

NOVEL SIMULINK MODEL FOR DETECTING LIVER TUMOR USING MULTIPLE THRESHOLD METHOD

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Abstract: Liver cancer is a pathological disorder of human, huge number of people are been affecting with liver cancer worldwide. The early detection and diagnosis of abnormal part of liver tissue, helps the physician for curing at early stage. Medical imaging is the trending area in the field of scientific imaging. Medical image segmentation is a tedious task for extracting tumor from liver tissue due to close similarity with neighbourhood organs. Liver tumor segmentation can be achieved using various methods, but their implementation requires high level language for coding. This objective lead to the use of a graphical dataflow based programming environment within Matlab, which is Simulink, which is very easy to handle with other software and also used for real-time implementation. In this paper a novel simulink model for detecting liver tumor using multiple threshold method is proposed. The proposed methodology is facilitated by using a median filter as a image pre-processing step, followed by multiple thresholding and finally tumor is extracted by applying most elementary morphological operations like erosion and dilation as post-processing. Dataset of CT scan liver tumor images used for testing the proposed simulink model. Finally area of perfectly extracted liver tumor is evaluated as a performance analysis using computer vision toolbox of simulink blockset.

IndexTerms - Medical Imaging, Segmentation, Simulink, Multiple threshold method, computer vision toolbox.

I. INTRODUCTION

Liver is the largest organ in the abdomen region, with many vital functions like protein synthesis, detoxification and helps in metabolic activities. It regulates biomedical reactions such as breakdown of complex molecules, produces bile, acts as an alkaline compound aids in digestion. Tumor is referred as abnormal growth of the tissue, detection and segmentation of liver tumor is difficult due to reasons like large variations in geometric properties of liver shape and size and its close similarity with nearby organs. In such case manual extraction of tumor leads to misdiagnosis. Therefore model is designed to segment out tumor part automatically from CT scan liver tumor image using simulink. Various imaging techniques has been adopted to detect abnormalities in liver. The imaging techniques are CT (computed tomography), MRI (Magnetic Resonance Imaging) and PET (Positron Emission Tomography).By using these three imaging techniques the anatomical structure of the organ is studied, mostly CT scan is commonly used for abdominal organs, which provides precise data about shape, size and position of liver tumor. Tumor may be either cancerous or non-cancerous.

Segmentation [2] refers to partitioning an image into segments, it is an essential step in medical imaging. The main aim of segmentation is simplification i.e. representing an image into meaningful and easily analyzable way. Image segmentation is necessary, and it is first step in image analysis. The goal of image segmentation is to divide an image into several parts/segments having similar features or attributes. There are many segmentation methods for extracting liver tumor, automatic and a semi automatic type. A great segmentation will benefit physicians because it will give important information for surgical planning or early detection of diseases/tumors.

Simulink, a model based design for processing, a graphical representation of MATLAB toolbox, it has ready-to-use blocks for modelling, simulating and analysing the models. Simulink, a add-on to MATLAB and a tool for rapid design, prototyping, graphical simulation. It is a multi-domain dynamic system since it has many toolbox like computer vision, control system, DSP toolbox etc. In simulink the model focuses on processing an image pixel by pixel and in modification of pixel neighbourhoods can be applied to the entire image. It has a special feature like efficient code generation, HDL coder and block sets can be used in conjunction with real-time workshop to automatically generate embedded C code for real-time execution. Simulink simply acts as interface between software and hardware, prior to hardware implementation software or models are been simulated with proper simulation stop time and solver types in simulink environment.

II. RELATED WORK

Sagir Lawan and CL Wamdeo [1] proposed image recognition using MATLAB simulink blockset to detect selected object from the crowd is presented. A unique simulink model is designed for recognizing objects of interest in an image using morphological

operations. This model can be used in emergency and search-rescue operations, security, surveillance etc., But the threshold and morphological strel functions defined in this model were not suitable to extract object of interest in all images.

Ina Singh [3] addresses a study of effective segmentation techniques for liver segmentation. A survey on various segmentation techniques like region growing, K-means clustering, Level set method, Adaptive thresholding, Ostu thresholding, region splitting and merging for segmenting liver from abdominal CT scan image has been made. This paper concludes by showing a comparative table of different segmentation techniques and it suggests ant colony optimization based K-means algorithm has to be chosen for future work to get optimized clusters.

Priyanka Kumar and Shailesh Bhalerao [4] explained about detection of tumor in liver using image segmentation and registration technique. This paper describes about automatic diagnosis of liver cancer detection using fuzzy logic and Neuro fuzzy image segmentation algorithms using IF-THEN fuzzy rules. Finally the tumor has been detected using both CT and MRI images using MATLAB R2012b.

M.Jayanthi and Dr.B.Kanmani [5] discussed an approach for segmentation of liver and tumor from CT scan images, which is mainly used for computer aided diagnosis of liver. The proposed method in this paper is region growing with optimised threshold algorithm, where liver is segmented using region growing by proper selection of seed point and tumor is extracted by applying threshold and morphological operations.

Even though there are enough segmentation techniques in literature survey for segmenting out the liver tumor, all those methods till date are been implemented using manual coding like MATLAB,C,HDL or any other and their execution is time consuming process. Moreover when the image size increases coding becomes quiet difficult, slow operation and not much effective for real time applications. Therefore proposed methodology involves, a model based design for liver tumor segmentation that is multiple threshold based simulink model for extracting liver tumor.

III. PROPOSED METHODOLOGY

The entire process of liver tumor segmentation goes through three phases which are explained as below:

- Image Pre-processing blocks.
- Multiple threshold blocks.
- Image Post-processing blocks.

The model based design for liver tumor segmentation using threshold method is shown in Fig.3.1

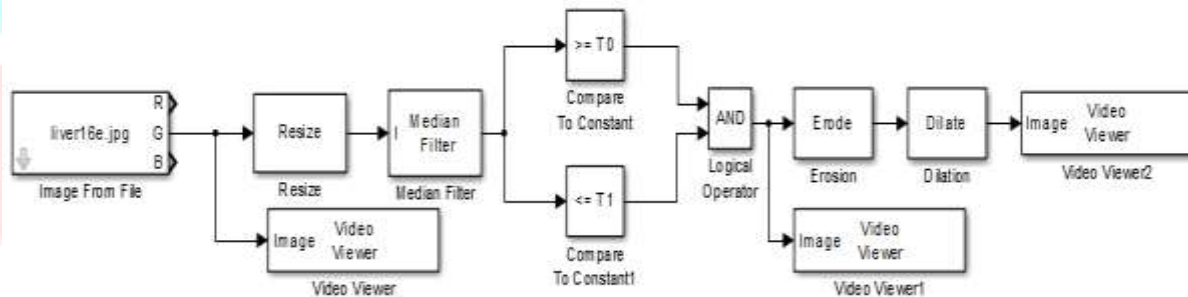


Figure 3.1: Simulink model for liver tumor segmentation using multiple threshold

3.1 Pre-processing: The pre-processing unit in this paper involves blocks like input image from file, resize block and a median filter block. Input CT scan liver tumor image is read from image from file block, the image can be taken as either one-multi dimensional or separate, as RGB component. Here green channel component is considered for further processing from image from file block. Resize block [7] either enlarge or shrink image sizes by resizing the image along one dimension (row or column). Then, it resizes the image along the other dimension (column or row). This block supports intensity and colour images on its ports. Median filter block perform 2-D median filtering. In general any medical image is corrupted by noise, mainly speckle noise due to many reasons like image acquisition techniques, environment etc. The median filter block replaces the central value of an M-by-N neighbourhood with its median value. As a result, the median filter block can remove salt-and-pepper noise from an image without significantly reducing the sharpness of the image.

3.2 Multiple threshold method: Threshold method is the simplest method for image segmentation. This method divides the image pixels with respect to their intensity level. There are many types of threshold methods. Multiple threshold method is consider, which contain multiple threshold values like T0 and T1. By using these, output image can be obtained. The values of thresholds can be computed with the help histogram analysis. The simulink blocks used to compute this thresholding are compare to constant block and logical operator AND. The main aim of using multiple threshold instead of single is, it results the tumor with more precise and accurate. Various image threshold outputs are shown in table 4.1.

3.3 Post-processing: The morphological operations like erosion and dilation are used as post-processing blocks in simulink. The output of extracted tumor is displayed using video viewer block. Different structuring elements has been used for erosion and dilation .Finally tumor is segmented, outputs are shown in table 4.1.

3.4 Parametric analysis of extracted tumor: Figure 3.2, shows the simulink model for area evaluation of segmented tumor. To know the exact tumor location and its characteristics then study of statistical parameters are necessary. Blob analysis block computes statistics for labelled regions only for a binary image, if the image is not binary it is converted by using data type conversion block .In this paper Tumor area is being evaluated using this block. Here area represents number of tumor pixels in an image and results are shown in table 4.2.

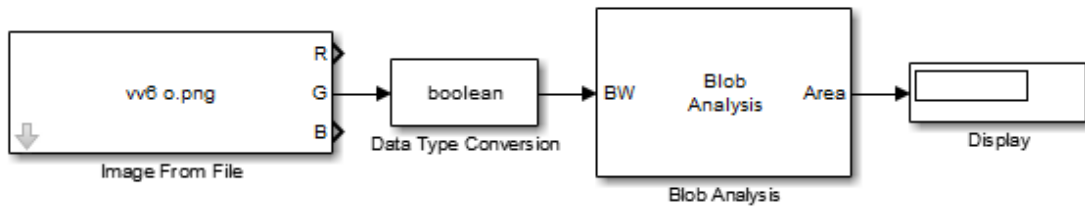


Figure 3.2: Simulink model for area evaluation of segmented tumor

IV. RESULTS AND DISCUSSION

Dataset of liver tumor CT scan images selected, with different tumor size and structures for analysing multiple threshold method. The experimental analysis is carried out in SIMULINK (MATLAB 2012b) on PC of 64-bit Operating system with AMD processor (2.00 GHz 4GB of RAM).Models in simulink are tested with suitable simulation time (here 10 sec) and solver type. The input CT scan images with tumor and output extracted tumor image and also intermediate output threshold image are tabulated for a few CT scan liver tumor images among several images in dataset, shown in table 4.1.Results of parametric analysis of extracted tumor from CT scan liver images are also been tabulated in table 4.2.From table 4.1,the observed fact is that the tumor with larger size (here S.no.2, 3,4 images) are been perfectly segmented using this novel simulink model than that of tumor with comparably small size. From table 4.2, it is clear that area of segmented tumors (S.no.2, 3, 4) are larger than other, which justifies the above statement. The other statistical parameters like 2-D mean, variance and standard deviation can be evaluated for studying tumor characterization, which is further analysis to this paper.

Table 4.1: Video viewer outputs of simulink model for liver tumor segmentation using multiple threshold method

S.no	Input CT scan liver tumor image	Output of multiple threshold block	Tumor segmented image
1			
2			

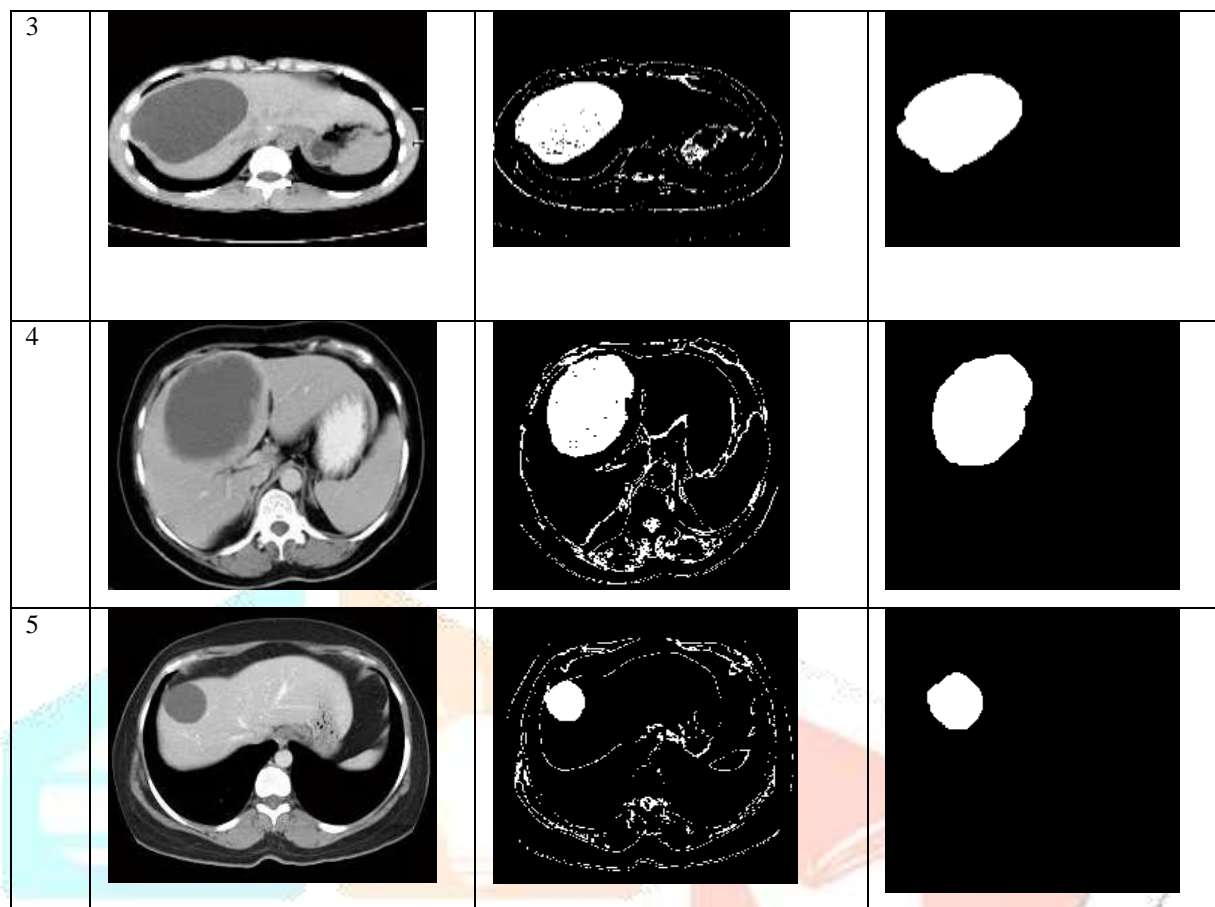


Table 4.2:Area of a tumor in final segmented image.

Image S. no	1	2	3	4	5
Area (no. of pixels)	8153	2.004e+04	2.904e+04	2.708e+04	6678

V. CONCLUSION

It is observed that the novel simulink model for extracting liver tumor using multiple threshold method gives best results for tumors with larger area and segments tumors of smaller size too. The use of multiple threshold method for extracting liver tumor by using simulink blocks like compare to constant and AND operator makes this model novel. Also innovative usage of Blob analysis block for area evaluation makes this model quiet different and peculiar. This simulink model using multiple threshold segmentation method for liver tumor detection is simple and effective; it can also be extended to other segmentation techniques. Apart from that simulink has the advantage of generating automatic HDL code, useful for hardware implementation and thereby this model can be used for real time applications.

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