EARLY CANCER DETECTION

Dang Dinh Tuan

School of Electrical & Electronic Engineering
Nanyang Technological University
E-mail: dangdinhluan@yahoo.com

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Abstract

In this paper, the general knowledge of cancer and detection methods will be discussed first. Computer-Aided software; which is running in Matlab, is helpful for doctors to detect cancerous areas. This software will display six helpful images to aid doctors to detect cancers. The histogram equalized image enhances the contrast and shows out the real boundary of the breast. The reduced noise image will give a smoother image of the breast; which is a medium stage before the final image is shown. The final image contains the best image of breast together with its detected high risk (cancerous) areas. Last but not least, a website with all information about cancers and its detection is launched for the interests and benefits of the public.

1 Introduction

In this modern life, human beings are living a life style which is very different from their healthier “natural” lifestyle. Pollution which comes in many forms, namely chemical toxic, radiation, noise, etc…, are harmful for human health. Furthermore, people are forgetting their healthy lives with lots of exercises, fruits, vegetables, natural food… As a matter of fact, the number of people having cancers has increased by time. And new kinds of cancers also appear with increasing level of harmfulness. Early cancer detection becomes a crucial matter when the recent medical achievement can cure more than 80% of all stage 1 cancers. The project requires much knowledge of Medical Diagnosis, Radiology, Image Analysis in Computed Tomography, Image Processing and Web design.

2 Theory

2.1 Kinds of Cancer

Cancer can appear everywhere in human body. For research and study purpose, it is divided into 6 categories:

- Lung cancer: the rate of lung cancer is decreasing by time. Most of cases of lung cancer are found to be connected to smoking.
- Breast cancer: which mostly occur in female due to the hormone. The numbers of breast cancer increase by time and accounting for 32% of all female cancer. The Survival rate at 8 years is varied from 90% for Stage I, 70% for Stage II, 40% for Stage III and only 10% for Stage IV. So it is crucial to detect the cancer as early as possible.
- Gastrointestinal cancers: are fatal in the vast majority of cases and contribute to the most common cancer in the world. Life style (foods, cooking, exercises) and toxic chemical are believed to be main causes.
- Genitourinary malignancies: most likely connect to male. Prostate cancer is the most common cancer in US man.
- Skin cancer: it is believed to be caused by the thinner of the ozone, the direct and long contact with UV and chemical. The numbers of skin cancer increase sharply and contribute to one third of all cancerous cases.

2.2 Methods of Detecting Cancer:

There are four most common methods to detect cancer early:

- CT Scan is a very popular method all over the world. It is a relatively cheaper examination comparing to the others. It is used to examine the damages on all over the body. Although it has limitation in scanning the head and brain; the process is fast, cheap and the image is acceptable in quality.
- MRI is evaluated by the specialist to be more advanced and have better quality of image. MRI can give a 3-D image which can show some of the hidden parts of the body that cannot be scanned in the CT scan method. A better quality image helps the radiologist easier to interpret the result. Moreover, MRI is considered harmless in the sense of radiation. MRI works well with tissue and it can detect damages in brain. In conclusion, MRI is a better method who can replace CT Scan in the near future.
- Mammography is a special case of CT Scan who adopts X-ray method. Mammography uses the high resolution film so that it can detect well the tumors in the breast. Low radiation is the strength of this method. Mammography is especially used only in breast tumor detection.
- PET comes latest in the radiology field. It uses a completely different approach to detect cancer; it uses radioactive material. As discussed above, PET detects the gamma rays which are released during the absorption of radioactive material embedded in sugar/water of the cells. Cancer has a greater rate of growth and requires a lot more energy so it will use up more sugar/water and release higher gamma rays which appear darker in the image. PET is considered to be very reliable to detect cancer. However, PET still has some limitations, for instance, it is a very expensive examination and requires close supervision (due to working with radioactive materials) and the results depend on the chemical balance of the patient (imbalance caused by diabetics or liver malfunction). As a result of expensive process and machine, PET is not very popular and is applicable only in large institutes to some countries.

3 Proposed Procedure

In real life, doctors and radiologists have limited time to deal with a huge load of work. Human errors and mistakes can take place and cause wrong diagnosis when reading blur or low quality film/image of the patient. Computer-Aid is a solution for fast and accurate diagnosis. A five-step procedure shows how the cancerous areas together with six enhanced quality images can be detected.

3.1 Importing the Image

In CT-Scan, MRI, PET and Digital Mammography methods, the image will be stored in the hard-disc of the machine. We can connect a parallel communication gate from the machine, which is supported by vendor, to the computer and copy the image as bitmap files. The bitmap files will be captured by the Matlab function – Imread – for subsequent execution.

In Conventional Mammography method, the film is directly developed after the examination. We can use the scanner to scan the negative film and export it to the computer. The quality of the image will depend very much on the resolution of the scanner. The procedure will be similar to above mentioned method.

3.2 Processing the Image

3.2.1 Enhancing the Contrast and Quality of the Image:

Normally, the image’s histogram is dense in one side of the spectrum as shown in Figure 1. This will cause the image to be very dark or very bright, different parts of the image with different grey intensity will not be well-detected by eyes. Spreading out the spectrum of the histogram (Figure 2) will enhance the contrast of the image. Normal eyes can now detect the full scale of the grey intensity easily.

The manipulated image (Fig. 4) is clearer than the original image (Fig. 3). In addition, the real boundary of the breast appears clearer, so the position of the cancer is detected more accurately. However, the noise appears on the black background. To solve this problem, we proceed to next stage which involves reducing noise.

3.2.2 Reducing Noise

The noise that we obtained from Fig. 4 can be reduced or smoothened by using the two dimensional linear filter. It filters the data in Ihist (Fig. 4) with the two-dimensional FIR filter in the matrix fspecial ('average',20). This function computes the resultant Inoise (Fig. 5), using two-dimensional correlation, and returns the central part of the correlation that is the same size as Ihist (Fig. 4).

In Figure 5, the cancer area is still bright and distinct from the surroundings. The vessels tend to mix to the others and become darker. However, noise filter requires a lot of calculations. This process takes minutes to complete. To fix this disadvantage, more RAM should be added in the computer.

3.2.3 Filtering Out the Cancerous (High Risk) Areas

Cancerous areas will normally appear as a brighter round shape in the image. So we can use a threshold filter to distinguish the bright area and the darker areas. The level of threshold is obtained by trial.
3.2.4 Reversing Color and Showing Cancerous Areas in the Image

After thresholding to figure out the high risk areas, these areas should be embedded on the image in order that the doctor can know the position of the cancer. Immultiply function is used to multiply two images together. Two multiplied images must have the same class and size. Inoise (Fig. 5) is double array class. It is essential to change the class and size of Inoise back to uint8 class.

In Matlab, black color is coded as 0 and white color is coded as 1 in logical (binary) image. Hence, we need to change or reverse the color of Ithres (Fig. 6) in order that the black background does not neutralize the whole image after multiplication. It is required that we have to reverse the color of Ithres (Fig. 6) to be complemented Image Icom (Fig. 7). The multiplied Image Imul (Fig. 8) is the result of multiplying Inoise8 (Fig. 5) by Icom (Fig. 7).

3.3 Displaying Results

On consultation with doctors and technicians, their most concerns about the image are Ihist (contrast enhanced without noise reduction), Inoise (noise reduced), Inoisecom (complemented image of Inoise), Icom (complemented image of Ithres), Imul (the resultant image with cancer detected). Comparisons of pairs I (original image) – Ihist (Fig. 10), Inoise – Inoisecom (Fig. 11), Inoise – Imul (Fig. 12) are extremely helpful for doctors to make decisions. Anyway, a multi-frames figure with all six interested images (Fig. 13) is also provided for reference.

After consulting experts, the complemented Image of Inoise (Inoisecom) (Fig. 9) giving the doctors a feeling of real transparent breast is developed. It is easier to interpret the complemented image rather than the negative image as appeared in film because it shows clearer the connections among vessels and cancer’s roots in the breast.
4 Further Discussions

There are many other approaches to detect cancerous areas. This project makes use of Matlab in image processing and has shown promising results. There is still a big room in the area of accuracy of detection methods. For example, the text and the noise of examination process can be filtered; or before being added to breast image, the threshold image is colored so that a colorful image can be obtained.

For now, another algorithm to detect the cancerous areas will be discussed. In this project, the threshold method is used to filter out the cancer. As the knowledge in part D (Theory), cancer often appears to be round shape, bright color and has a relatively bigger size than text and noises. So one can develop an intelligent software to detect cancer. In Matlab, the image is coded as a matrix whose value of the element is the intensity of each point (pixel). Based on this, we can divide the image to many groups of pixels which contains pixels of similar intensities. The small areas (appear to be noise and text) can be deleted and this leaves only the interested cancerous area.

Another approach is the so called “Find and Grow” method. The algorithm of this method is shown below:

Firstly, we will scan pixels by square detector (the size of the square is set according to standard size of cancer) horizontally. After one scan, the square detector will increase its vertical value to move to the next row. Once the square detector finds the area that has the intensity level falling in its interested range and covers the entire detector, it will grow until all the above requirements are satisfied. Then the detector will make a mark on this area and continue to scan the entire image.

This method (“Find and Grow”) is extremely useful when it is applied to detect head cancer. As we know, head cancer does not appear white as it is in the breast cancer; it appears as a gray (darker) round shaped area. The black areas in the head image are the blood vessel and empty halls. This is the reason why the customizable intensity level of interest is very helpful and the customizable size of the square detector can omit the noises cause by blood vessels.

Unfortunately, both of the alternative methods fail to detect small cancers.

5. Conclusions

The software can detect the cancerous areas in the image of breast. The cancer is highlighted by the black dot color. And several of helpful images are processed and shown to aid the doctors in detecting the roots of cancer.

Although the final image still shows some of non-cancerous areas; on the consultation with doctors, this project is considered to be a very useful aid for them to read the image more accurately and it saves their time.

For the benefit of the public, a website containing some useful information has been launched. The website is: www23.brinkster.com/dangdinhhtuan/main/index.htm

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