Chairman's Preface

Message from General Chair

Dr. Dyah Erny Herwindiati
Vice Dean of Faculty of Information Technology, Tarumanagara University

Information technology continues to evolve and can be applied to various fields of science. Mathematics is seen as being fundamental to the engineering, information technology, economics, medical and many other, if not all, today’s applicable sciences.

Information and communication technology (ICT) cannot be separated from our daily life; it has changed the quality of life in positive ways. ICT is usually defined as form of technology used to create, transmit, store, organize, share or to exchange information for decision making purpose.

Mathematics is seen as being fundamental tool for development ICT. Mathematical structures, operations, processes, and languages provide learners with a framework and tools for reasoning, justifying conclusions, and expressing ideas clearly. Through mathematical activities that are practical and relevant to their lives, learners develop mathematical understanding, problemsolving skills, and related technological skills that they can apply in their daily lives and, eventually, in the workplace.

International Conference on Information Technology and Applied Mathematics 2012 (ICITAM 2012), organized by Faculty of Information Technology of Tarumanagara University together with Universiti Malaysia Terengganu committee, is a forum to bring together information technology and mathematics researchers to present research results and discuss each other to result newest findings.

I sincerely hope that all participants will have valuable experiences in ICITAM 2012 conference through gaining new knowledges and ideas.

Finally, I would like to thank the key note speakers and invited speakers for accepting our invitation at this conference. Our thanks also go to the committee and partners that support the ICITAM 2012 to be succesful.

Dr. Dyah Erny Herwindiati
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DETECTION OF ABNORMALITIES OF LYMPH NODE TISSUES USING IMAGE TEXTURE ANALYSIS

Arlends Chris, Sony Sugiharto, Lina

Abstract - This paper presents the development of an intelligent system to detect abnormalities of lymph node tissues using image texture analysis. The abnormalities of lymph node tissues are detected based on the changing structure of lymph node tissues, which were marked by the existences of granulomas. The typical structure of a granuloma of the Tuberculosis disease is in the form of a necrosis area in the center, surrounded by Datia Langhans cells, epitheloid cells and lymphocytes. The proposed detection system applied the co-occurrence matrix method for analyzing the image texture. Three features: entropy, contrast, and homogeneity were used to construct the feature vectors, then the detection process were performed by the Euclidean distance measurement. The experimental results show that the proposed detection system could achieve 100% detection accuracy using 0.1 threshold value of Euclidean distance.

Key words - Detection system, lymph node, co-occurrence matrix, texture analysis.

I. INTRODUCTION

Nowadays, digital images are often used to develop intelligent systems in medical area. Its applications such as detection, segmentation, identification of organs (kidney, brain, etc.), and simulation of medical steps are based on the analysis of digital images.

Texture is one of the important characteristics used in identifying an object or a region of interest in an image [1]. Texture features play an important role in image analysis that can be used to distinguish the normal and abnormal morphology of organs/tissues. The abnormality detection can be used as a tool to help medical experts in identifying disease from lymph node tissues.

Lymph node tissues are such organized lymphoid organs which contain lymphocytes within a fine reticular stroma. The structure of a lymph node includes the capsule, subcapsular sinus, cortex (nodulus and germinal centers), paracortex, medullary sinuses, medullary cords and hilus [2]. Figure 1 shows the samples of normal lymph node tissues.

One cause of morphological changes of lymph nodes is tuberculosis lymphadenitis or tuberculosis of the lymph node. In Indonesia, tuberculosis is considered as one of the most common causes of death. A survey from Survei Kesehatan Rumah Tangga (SKRT) in 1995 places tuberculosis as the third largest cause of death after cardiovascular disease and respiratory disease [3]. In developing countries where the incidence of tuberculosis is high, tuberculosis lymphadenitis is one of the most frequent causes of lymphadenopathy [4].

In this paper, an intelligent system is developed to detect abnormalities of lymph node tissues by analyzing its textures. The texture analysis is conducted by calculating three features of the co-occurrence matrix method, i.e. the entropy, contrast, and homogeneity. These features are then used to construct the feature vectors, and the detection process is finally performed using the Euclidean distance measurement.

The outline of this paper is as follows: Section 1 presents the introduction of the proposed system, while Section 2 explains the detail procedure and method used for abnormality detection of lymph node tissues. Next, the experimental setup and results are presented in Section 3. Finally, Section 4 contains the conclusion of this paper.

![Fig. 1. Sample of normal lymph node tissues with: (a) 50x, and (b) 100x magnification level on microscope.](image)

II. ABNORMALITIES DETECTION SYSTEM

Texture plays an important role in imaging system, such as surface analysis, surface orientation, object clustering, and object shape determination [5]. Texture quality depends on resolution factor, distance of object and angle of image capturing process. In order to analyze the image texture, characteristic values of an image are calculated based on the constructed co-occurrence matrix. The block diagram of the developed detection system is depicted in Fig. 2.

![Fig. 2. The block diagram of the developed system.](image)
First, the matrix co-occurrence is constructed by clustering the intensity values of an image. A co-occurrence matrix is based on the distribution of gray-scale level. Such matrix is derived from the angular relationship between the neighboring pixels as well as the distances between them. The size of the co-occurrence matrix is dependent on the number of the intensity color used in an image. A high color intensity image could bring a large size of the co-occurrence matrix. The co-occurrence matrix is defined as follows:

$$p(i, j) = \frac{1}{\sum f(i, j)} \times \begin{bmatrix} f(i, j) & f(i, j) & \ldots \\ f(i, j) & f(i, j) & \ldots \\ \ldots & \ldots & \ldots \end{bmatrix}$$  \hspace{1cm} (1)$$

with $p(i, j)$ is the probability value, $f(i, j)$ is the color frequency of index pair, $i$ is the row index of the co-occurrence matrix, and $j$ is the column index of the co-occurrence matrix.

Next, the characteristic values are obtained by processing the values of the co-occurrence matrix. Three characteristic features are applied in the proposed system, i.e. entropy, contrast, and homogeneity. These three features are used due to their high ability to separate images with high contrast, which is very useful for object identification and detection.

Entropy is used to measure the randomness of intensity distributions. Entropy can show the pattern of an object, since the color intensities of an object are usually scattered without a certain structure. The entropy value is calculated by:

$$\text{Entropy} = - \sum_{i=0}^{I} \sum_{j=0}^{J} p(i, j) \log p(i, j)$$  \hspace{1cm} (2)$$

Another characteristic measurement is the image contrast. Contrast is used to measure the power of intensity differences in an image. The higher the intensity values of an image, the higher the contrast value. The calculation of contrast value is as follows:

$$\text{Contrast} = \sum_{i=0}^{I} \sum_{j=0}^{J} (i - j)^2 \cdot p(i, j)$$  \hspace{1cm} (3)$$

As the contrary of the contrast, is the homogeneity. The homogeneity calculates the uniformity of intensity variations in an image, through

$$\text{Homogeneity} = \sum_{i=0}^{I} \sum_{j=0}^{J} \frac{p(i, j)}{1 + |i - j|}$$  \hspace{1cm} (4)$$

After calculating the three characteristic features above, the feature vector of an image is constructed by arranging the entropy, contrast, and homogeneity values in a one dimensional vector. These processes are performed for each training and testing images.

For detection process, the dissimilarities of the input image with the training images are calculated using the Euclidean distance. The equation of the Euclidean distance measurement is as follows:

$$r = || x - w ||$$  \hspace{1cm} (5)$$

where $r$ is the Euclidean distance between $x$ as the input vector and $w$ as the training vector. A small $r$ value indicates a high similarity of two images.

Finally, the threshold value $\delta$ is used to determine whether the examined lymph node images are in normal or abnormal structure.

![Image](image_url)

**Fig. 3. Samples of lymph node images used in the experiments. Normal lymph node with: (a), (b) 50x, and (c), (d) 100x magnification level. Abnormal lymph node with: (e), (f) 50x, and (g), (h) 100x magnification level.**

### III. RESULTS AND DISCUSSIONS

We conducted several experiments to evaluate the performance of the developed system. The database used in the experiments consists of two datasets with a total of 40 images of human lymph nodes. The first dataset contains 20 images captured with 50x magnification, while the second dataset consists of 20 images with 100x magnification. The images were captured and processed in the RGB color domain. Figure 3 shows the samples of lymph node images used in the experiments.

For each dataset, there were 10 images with normal lymph node structure and 10 images with abnormal lymph node structure. The normal lymph node images were used for training, while the images of abnormal lymph node were used for testing. Various threshold values were used to ensure the flexibility of detection criteria. The detection results is depicted in Figure 4.
Figure 4 shows that the detection accuracies of Dataset 1 and Dataset 2 were 100% for $\theta=0.1$, 90% for $\theta=0.2$, and 80% for $\theta=0.3$. Meanwhile, for $\theta=0.4$, Dataset 1 achieved 40% and Dataset 2 obtained only 30% of detection accuracy of abnormal lymph node images.

Table 1. Distance Values of Dataset 1

<table>
<thead>
<tr>
<th>No.</th>
<th>Testing Image</th>
<th>Distance Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ab5x1.JPG</td>
<td>0.357</td>
</tr>
<tr>
<td>2</td>
<td>Ab5x2.JPG</td>
<td>0.333</td>
</tr>
<tr>
<td>3</td>
<td>Ab5x3.JPG</td>
<td>0.448</td>
</tr>
<tr>
<td>4</td>
<td>Ab5x4.JPG</td>
<td>0.672</td>
</tr>
<tr>
<td>5</td>
<td>Ab5x5.JPG</td>
<td>0.653</td>
</tr>
<tr>
<td>6</td>
<td>Ab5x6.JPG</td>
<td>0.229</td>
</tr>
<tr>
<td>7</td>
<td>Ab5x7.JPG</td>
<td>0.378</td>
</tr>
<tr>
<td>8</td>
<td>Ab5x8.JPG</td>
<td>0.157</td>
</tr>
<tr>
<td>9</td>
<td>Ab5x9.JPG</td>
<td>0.348</td>
</tr>
<tr>
<td>10</td>
<td>Ab5x10.JPG</td>
<td>0.370</td>
</tr>
<tr>
<td></td>
<td><strong>Average</strong></td>
<td><strong>0.3945</strong></td>
</tr>
</tbody>
</table>

It is clearly seen that the detection accuracies were decreased along with the increment of the threshold values. This phenomenon indicates that in order to classify an abnormal lymph node image, a strict value of threshold is necessary.

Table 1 and Table 2 show the detail distance values of each dataset. Table 1 presents the distance values of 10 testing images in Dataset 1 with 50x magnification level on microscope. The obtained average distance value for Dataset 1 was 0.3945. Meanwhile, the average distance values for Dataset 2 with 100x magnification on microscope was 0.4319, as shown in Table 2.

IV. CONCLUSIONS

The development of an intelligent system to detect abnormalities of lymph node tissues using the image texture analysis has been discussed in this paper. The main purpose of the developed system was to determine whether the input images were normal or abnormal (infected by the Tuberculosis disease) according to its lymph node structure. The proposed detection system applied the co-occurrence matrix method for analyzing the image texture, constructed the feature vectors based on entropy, contrast, and homogeneity values, and finally determined the detection result by comparing the Euclidean distance values with a pre-defined threshold. The highest detection accuracy was 100% when using 0.1 threshold value of Euclidean distance. In the future, a combination of texture, color, and shape analysis is expected to present more sophisticated results of the detection process of lymph node abnormalities.

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REFERENCES


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