Proposed framework

The required outputs are being obtained with the help of scikit image which is an image processing and python based library.[9] The language used to implement the algorithm in python. [8]Different techniques of supervised-based segmentation have been used to segment the tumour from the original image. The three different segmentation techniques used here are Active Contour, Random walker, and Watershed which work on different principles.[12] Explaining about Active contour, a small part of the tumour is segmented by the algorithm and simultaneously the points of the image are defined and the snake is initialized. Further, the coordinate points x, and y are calculated using the circle boundary.[10] Hence, the tumour is segmented mainly based on two parameters that are alpha and beta. The higher the alpha value, it decreases the snake value. Simultaneously, beta makes it smooth and even. Coming to the case of a Random walker, a huge number of pixels initialize the labels. The algorithm expects labeled images and further calculates probability and obtains the segmented image of high quality. The segmented region can be improved by making changes in the parameters of beta to obtain the required tumour. To implement the watershed algorithm, MATLAB is being used.[11] The original image is made to pass through the algorithm. Initially, the image is filtered, later the tumour is detected and the outline of the tumour is observed finally the tumour part is marked and detected as the output. Figure 1 shows the represents Proposed framework of this research.[16][17][18].

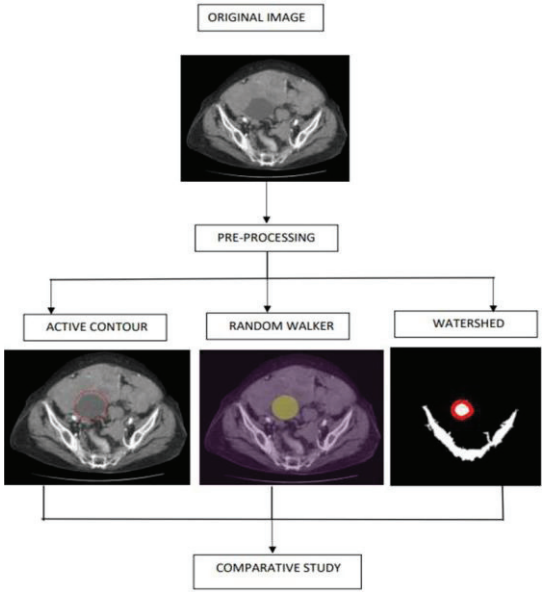

Figure. 1. Proposed framework

C . Algorithm

1. Active Contour Algorithm [23][24][25]

Active Contour algorithms are mainly known as snakes. It initially starts with a pre-defined contour and then would continue slowly with a line contract and at the same time contracts, later on, it would even attract or even repel off lines and edges.[13] For example, In the results, we can notice that a circle is being drawn that is surrounding ovarian cancer i.e. initialization. After initialization, the algorithm segments the raised portion of the image by choosing a mere circle to the boundaries of the tumour. It is the type of methodology for procuring the necessary outline of the image. Internal and external energies are taken into consideration. The main criteria to choose the expression that belongs to the external energy is that its expression must be minimum at the image boundary.[17] Whereas the expression for internal energy is the result of summation of contour that is continuous and which is also smooth. In the first stage, the outline of the image is marked as a curve that is parametric by the algorithm. Later, the curve is with the energy function. The main issue known as the energy minimizing problem is the process of finding out the boundary of the given image.[14] The snake follows certain criteria to choose the kind of gradient. For example, it would choose a gradient of higher intensity only if there is a proper gradient reflection to the image boundary or else it would choose a smoother boundary by correcting the missing gradient present in that region.

2. Random Walker Algorithm[7]

Random Walker Algorithm, coming to this algorithm we use something called labels that are nothing but labeled pixels of numbers that are in a small range, A pixel is considered to produce a random walker if it is not labeled. Taking this as evidence we can determine random walker probability starting from unlabelled pixels to pre-labeled pixels.[15]The calculation of probability is done by associating every pixel to the label and hence a segmented image of high quality could be obtained as a final result.[18][26][27] The algorithm would usually look out for a labeled image as the initial input and further by providing a larger circle that consists of the major part of the tumour and the minor circle in the region of the tumour.

3. Watershed algorithm:

Here, the watershed algorithm usually visualizes a grayscale image as a kind of topographic surface and considers high intensity as hills and peaks whereas it considered low intensity as valleys. Initially, it starts filling every independent valley with different labels as and when it raises based upon the nearby gradients as obvious water from different colours would start to combine.[20][28][29]. To overcome this situation, the algorithm builds a kind of barrier in all the places where water combines. Hence, the important work of filling up of water and building barriers until each peak point is below the water. Finally, the barriers that have been created produce the segmentation result.

IV. RESULTS AND DISCUSSIONS

Concentrating on the results obtained after implementing the three algorithms, the following images shows the final result of the implementation of the three algorithms. The results of the Active Contour algorithm are represented in Figures 2a, 2b, 2c, and 2d. The results gained from the Random Walker algorithm are Figures 3a and 3b. Figures 4a and 4b represent the result of the Watershed algorithm. Hence from all three results, we can see that Watershed and Random Walker gave the efficacious result and among those two we could notice that Watershed showed more accuracy.

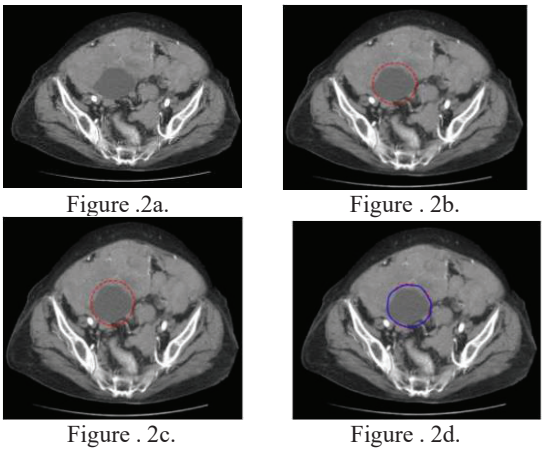

Figure .2a. Figure . 2b.

Figure . 2c. Figure . 2d.

Figure 2: Results of Active contour Algorithm

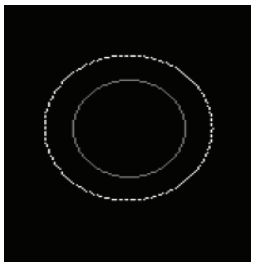

Figure .3a.

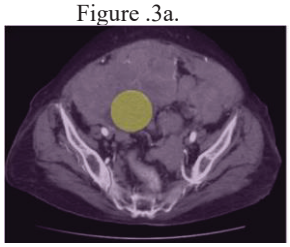

Figure. 3b.

Figure 3: Results of Random Walker Algorithm:

Figure. 4a.

Figure. 4b.

Figure. 4c

Figure 4: Results of Watershed algorithm

V. CONCLUSION

We were satisfactorily able to apply the three algorithms Random walker, Watershed and Active Contour in order to find the cancer in the ovaries. With the help of human eye, the results were being compared manually. Watershed algorithm was able show more accurate results compared to other algorithms. We would also like to come up with more algorithms and carry forward, this research work in the coming future.

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