GRAPH CUTS AND ORIENTED ACTIVE APPEARANCE MODELS BASED SEGMENTATION USING CT SCAN IMAGES FOR EARLY DIAGNOSIS OF LUNG CANCER

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ABSTRACT

Introduction: Lung cancer is one of the most common severe diseases in human healthcare. The digital chest film in lung cancer database is divided into normal, benign and malignant. The normal ones indicate healthy patients (non-nodules) and can either benign (non-cancerous) and malignant (cancerous).

Aim: Segmentation divides the image into various parts and used to identify the substance or other relevant information in digital images. The applications of segmentation are taken part in medical image processing, object detection, traffic control systems and surveillance systems.

Objective: In this paper, we proposed segmentation based method for lung lobes in computed tomography (CT) images. GC–OAAM (Graph Cut- Oriented Active Appearance Model) is implemented in this research paper to segment the lung cancer CT scan images.

Conclusion: There are three main phases involved in this proposed research work such as model building, object recognition and delineation and it is tested on the data sets collected clinically.

Keywords: Cancer Detection, Lung Segmentation, Active appearance model (AAM), Graph Cut (GC), Graph Cut-Oriented Active Appearance Model (GC–OAAM).

I. INTRODUCTION

Cancer is one of the major diseases faced by mankind. There are more than 100 different kinds of cancer including lung cancer, breast cancer, skin cancer, etc in the medical society. Cancer occurs due to the abnormal growth of cells¹. Lung cancer is one of the most common cancers. When it occurs, the cells in the lung grow abnormally. In most of cases, affected tissues spread out to nearby parts of the body and grow continually, and form a tumor in the new place².

Computed Tomography is a technology that uses computer-processed x-rays to produce tomography images of specific areas of the scanned object² for surgical planning in clinical settings read Computed Tomography (CT) images for using anatomical information from lung lobes, fissures, vessels, and Bronchi³. In general, image segmentation is based on some basic properties of intensity values like discontinuity and similarity. In Discontinuity, the image is dividing by based on intensity values, such as edges in an image. The similarity of the image is dividing into regions based on a set of predefined criteria. In this research paper, Lungs region can be segmented using Graph Cuts and Oriented Active Appearance Models.

II. OVERVIEW

Graph Cut-Oriented Active Appearance Model is introduced in this research work to segment the lung cancer by effectively combining the Active appearance model (AAM), Live Wire (LW) and Graph Cut (GC) techniques.
There are two phases involved in the proposed method: training and segmentation. In the training phase, the AAM based test image is constructed, the GC parameters and LW boundary cost methods are determined. The segmentation phase includes recognition and refinement process.

### III. PROPOSED METHODOLOGY

**A. Training phase**

In the training phase, the model is trained using AAM, Live wire and Graph Cut methods that are needed for the segmentation phase.

1. **Interpolation**

   In the field of mathematical and numerical analysis, interpolation is a methodology in which a range of the discrete set of known data points and new data points are constructed. Sampling or experimentation produces any numbers of data points that characterizes the independent variable from the value of a function for limited numbers. For the independent variables are having intermediate value, it is more likely needed to interpolate (i.e. estimate) the value of the given function. Curve fitting or regression analysis is used to achieve the function. The number of intermediate points between the two endpoints is improved by the interpolation technique and it is commonly used to fill the gaps in an image. The major application of the interpolation technique is employed in computer graphics.

   **Linear interpolation**

   Linear interpolation is simple and one of the easiest methods to understand and implement. A straight line (linear) relationship is assumed in-between two known points which essentially means that it averages the two rates in the interpolation period.

2. **Landmark specification**

   A three-dimensional shape is represented as two-dimensional contours & annotate the 3-D shape part by part manually. Either automatic or semi-automatic methods can access for annotating lung images by its simplicity, generality and efficiency but still, traditional landmarking process is used in clinical research. So, manual landmarking is using to annotate the lung cancer’s shape. In manual landmarking, from the displayed slices, prominent landmarks on each shape are identified by the trained operators. A semiautomatic landmarking, also known as equal-space landmarking is assessed by manual landmarking. It indicates the presence of tight correlation within the shapes encoded by the manual and semi-automated landmarking. Different objects consist
of a different number of landmarks based on their size. Though A thousand of million literatures in the evaluation of impression of distribution landmarks on segmentation results and model building, repeating these experiments is repeated, but the equal-space labelling method of manual landmarking is validated.

The number of mouse clicks required is based on the image size and shape. The total cost structure associated with all the landmarks may now be defined as,

\[ K(x) = \Sigma (X_k, X_k - 1)m_k - 1 \]

where ‘m’ is the number of landmarks of the region of interest

![Figure 1. Output of landmark Specification](image)

After choosing the region of interest and extracting the particular region, ground truth for that lung is done. Ground truth is a set of measurements which is much more accurate compared to measurements from the system which is to be tested. It is used to refer the absolute truth of the given image. The input image is interpolated and converted into gray scale image and then into a binary image. To extract the region of interest, the boundary values of that region are identified and set as a threshold for the ground truth to be done.

![Figure 2. Output of groundtruth and boundary element construction](image)

3. **Active Appearance Model construction (AAM)**

Active Appearance Models (AAMs) is one of the techniques to interpret or segment images and it has been in computer vision research in the last few decades. The image is matched based on that the current residuals that are calculated and used with the model that predict changes to the current parameters for a better fit. Little iterations are made to obtain a good overall match even starting from poor estimates. An AAM algorithm plays a major role to detect objects in many deformable images. The AAM algorithm makes use of the difference between the
available estimation of appearance and the target image to lead an optimization process. The AAM model takes advantages of the least square techniques that help in matching to new images.

B. Segmentation phase

The segmentation phase includes the recognition and delineation. In the recognition part, the test image (input image) is localized and the object recognition by GC-OAAM is performed and the shape is refined. In the delineation part, GC-OAAM is done and the region of interest is segmented.

Figure 3. Output of segmentation phase

Mean Distance to the Segmentation Results of the proposed method is in the following table 1.

Table 1. Mean Value

<table>
<thead>
<tr>
<th></th>
<th>Normal Left</th>
<th>Diseased Left</th>
<th>Normal Right</th>
<th>Diseased Right</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean</strong></td>
<td>0.9751</td>
<td>0.97399</td>
<td>0.9767</td>
<td>0.967</td>
</tr>
<tr>
<td><strong>Std</strong></td>
<td>0.0042</td>
<td>0.0069</td>
<td>0.0061</td>
<td>0.0049</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>18.64</td>
<td>19.33</td>
<td>21.56</td>
<td>20.99</td>
</tr>
<tr>
<td><strong>Std</strong></td>
<td>5.50</td>
<td>5.832</td>
<td>9.00</td>
<td>5.501</td>
</tr>
</tbody>
</table>

IV. CONCLUSION

The GC-OAAM method integrates the LW, AAM and GC ideas are effective to exploit their complementary strengths. It consists of training phase as well as the segmentation phase. The data set for the lung cancer images is collected and it is interpolated using linear interpolation technique. Then the interpolated output is given to the landmark specification to choose the region of interest. The region of interest part is then ground truth and boundary element is constructed. The AAM model is constructed using Livewire, Graph cut and AAM method. In the segmentation phase, the input image is tested with the trained image using IGC-OAAM technique and the region which matches with the trained image is segmented. By combining these three methods, the segmentation accuracy (true positive volume fraction TPVF and false positive volume fraction FPVF) is increased.

REFERENCES