IMPLEMENTATION OF IRIDOLOGY APPLICATION ON SMARTPHONE

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ABSTRACT

Iridology is alternative medicine for predicting human health condition through film/digital iris image. Several researchers have developed an Iridology application on personal computer to substitute their manual method. Now Smartphone device is very popular. It has attributes of portability, economic value, and easy to use. Implementation of Iridology application on Smartphone is great chance to support remote areas where accessing to healthcare services still a main issue. The proposed application use Canny Edge Detection to detect a specific area on the digital iris image, Texture Future Analysis to analyze the specific area of iris, and Artificial Neural Network to learn and predict health condition. For this study, the cases of health prediction are limited to heart disease, lung disease, spleen disease, and liver disease. The eye images of 32 samples that have indicated diseases according to Iridologist are tested. Result comparison to Iridologist: 95% for heart disease, 90% for lung disease, 90% for spleen, and 90% for liver. Although it was successfully implemented on Smartphone, the capture iris image directly from camera phone is still insufficient. For further studies, we will complete disease detection and make additional tool for eye image capturing.

Keywords: Artificial Neural Network, Iridology, Automatic Disease Detection, Smartphone

1 INTRODUCTION

Raising awareness, willingness, and ability for healthy living depends on many factors. The general condition that usually happen in society that related to those factors, be said, awareness of public community, easy access to healthcare services [1], and inexpensive healthcare cost. Almost all countries, from developing country to developed country, and world organization, from religious organization to social organization give a deep attention to humanity about healthy life. However, there is a barrier to raise health awareness among the people when easy access to healthcare provider and lower medical cost is not provided.

Now, alternative ways to medical treatment are more popular. It is not only used in developing countries but also in developed countries such as USA, even in Europe, alternative medicine has been started earlier. In fact, patients in USA who use alternative medicine are greater than use modern medicine, but in Europe are more varieties [2]. In china land, old traditional medicine has been used from generation to generation before modern medical technologies from Western came. This popularity may occur due to the use of holistic phenomenon and simple methods in the treatment of alternative medicine often give a good result.

Methods, tools, and material in alternative medicine are not included in modern medicine, therefore benefits and merits of this alternative way still in contradiction [3]. Regardless of that contradiction, this alternative treatment commonly use as complement of conventional or modern medical treatment. Beside the treatment has been looked effective to detect signs and symptoms, this examination cost is cheaper then the high and sophisticated modern medical treatment [4].

One of the most popular in alternative medicine is known as Iridology. It uses iris images to diagnosis of human organ/body condition. Based on their research and observation over the years, they believe that iris of eye is a window of current condition of human [5]. Iris surface is like a map, which divided into several segments. Each segment represented or related to inner organ in a body system or a human body. Iris analysis in traditional manner is done by placing and projecting the iris image on Iris Chart.

Nowadays researcher are designing and implementing a software analysis on iris images in semi or full automatic manner using a computer device like desktop or portable computer [6]. The merit of this computerized system is better accurate measurement than traditional method in performing iris segmentation, boundary detection, and color identification [7]. Possible constrains that may be appeared from the computerized system are low
portability, relatively high price, and several people have difficulties when using a computer.

Today, most people in the world give more attention to mobile device, thus merits and roles of the mobile device is very important including to the future of healthcare services. Those matters are challenges to consider a portability mobile device as medium for analyzing iris image. The idea of the developed health application on a mobile device is beside characteristic of portability, but also compact device, distributed application, economical cost, and easy to use.

This proposed application is not focusing on high-end devices; if their mobile device essentially has several features like Smartphone, anyone can experience all benefits of it. Additional benefit is mobile/wireless networking infrastructure has been penetrating to remote area then this situation solved the barrier access to healthcare services because of geographic restrictions. In this way, a high cost of early examination can be cut down if a mobile health application is available.

The developed application is emphasize to early diagnose of human organ or body in fully automatic way. Bad sign report obtain from this application, however, must be confirmed using standard medical procedure at near hospital. Alternative medicine treatment is a complement and not intended as a substitute to standard medical procedure.

One of the way accesses to the healthcare services can be fulfilled by this developed application. They can self-examine their condition routinely, before meet their doctor in a hospital center which long distance from their home. Therefore, expectation to promote health awareness with slogan “prevention is better than cure” would be fulfilled.

2 IRIS CHART

Radiology devices are used as medical standard tools to examine a person health condition through their inner organ pictures, for example Ultrasonography (kidney, spleen, pancreas, cavity, muscle, and uterus), CT scan (brain, lungs, liver, cardiovascular, and abdomen), and MRI (brain, backbone, and joint). The used of those devices certainly consume a lot of cost. There is an alternative method to detect functionality of inner organ disorder, which is called Iridology. This method studies several signs on eye iris structures as reflection of various body organs and systems [8]. Some European countries such as Germany, Switzerland, and Sweden have known Iridology in quite a long time and more than 80 percent of Heilpraktiker (non-medical health practitioners) to practice this method. Iridology history began in 1800 when the Hungarian physician Ignatz observed changes in the iris of some patients who are recovering from illness. Then he became the first person who creates an Iris Chart. Dr. Bernard Jensen revised the chart and it is used internationally. According to the Iridology, certain area of our iris represents condition of a particular organ. All those specific areas are mapped in Iris Chart.

![Image of Iris Chart]

Figure 1. The left side of Iris Chart

3 APPLICATION DESIGN

There are three main tasks to develop the Iridology application through digital eye image as shown in Figure 2. First step is eye image acquisition. Second step is eye image processing to get boundary of iris and pupil, and specific area that depicted on Iris Chart. The last step is the detection of diseases through pattern matching between the observed set of iris images. The pattern is obtained from the learning process via Artificial Neural Network (ANN).

Currently the camera sensor attached to the Smartphone device has minimum specifications 3 Mega pixels or equal to 2048 x 1536 pixels. Although it is able to take pictures like a common digital camera, but there are some limitations in their use, for example, not all of Smartphone equipped with zooming features (enlargement) and flashing (lighting). Therefore, we need an additional tool, which will be made in future studies. Currently, the used images were taken from the existing one.

The main purpose of eye image processing is to obtain the Region of Interest (ROI) eye iris that
represents the specific state of body/organ system. It consists of several processes: pre-processing, edge detection, determination of the iris and pupil radius, and the process of mapping the Iris Chart. This process includes a separation the iris image with its background. The original image will be scaled down to reduce the computational process in finding the radius of the iris and pupil, while determining the ROI on iris image will use the original image size.

\[
O(i,j)_{max} = \frac{255 \cdot (O(i,j) - \min)}{\max - \min}
\]  

(4)

where max is the maximum gray level value of O, and min is the minimum value of the gray level.

Sobel operator is used to find the magnitude and direction of the gradient, by the following equation:

\[
M[i,j] = (P[i,j] + G[2 \cdot Q[i,j] + 2]) \times 0.5
\]

(5)

\[
\theta[i,j] = \arctan(G[i,j],P[i,j])
\]

(6)

where M is the magnitude, and \( \theta \) is the direction of the gradient. While P and Q as follows:

\[
P[i,j] = (O[i +1, j +1] - O[i, j +1] + O[i +1, j] - O[i,j]) / 2, \quad \text{and}
\]

\[
Q[i,j] = (O[i +1, j +1] - O[i, j +1] + O[i, j +1] - O[i +1, j]) / 2
\]

Gradient direction will then be narrowed down into four groups where:

- If \( 22.5^\circ < \theta[i,j] <= 67.5^\circ \) then \( \theta[i,j] = 45^\circ \),
- If \( 67.5^\circ < \theta[i,j] <= 112.5^\circ \) then \( \theta[i,j] = 90^\circ \),
- If \( 112.5^\circ < \theta[i,j] <= 157.5^\circ \) then \( \theta[i,j] = 135^\circ \),
- If \( 0^\circ <= \theta[i,j] <= 22.5^\circ \) and \( 157.5^\circ < \theta[i,j] <= 180^\circ \) then \( \theta[i,j] = 0^\circ \).

Non-maximum suppression aims to eliminate edge not really edge. It related with gradient direction as follows,

- \( \theta^\circ \text{and} M[i,j] < M[i,j+1] \text{or} M[i,j] < M[i+1,j] \) then \( M[i,j]=0 \)
- \( 45^\circ \text{and} \text{if} M[i,j] < M[i-1,j+1] \text{or} M[i,j] < M[i+1,j-1] \) then \( M[i,j]=0 \).
- \( 90^\circ \text{and} M[i,j] < M[i-1,j] \text{or} M[i,j] < M[i+1,j+1] \) then \( M[i,j]=0 \).
- \( 135^\circ \text{and} M[i,j] < M[i-1,j] \text{or} M[i,j] < M[i+1,j+1] \) then \( M[i,j]=0 \).

Last step of the eye image processing is to find the central point and radius of the iris and pupil. For iris is the following step:

a. Determine a circle size with central point range from image matrix \( M[1/3h, 1/3w] \) to \( M[2/3h, w-1/3h] \) and radius ranging from 1/3h up to 1/2h, (h = image height and w = image width).

b. Browse around the matrix M using that circle radius to find edge pixels.

c. Count how many times the circles pass through the edges of pixels.

d. Take the central point and the radius of a circle when they get the highest value.

Those steps are used to find a central and a radius of pupil, with central point that starting from \( M[p-0, p-10] \) to \( M[p+10, p+10] \) and radius from 1/6r to 1/2r (p = iris central point, r = iris radius).

Areas of ROI for specific organs are adapted in Iris Chart. Those ROI on the chart is in the iris area and not include the pupil area. Mapping ROI iris using a circular area is represented by the angular size: 0° to 360° or analog clocks: 0 to 12 o’clock.
see Figure 1. For example, 30° is equal to 1 o’clock. ROI’s heart is set on angles range 68° to 95° with scale of iris radius from 0.26 to 0.42. ROI’s lung is set on angles range of 63° to 90° with scale of iris radius from 0.49 to 0.85. ROI’s spleen is set on angles range of 125° to 132° with scale of iris radius from 0.36 to 1.0. Then ROI’s liver on angles range from 235° to 242° with scale of iris radius 0.36 to 1.0.

The developed application uses Backpropagation Neural Network with 11 input nodes, 1 hidden layer with 4 nodes, and 1 output node. The 11 input nodes (weight values) are used to analyze the texture of the iris image: Angular Second Movement, Contrast, Variance, Correlation, Inverse Difference Movement, Sum Average, Sum Variance, Sum Entropy, Entropy, Difference Variance, and Difference Entropy [9][10]. The output node is used in ANN as expected output value. Activation function used is the sigmoid activation.

The process of ANN is divided into two parts: learning and prediction processes. The learning process is performed using a desktop PC to accelerate the process of ANN computing. The results of learning are weight values, which are saved on storage. These weights will be used by application on Smartphone for the prediction process. Below is a learning process of ANN:

a. Do textural feature analysis for ROIs that have been diagnosed to get their variable texture.
b. Define the value of expected output for each input. The expected output with value "0" is for healthy condition and "1" for health problems.
c. Define initial value 0 for every weight values that are being used.
d. Calculate the expected output based on the weight values that are being used.
e. Calculate the error from a given output expectations, and change the weight values until error value is below 10^-6.

Prediction process of organ/body health condition by ANN as follows:

a. Do textural feature analysis to get a variable iris image texture in the form of weight values.
b. Use the weight values of learning outcomes.
c. Evaluation the values of ANN output in each ROI area. When the value is less than or equal to 0.5 then the organs are healthy, and vice versa when more than 0.5 then there is suspected disorder on the body's organs.

4 IRIDOLOGY APPLICATION

Iridology application is tested using eye images took from electronic books or on internet. We have tried also taking eye image using Smartphone camera, and found several problems. The eye must be glared at camera with a helping hand of two fingers. Lower quality of light causes captured image is darker. The low quality of image produces insufficient data analysis. In other hands, several Smartphone are equipped with flashlight, but others are not. However, the used of flash light can cause irritation on the eye. As a mention, taking eye image directly needs additional tool. The tool will be developed further in the next research.

In image processing, getting boundary on iris and pupil has done through several processes. The original image was converted into a gray image (Figure 4(a)). Gaussian filter smoothes the gray image so that edges can be better detected (b). The method of canny edge detection processes the image to obtain the desired edge as shown in (c).

Tests on the localization of the iris and pupil have been carried out with eye image of 10 samples. Determination circle point and radius for iris and pupil area is seem accurate as showed on Figure 5. This figure shows 3 of 10 sample as results of iris and pupil localization. The obtained results will facilitate the process of mapping iris image on Iris Chart.

Iridology determines the abnormalities on a specific organ based texture on the specific area (ROI) of iris that usually marked as spots or
abnormal patterns. That ROI of iris is determined by Iris Chart. For an application to be able predicting health of certain organs such as iridologist, the application used ANN to learn the iris textures that belong to healthy and sick people.

At this moment, learning objectives are limited only to determine organ disorder of the heart, lungs, spleen and liver. ANN studies four image samples belong to healthy and other four images belong to sickness for each organ disorders mentioned above. Table 1 is result of 32 samples obtained from Textural Feature Analysis. The result is used as inputs by ANN learning process.

Table 2 is sample eye images of Figure 3 with a heart and lung disorder, while the spleen and liver healthy according to Iridologist. Application marking ROI of the heart, lungs, spleen, and liver with square color of white, red, yellow, and blue, in sequence. Information on the right shows ANN prediction toward Iridologist opinion.

Table 1. Value of textural feature analysis for each organ: heart, lungs, lymph, and liver (rounding to 2 digits).

<table>
<thead>
<tr>
<th>Organ</th>
<th>Heart</th>
<th>Lung</th>
<th>Lymph</th>
<th>Liver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>0.29</td>
<td>0.25</td>
<td>0.27</td>
<td>0.25</td>
</tr>
<tr>
<td>Error</td>
<td>0.24</td>
<td>0.23</td>
<td>0.26</td>
<td>0.26</td>
</tr>
<tr>
<td>Accuracy (%)</td>
<td>95.5</td>
<td>95.25</td>
<td>95.25</td>
<td>95.75</td>
</tr>
</tbody>
</table>

**5 IRIODOLOGY APPLICATION ON SMARTPHONE**

The iridology application was tested on Smartphone equipped Android OS v2.3.4 (Gingerbread), Processor 1 GHz Scorpion, chipsets Qualcomm MSM8255 Snapdragon, GPU Adreno 205, RAM 512 MB RAM, Display Type LED-backlit LCD capacitive touch screen, 16M colors, Display Size 480 x 854 pixels, 4 inches (~265 ppi pixel density), and standard battery Li-Ion 1500 mAh. The device takes time about 21-23 seconds to analyze an eye image.

To run this application, user has to insert the eye image to be analyzed. There are two ways, taking the eye image directly using a Smartphone camera or taking the image file that have been stored in memory.

This application is provided for multi-user where the user name and date are recorded during image capturing. Using this Smartphone, the image can be zoomed in or out by moving two fingers on the display screen. Input eye images will be analyzed when the user touches the "Process" button, then the application will process the eye image (Figure 6(a)), converting image to grayscale (b), and to obtain the iris and pupil area. In (c) showing results the location of the iris and pupil are visible in the phone screen. White circle line shows detected area of iris and pupil appropriately by the application. It has to be verified whether those detections are iris and pupil area, if not, the user must select appropriate eye image so that the process of predictions can be done well.

Specific ROI for each organ, then, detected base on Iris Chart as depicted in Figure 6(d). While Smartphone screen smaller than computer screen, the image can be zoomed out. The specific ROIs are analyzed by doing textural Feature Analysis to provide input to the ANN. The prediction result is given about health condition of the body's organs based on ANN learning outcomes.

The experimental result of 32 samples using ANN to predict the condition of organs is show in Table 2. Accuracy of prediction compare to radiologist is more than 90%.

Table 2. Health prediction according to Iridology and ANN.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Iridology</th>
<th>ANN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart</td>
<td>ill</td>
<td>ill</td>
</tr>
<tr>
<td>Lung</td>
<td>ill</td>
<td></td>
</tr>
<tr>
<td>Lymph</td>
<td>healthy</td>
<td>healthy</td>
</tr>
<tr>
<td>Liver</td>
<td>healthy</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Result accuracy compare to Iridologist examination

<table>
<thead>
<tr>
<th>Organ</th>
<th>Error prediction</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart</td>
<td>1</td>
<td>95</td>
</tr>
<tr>
<td>Lung</td>
<td>2</td>
<td>90</td>
</tr>
<tr>
<td>Lymph</td>
<td>2</td>
<td>90</td>
</tr>
<tr>
<td>Liver</td>
<td>2</td>
<td>90</td>
</tr>
</tbody>
</table>
This result indicates the Iridology application on Smartphone can be used to analyze the specific ROI on iris in predicting health problems.

![Image of Iridology application on Smartphone]

6 CONCLUSION

Iridology applications implemented on a PC obviously can be applied on a Smartphone. The application can give predictions with a good accuracy. Gaussian filter and canny edge detection methods work very well to separate iris and pupil of the eye image. Weigh values of Textural Feature Analysis used as inputs to the ANN can work well to detect a pattern representing abnormalities in organs according Iridology. However, there are several imperfections in developed application, those includes the used of image data for ANN learning is still a bit. The application can analyze just four type of disease, not to include all kinds of diseases. Taking picture by internal Smartphone camera has limitations. Zooming features and flashlight matter are still in issue. Therefore, elaboration of this study to solve the mention problems is needed to enrich the functional of Iridology application.

REFERENCE