Analysis of small tumours in ultrasound breast echography

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Abstract. Breast ultrasound can image several different types of breast conditions, including both benign (non-cancerous) and malignant (cancerous) lesions. Ultrasound is frequently used to evaluate breast abnormalities and allows significant freedom in obtaining images of the breast from almost any orientation. Due to strong overlap of benignancy and malignancy in ultrasonic images and subjectivity of interpretation the digital processing of the images is a useful tool for an accurate and reliable diagnostic second opinion for physicians. This paper presents an analysis of small tumours of ultrasound breast using the methods: correction for non-uniform illumination, thresholding to create a binary image, counted method, measurement each tumour of ultrasound breast and build an array. It is concluded that a considerable amount of new, potentially useful clinical information can be revealed from ultrasound using image analysis approach proposed. These methods offer information about the characteristics of the small tumours and easily compute statistics for all the small tumours in the image.

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1. Introduction

Using an ultrasound of breast, we present the ways to enhance an image to correct for non-uniform illumination, and then use the enhanced image to identify individual small tumours.

Binary image is a digital image that has only two possible values for each pixel , black or white. [1]

Most binary image algorithms work with groups of pixels called neighbourhoods. A pixels neighbourhood is some set of pixels, defined by their locations relative to that pixel. The neighbourhood can include or omit the pixel itself, and the pixels included in the neighbourhood are not necessarily adjacent to the pixel of interest. Different types of neighbourhoods are used for different binary operations[2]

If a pixel is near the border of an image, some of the pixels in its neighbourhood may be missing. For example, if the neighbourhood is defined to include the pixel directly above the pixel of interest, then a pixel in the top row of an image will be missing this neighbour. In order to determine how to process these pixels, the binary image functions pad the borders of the image, usually with 0s. In other words, these functions process the border pixels by assuming that the image is surrounded by additional rows and columns of 0s. These rows and columns do not become part of the output image and are used only as parts of the neighbourhoods of the actual pixels in the image. However, the padding can in some cases produce border effects, in which

the regions near the borders of the output image do not appear to be homogeneous with the rest of the image. [2]

Thresholding is the simplest method of image segmentation. From a gray scale image, thresholding can be used to create binary images. [3]

According to Ch.Hima Bindu the threshold segmentation is wildly used in many fields because of its simplicity and efficiency. Thresholding is a technique frequently applied to image segmentation. Its basic objective is to classify the pixels of a given image into two classes: those pertaining to an object and those pertaining to the background. For the image with clear objects in the background, the bi-level thresholding method can easily divide the object from the background. But to segment complex images, a multilevel threshold method required. The multilevel threshold segments the pixels into several distinct groups in which the pixels of the same group have grey levels within a specific range. However, when the thresholding method is extended to multi-level thresholding, the computation time grows exponentially with the number of thresholds.[1]

For processing ultrasound image we used the methods and tools from application Matlab the package Image Processing Toolbox [2]

We are used the functions which count, return the area of the objects on binary image. The area is a measure of the size of the foreground of the image; the areas are the number of pixels in the image.

2. Binary image processing in Matlab

Binary images have a very specific meaning in MATLAB. A binary image is a logical array of 0s and 1s. In a binary image, each pixel assumes one of only two discrete values. Essentially, these two values correspond to on and off. A binary image is stored as a two-dimensional matrix of 0s (off pixels) and 1s (on pixels) [4].

A binary image can be considered a special kind of intensity image, containing only black and white. Other interpretations are possible, however; you can also think of a binary image as an indexed image with only two colours. A binary image can be stored in an array of class double or uint8. However, a uint8 array is preferable, because it uses far less memory. In the Image Processing Toolbox, any function that returns a binary image returns it as a uint8 logical array. The toolbox uses the presence of the logical flag to signify that the data range is [0, 1]. If the logical flag is off, the toolbox assumes the data range is [0,255].

Looking at an image in this way makes it easier to distinguish structural features. For example, in a binary image, it is easy to distinguish objects from the background. Thus, an array of 0s and 1s whose value are data class, say unit8, is not considered a binary image in MATLAB. A numeric array is converted to binary using function logical, thus, if A is a numeric array consisting of 0s and 1s, we create a logical array B suing the statement [4]:

$$A = logical(B), \qquad (1)$$

If A contains elements other then 0s and 1s, use of the logical function converts all nonzero, quantities to logical 1s and all enters with value 0 to logical 0s [5]. In the Image Processing Toolbox, a binary image is stored as a two-dimensional matrix

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[1]Ch.Hima Bindu, AN IMPROVED MEDICAL IMAGE SEGMENTATION ALGORITHM USING OTSU METHOD, International Journal of Recent Trends in Engineering, Vol 2, No. 3, November 2009

of 0s (which represent off pixels) and 1s (which represent on pixels). The on pixels are the foreground of the image, and the off pixels are the background. Binary image operations return information about the form or structure of binary images only. To perform these operations on another type of image, you must first convert it to binary [4].

An arbitrary binary image object (or structuring element) A can be represented as [6]:

$$A \leftrightarrow \sum_{i=-\infty}^{\infty} \sum_{j=-\infty}^{\infty} a[i,j] \bullet \delta[m-j][n-k] \tag{2}$$

where Σ and $\bullet$ are the Boolean operators OR and AND . a[j,k] is a characteristic function that takes on the Boolean value 1 and 0 as follows:

$$a(i,j) = \begin{cases} 1 & , a \in A, \\ 0 & , a \notin A. \end{cases} \tag{3}$$

And $\delta[i,j]$ is a Boolean version of Dirac delta function that takes on Boolean value 1 and 0 as follows:[4]

$$\delta(i,j) = \begin{cases} 1 & , i = j = 0, \\ 0 & , otherwise. \end{cases} \tag{4}$$

3. Experiments and resultants

The ultrasonic images are captured at the largest diameter of the tumour. Sonography is performed using the scanning systems namely, SLE-401 with a linear-array transducer with a frequency of 5 MHz. We utilized a generally used computer (Hewlett Packard 2008) and software (MATLAB 7.8.0-R2009a, The Math Works, Natick, USA) to analysis the breast image. In the field of analysis and processing of medical images a variety of technologies have been introduced enabling improved quality and sensitivity for the representation of human organs and tissues [3].

Using an ultrasound image of the breast we enhance this image to correct for non-uniform illumination, and then use the enhanced image to identify individual small tumours. In this way we analyse the characteristics of the small tumours and easily compute statistics for all the small tumours in the image

The original image from figure 1.a was adjusted with a method by increase the contrast image so we obtained the image from figure 1.b. In this image we removed the background noise, displayed in figure 1.d. In next stage we are created a new binary image, by thresholding the adjusted image, removes from a binary image all connected components (objects) that have fewer than p pixels, producing the binary image, in figure 1.c. The image from figure 1.c was obtained substracting background noise from figure 1.d.

4. Conclusion

The presented image processing system implements a method to measure the area of small breast tumours using ultrasound image. Creating a binary image by thresholding the adjusted image and increase the image contrast obtaining a quality image where the small tumours which have white colour are very well outlined.

The area of the tumours are contained in the vector V, in descending order and we notice that this ultrasound image contains one big tumour, over 14 small tumours
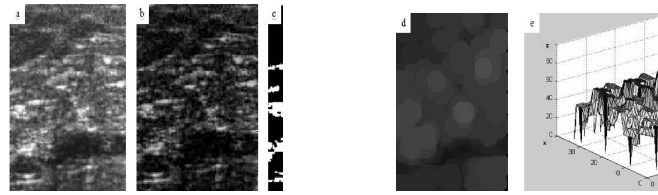
FIGURE 1. a. Original image, b. Image with increase contrast, c. Binary image, d. Background image e. Outline of background illumination

with mean areas and very small tumours in the rest. The tumours which have the dimension between 1 and 20 pixel can be cancerous cells.

This study can be that double response to assist patients at risk of malignant tumours because this method measure and it can monitor with accuracy area tumours.

Future work based on this study could include the incorporation of more methodologies suitable for image processing and analysis of ultrasound images in a system CAD.

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