Indexing Analysis by MATLAB on Thermal Imaging Application

AIMI ZAFIRAH MOHAMED  MUHAMAD KAMAL MOHD AMIN
Electronic System Engineering Department
University of Technology Malaysia International Campus
Malaysia-Japan International Institute of Technology, Jalan Semarak, 54000 Kuala Lumpur
MALAYSIA
aimi.zafirah.mohamed@gmail.com  m_kamal@ic.utm.my

Abstract: - Precancerous or malignant tumours require rich supply of nutrients that can only come from elevated blood flow, causing an increase in temperature that can be shown through thermography. Indexing analysis of thermal image is one of the proposed methods for understanding the image by slicing the image through the system and examining each slice. This algorithm is compiled from a specific method of indexing; namely the Rand Index Analysis. The method is tested with a normal breast image and the results observed to determine the success of the method or otherwise.

Key-Words: - indexing analysis, MATLAB indexing, thermography analysis, general indexing.

1 Introduction

Over thirty years of clinical use and more than 800 peer-reviewed studies in the medical literature have established thermography as a safe and effective means to examine the human body [1]. Thermal imaging is used widely these days as its capability for detecting abnormal growths superficially has expanded rapidly. A list of application for this method of detection is also growing in numbers and its capability continues to grow. Learning techniques for executing the analysis vary from previous research until currently when indexing analysis is applied. Whilst indexing analysis has many ways of representing its properties, there are many types of ways of running the programme in accordance with the expected result of the research such as other neural network techniques, whether traditional or modern techniques.

In this paper, the application of Adjusted Rand Index algorithm is introduced and further developed to expand its functionality. We have come out with a general equation to show the flow of mathematical algorithm by the MATLAB software. Some variations of Rand Index are also introduced in Details of the Adjusted Rand index and Clustering algorithms (Bioinformatics) by increasing the index range, which is used for increasing the sensitivity of the index value [2].

2 Problem Formulation

Thermal image analysis can be varied in such a way depending on how the requested outcome has to be produced. Other methods in analyzing the thermal images include putting the image in Image Processing software base, generic model of image measurement and other methods.

In this paper we introduce additional index structure which allows random access to image segmentation, thus decreasing the number of required disk accesses during the merging phase [3]. In addition, this structure simplifies the editing process of the image segmentation. We further propose a merging algorithm that utilizes this additional data structure and estimate the expected performance improvement.

A problem with the Rand index is that the expected value of the Rand index of two random partitions does not take a constant value. The adjusted Rand index proposed by Hubert and Arabie (1985), assumes the generalized hypergeometric distribution as the model of randomness, i.e., the A and B partitions are picked at random such that the number of objects in the classes and clusters are fixed [4].

The adjusted form of the Rand Index, also known as the Adjusted Rand Index, is defined in the following equation:

\[ AdjustedIndex = \frac{Index - ExpectedIndex}{MaxIndex - ExpectedIndex} \]

(1)

To be more specific, in mathematical equation:

\[ AdjustedIndex = \frac{\sum_{ij} \binom{n_i}{2} \binom{n_j}{2} - \left( \sum_{i} \binom{n_i}{2} \sum_{j} \binom{n_j}{2} \right) / \binom{N}{2}} {\frac{1}{2} \left( \sum_{i} \binom{n_i}{2} + \sum_{j} \binom{n_j}{2} \right) - \left( \sum_{i} \binom{n_i}{2} \sum_{j} \binom{n_j}{2} \right) / \binom{N}{2}} \]

(2)
where $n_{ij}$, $a_i$, $b_j$ are values from the respective table or matrix.

2.1 Simple Index Algorithm Formulation

Referring to this algorithm equation, this paper has proven an adjusted function to be a simple method of slicing the image which is fed to the system. The function is as follow:

Variables defined in MATLAB:
- $a = \text{rows}$
- $b = \text{columns}$
- $c = \text{blocksizeRow}$
- $d = \text{blocksizeColumn}$

(c and d are predefined from user, depending on the size of the image)

Thus, the equation

$$\begin{bmatrix} \text{Matrix of image} \end{bmatrix} = \begin{bmatrix} \text{Summation of Rows, Summation of Columns} \end{bmatrix}$$

$$\sum_{n=1}^{\infty} (x, y) = \sum a_n , \sum b_n$$

Where,

$$\sum a_n = a_{n-1} + (c - 1)$$

$$\sum b_n = b_{n-1} + (d - 1)$$

2.1.1 Algorithm Confiscation

The summation of two axes for one matrix represents the output array from MATLAB. The x-axis represents rows looping progress while y-axis for the column, respectively. The summation of the two variables is defined in matrix array so that the image can be analyzed sequent to the formation of the RGB image. This arrangement is to allocate the blocks and labeled to the area on the human breast at the torso part. The affected area on human skin can be seen due to the color intensity

3 Problem Solution

From a mathematical perspective, Rand index is related to the accuracy, but is applicable even when class labels are not used.

The indexing method is started by setting up the base for the image to be processed.

```matlab
for row = 1 : blockSizeR : rows
    for col = 1 : blockSizeR : columns
        row1 = row;
        row2 = row1 + blockSizeR - 1;
        col1 = col;
        col2 = col1 + blockSizeC - 1;
        oneBlock = RGBImage(row1:row2,
                             col1:col2);
        subplot(3, 4, sliceNumber);
        image(oneBlock);
        caption = sprintf('Block #%d', sliceNumber);
        title(caption);
        drawnow;
        set(gcf, 'units','normalized','outerposition',
             [0 0 1 1]);
        sliceNumber = sliceNumber + 1;
    end
end
```

Programming in the above paragraph shows the style of the MATLAB structure for the segmentation of the image to be executed. The algorithm starts with predefined looping sequences by users to slice/divide the picture which in this case is a 3 by 4 matrix. The first or initial row, which has been started by pixels from 0 to 100 units, is defined as the first row, the size of 100 pixels. This is simultaneously done for other rows, where the equation goes to calculate the algorithm involved. The subsequent rows are then defined as second row after the block of 0-100 pixels area.

The term ‘oneBlock’ is a label after the slicing process is done and set in RGB format from the first row until the last 100th pixels. Subplot is a command that arrange the blocks in the canvas or base, respective to the sequence of slicing. The image is then shown in single base or canvas along with the label of each blocks represented. This representation is crucial to the next step of analyzing each block into color clustering.
Thermal image is provided by American College of Clinical Thermology (ACCT) which was founded by certified thermographers and thermologists with the American Medical Thermology Society. The temperature of the breast shows no abnormalities found. While the FDA has approved breast thermography since 1982, the greatest developments in this field have boomed in the last few years with the advent of digital photography and high-resolution digital imaging to display patterns of heat and vascularity within the tissue itself. Heat pattern and contour can display the earliest indications of disease while they are still in the shaping stages. Thermography can also detect the presence of heat from an infectious process or from a pre-existing anatomical abnormality (i.e. lump) in the breast [5]. The image above can also be a benchmark for a normal breast study to be compared with the other studies. Subsequently, the image is fed to the proposed system and sliced as shown in the following images.

RGB mode is selected to enhance the intensity of colors shown in the segmentations. The blocks are sliced accordingly to the pre-set value among the variables involved. As seen in the above image, heat pattern forms asymmetrically as the tissue properties and are dissimilar in each region and it might be the result of environmental effects or even superficially affected to its temperature. Most of the skin layers at other regions are not affected by the heat dispersion. Thus, this method of segmentation can help doctors or medical practitioners to highlight regions that are potentially affected.

4 Conclusion

It has been shown that Simple indexing analysis can contribute to this isolation and identification of region of abnormalities in thermal breast image study. However, the data used in this experiment is not sufficient as found in operational clinics. This study has not proven that indexing analysis can cater for large data feed. However, comparison between Indexing Analysis and Kohonen SOM in thermal images application explains the matchless elements as each method has its own unique advantage. On the other hand, both methods can share favorable elements on the technique of K-means clustering. Kohonen requires weights registration before final execution of the whole program and training session, while indexing require only straightforward programming. The advantage of Kohonen over indexing analysis is that Kohonen can be done unsupervised but indexing has to be predefined before execution of programming. It is proposed that further experiment with Modular Kohonen Analysis is continued to determine the pro and cons of both architectures. Modular neural network is inspired from human brain which divides the task of visual perception into many subtasks to perform parallel to each one. It is known that multi-nets are having better performance solving approach than monolithic neural networks. Modular neural network is comprised of multiple neural networks deployed parallel to divide and solve the problem [6].

References:


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