Effective Image Processing Procedure for Skin Lesion Recognition in Contactless Skin Diagnosis Devices

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Abstract: An image analysis procedure for recognizing various skin lesions under contactless skin diagnosis environment is proposed. The proposed procedure is composed of five stages, and experimental results show that issues such as uneven distribution of light are properly addressed, and various skin lesions are effectively discriminated according to their characteristics using the image processing technology and the shadow analysis.

1 INTRODUCTION

Composed of epidermis, dermis, and subcutaneous tissues, skin is the largest organ of human body (Wei et al., 2018). Containing blood vessels, lymphatic vessels, nerves, and muscles, which can perspire, perceive the external temperature, and protect the body. Covering the entire body, the skin can protect multiple tissues and organs in the body from external invasions including artificial skin damage, chemical damage, adventitious viruses, and individuals' immune system. Besides, skin can also avoid the loss of lipids together with water within epidermis and dermis so that skin barrier function can be stabilized (Hu and Yu, 2013). Skin is the first defender of human body, from various external hazards.

It is of great theoretical significance and practical value to study how to extract symptoms of diverse skin diseases on the basis of modern science and technology. Under this circumstance, effective and accurate identification of the types of skin diseases can be achieved to prescribe treatment according to patients' symptoms (Vezhnevets et al., 2003).

Television, social media, and advertising have had a tremendous impact on consumers' paying increased attention to physical appearances and aesthetics. This has also raised interest in a variety of cosmetic and aesthetic surgeries and procedures. This, supported by surge in consumer disposable income and introduction of technologically advanced solutions, has had a major impact on market demand (Market Research Report, 2018). As a standard of beauty, skin increases its importance as society develops. However, various skin disease have emerged due to air pollution, micro dust, and unnecessary UV exposure due to the ozone depletion.

With the development of dermatology and skin medicine, the skin analysis technology with image processing and computer vision gains its importance recent years. In addition, research has been conducted to measure skin condition quickly, easily, and accurately.

In this paper, an image processing procedure for recognizing skin lesions over contactless skin imaging device is proposed. Experiments show that analyzing the shadow of the skin lesions can effectively detect and classify the lesion of concern.

The rest of this paper is as follows. In Section 2 , recent studies and technologies for skin analysis are introduced. Details of the proposed procedure are shown in Section 3 . Experimental Results are shown in Section 4 and Section 5 concludes with future work.

2 RELATED WORKS

2.1 Skin Diagnosis Device

With the development of semiconductor technology and small electronic devices industry, devices for measuring skin using various computerized and electronic technologies have emerged.

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The global dermatology devices market size was valued at over USD 9.6 billion in 2017 and is expected to showcase lucrative growth over the forecast period, registering a CAGR of 13.5%. Increasing prevalence of skin cancer and other skin diseases has significantly contributed to high demand for various dermatological diagnostic and treatment procedures in recent times, thereby spurring product demand (Market Research Report, 2018). Figure 1 shows one of the representative personal skin diagnosis devices (Ahn, 2019).

Figure 1: Sample of skin diagnosis device.

To get a clear image, most of these devices make contact with the skin. Contacting the cylindrical body with the skin enables to get a clear skin image with fixed focal length and stable light source.

However, contact with the skin can cause possible skin contamination due to uncleanness and corrosion of the contact part. To prevent this, the contact part needs to keep clean and sterilized which lead to additional costs and actions.

2.2 Skin Analysis Technology

There have been many researches on skin analysis using image processing. Various statistical methods for segmentation and classification of skin lesions in dermoscopic images is developed (Zaqout, 2016). Texture and color features of skin diseases are analysed (Wei et al., 2018; Yang et al., 2018).

Also, applying neural networks including the Artificial Neural Network (ANN) and the Convolutional Neural Network (CNN) are conducted for effective skin recognition (Abbadi et al., 2010; Menaka and Rohini, 2014; Yang et al., 2018).

2.3 Object Detection and Recognition

For a long time, algorithms for finding objects in images have been studied extensively. Numerous researches have been done in object detection, recognition, classification and discrimination.

Scale-Invariant Feature Transform (SIFT) has been studied and applied various applications (Gonzalez and Woods, 2018). Speeded Up Robust Features (SURF) and RANdom Sample Consensus (RANSAC) are also well-studied algorithms (Kim and Kim, 2014). Circular Hough Transform (CHT) is one of the widely used algorithms (Vegt, 2015).

Also, light source detection has been researched in a number of areas, including human vision, optical science and photometric engineering (Nillius and Eklundh, 2001; Funk and Yang, 2007)

3 PROPOSED PROCEDURE

The proposed procedure is composed of five stages: *Preprocessing*, *Parameter Configuration*, *Abnormal Area Separation*, *Lesion Recognition*, and *Categorization and Visualization*. The flowchart for the overall procedure is shown in Figure 2, followed by its pseudocode shown in Figure 3.

3.1 Preprocessing

To analyse skin and its lesions, an image is taken by skin diagnosis device. As the device does not touch the skin and is exposed to external light source (sunlight, indoor lamp, etc.), various factors such as direction and amount of light, vignetting and lens distortion should be considered. So, color temperature and lens distortion calibration, vignetting and chromatic abberation correction and other necessary processing should be applied on the stage of imaging the skin.

After the correction and calibration of the image, basic properties such as the image size, resolution and the image file type are acquired for further analysis.

3.2 Parameter Configuration

Detailed and practical properties such as the average brightness for entire image and the image histogram are obtained in this stage.

In addition, the image is divided into number of image blocks. For each image block, average brightness is obtained so that the threshold for each block is configured using the average brightness. The threshold for each block is used to separate the lesion part from the skin part. This adaptive threshold configuration enables the separation of the skin and its lesions effectively.

3.3 Abnormal Area Separation

Using the parameters and properties acquired from Section 3.1 and 3.2, the lesion part is separated from the skin part.

By the threshold value on each designated image block, each pixel is classified upon the binarization method (black and white manner).

3.4 Lesion Recognition

Among the number of image processing and object recognition technologies described in Section 2.3, CHT is one of the most appropriate algorithms to detect and recognize the skin lesions.

In general, lesions are dark and circular in shape compared to the skin, so it is expected that CHT is possible to detect and recognize the skin lesions effectively.

Furthermore, as there are lesions in a concave shape such as pores and a convex shape such as moles, the location of dark and bright part of those lesions is different according to the direction of light. Therefore, it is possible to distinguish lesions by the direction of the shadow. In this stage, the *Smart Shadow* analysis is performed; the discrimination of the lesion by its shadow.

3.5 Categorization and Visualization

After obtaining the concave and convex lesions according to the shadow analysis, each feature is analysed and marked in the final stage.

Since the information obtained by the CHT includes the position (coordinates) and size of each lesion, the detected lesions can be displayed in an image for visual understanding, and statistical features such as area can also be analysed.

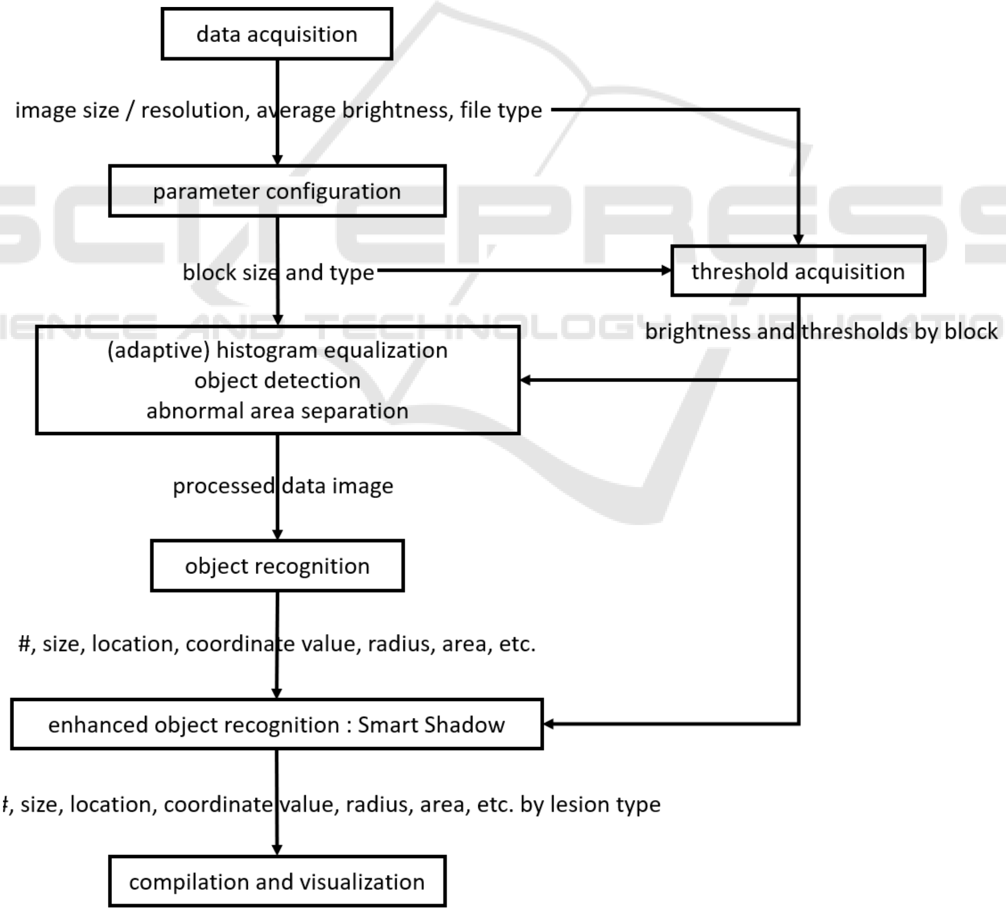

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Figure 2: Flowchart for the proposed procedure.

```
INPUT : skin_Image
OUTPUT : p_center and p_radius according to lesions

/* parameter definition & configuration */
skin_Image      // skin image to analyze
skin_h, skin_w  // size of skin_Image
n_blocks        // number of blocks (horizontal and vertical)
th_lesion       // threshold value to classify lesions
p_comp      // compensation parameter
p_center    // array of p_center coordinate values of lesions
p_radius    // array of radii of lesions
LESION          // value for separating lesions
n_blocks_h=skin_h/n_blocks
n_blocks_w=skin_w/n_blocks

/* th_lesion acquisition */
for k=1 to n_blocks
s=(k-1)*n_blocks_h
for m=1 to n_blocks
n=(m-1)*n_blocks_w
g=1
for ni=1+s to n_blocks_h+s
e=1
for nj=1+n to n_blocks_w+n
tmp_Image(g,e)=skin_Image(ni,nj,1)
     // the R value
e=e+1
g=g+1
th_lesion(k,m)=mean(mean(tmp_Image))-p_comp

/* lesion (abnormal area) separation */
for k=1 to n_blocks
s=(k-1)*n_blocks_h
for m=1 to n_blocks
n=(m-1)*n_blocks_w
for ni=1+s to n_blocks_h+s
for nj=1+n to n_blocks_w+n
if (skin_Image(ni,nj,1)<=th_lesion(k,m))
proc_Image(ni,nj,1)=LESION
proc_Image(ni,nj,2)=LESION
proc_Image(ni,nj,3)=LESION

/* object detection & recognition */
// to find abnormal area (dark area regarded as lesions) and localize
// put the center points and radii into arrays of p_center and p_radius
// use imfindcircles in MATLAB (Circular Hough Transform is used)

/* enhanced object recognition: Smart Shadow */
for i=1 to size(p_center)
if (a(p_center(i,2)+p_radius(i)/4,p_center(i,1),1)
>=a(p_center(i,2)-p_radius(i)/4, p_center(i,1),1))
// assumed the light direction goes downwards
p_center(j,:)=p_center(i,:)
p_radius(j)=p_radius(i)
j=j+1
```

Figure 3: Pseudocode of the proposed procedure.

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4 EXPERIMENTAL RESULTS

The procedure proposed in Section 3 has been implemented using Mathworks MATLAB R2016a on Microsoft Windows 7. After a number of close concern of various skin lesion images taken by skin diagnosis devices, the skin images are artificially produced using Adobe Photoshop CC 2018.

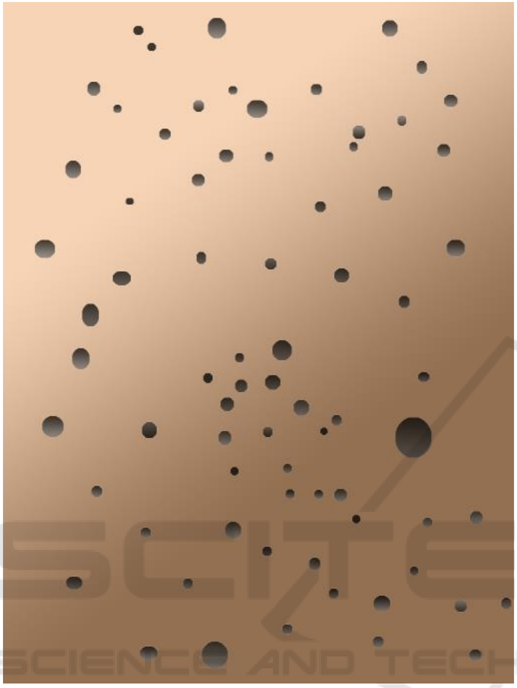

Figure 4: The original skin.

Figure 4 shows the original skin image, regarded as taken from a skin diagnosis device. It is regarded as previously processed to address the issues of color temperature difference, lens distortion, vignetting and chromatic abberation. It is set that the light source is at the upper left (the brightness gradually decreases from upper left to lower right) with the light brown skin.

Figure 5 shows the result of separating abnormal area which are regarded as skin lesions. Red circles denote the abnormal area. After the analysis of recognized lesions, the number of lesions is 74 with the total area of 40787.6 ($pixels^2$) and the average area per lesion of 551.2 ($pixels^2$).

After the enhanced object recognition using the shadow analysis called Smart Shadow, possible pores (concave objects) are shown in Figure 6 and possible moles (convex objects) are shown in Figure 7. After the analysis, the number of possible pores is 65 and the number of possible moles is 8. The overlapped parts in Figure 5 and Figure 6 are identified as errors, mainly due to the CHT parameter settings.

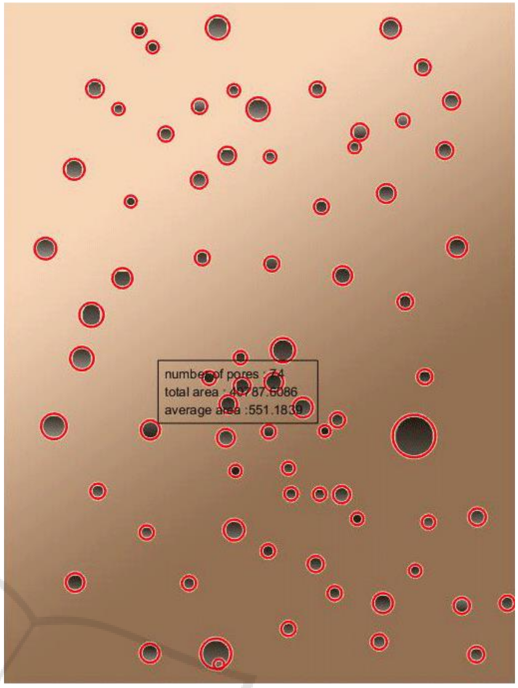

Figure 5: The result of recognizing skin lesions.

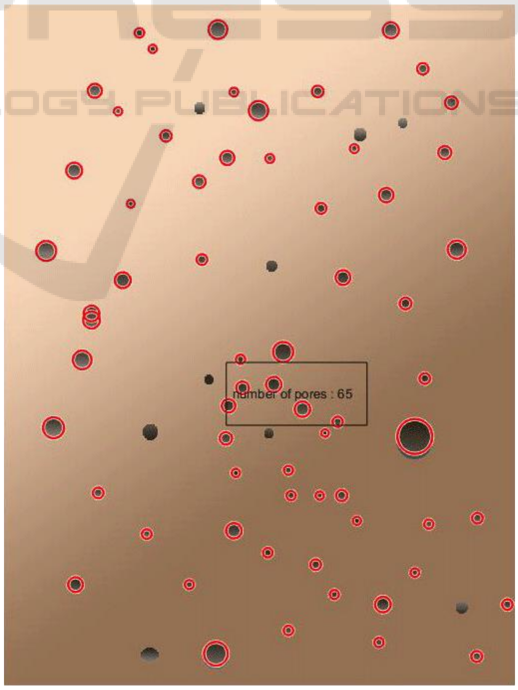

Figure 6: The result of recognizing possible pores.

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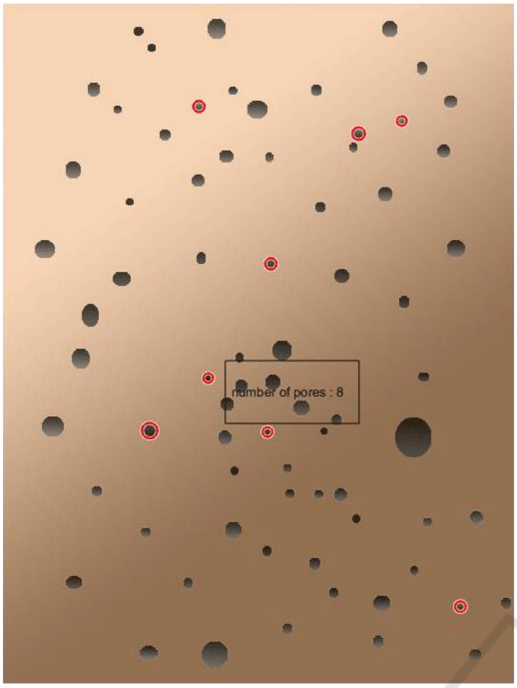

Figure 7: The result of recognizing possible moles.

5 CONCLUSIONS

An effective image analysis procedure for discriminating and recognizing various skin lesions under contactless skin diagnosis environment is proposed. Issues such as uneven distribution of light are properly addressed, and various skin lesions are effectively discriminated according to their characteristics, using the image processing technique and the shadow analysis.

To generalize and objectify the proposed procedure, additional analysis and comparison of detailed skin lesion would be performed under additional light source including the variety of its strength, angle, wavelength, etc. Further researches after this work include detailed lesion discrimination upon appropriate decision-making frameworks such as deep learning, and Bid Data analysis over various kinds of skin image.

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REFERENCES

Abbadi, N. K. A., Dahir, N. S., Al-Dhalimi, M. A., and Restom, H., 2010. Psoriasis Detection Using Skin Color and Texture Features. In *Journal of Computer Science*, 6(6):648-652.

Ahn, Y. K., 2019. Genie Skin. In *AMC Co., Ltd.*, http://www.amc11.com

Funk, N., and Yang, Y.-H., 2007. Using a Raster Display for Photometric Video. In *Proceedings of Canadian Conference of Computer and Robot Vision (CRV 2007)*, 201-207, Montreal, Canada.

Gonzalez, R. C., and Woods, R. E., 2018. *Digital Image Processing*, 4th Ed. By Pearson Education.

Hu, Z., and Yu, C. S., 2013. Functional Research and Development of Skin Barrier. In *Chinese Journal of Clinicians*, 7(7):3101–3103.

Kim, J., and Kim, D., 2014. Matching Points Filtering Applied Panorama Image Processing Using SURF and RANSAC Algorithm. In *Journal of the Institute of Electronics and Information Engineers*, 51(4):820-835.

Market Research Report, 2018. Dermatology Devices Market Size, Share & Trends Analysis Report By End Use (Clinics, Hospitals), By Product & Application (Diagnostic, Treatment), By Region, And Segment Forecasts, 2018 – 2025. In *Grand View Research*, 2018.

Menaka, R., and Rohini, S., 2014. Efficient Detection of Ischemic Stroke from MRI Images Using Wavelet Transform. In *International Journal of Computer Science and Information Technology Research*, 2(3):446-454.

Nillius, P., and Eklundh, J. O., 2001. Automatic Estimation of the Projected Light Source Direction. In *Proceedings of the 2001 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR 2001)*.

Vegt, S. E., 2015. A Fast and Robust Algorithm for the Detection of Circular Pieces in a Cyber Physical System. In *ES Reports, Eindhoven University of Technology*, 1-5.

Vezhnevets, V., Sazonov, V., and Andreeva, A., 2003. A Survey on Pixel-Based Skin Color Detection Techniques. In *Proceedings of Graphicon 2003*, 85–92, Moscow, Russia.

Wei, L., Gan, Q., and Ji, T., 2018. Skin Disease Recognition Method Based on Image Color and Texture Features. In *Computational and Mathematical Methods in Medicine*, 2018(7):1-10.

Yang, J., Sun, X., Liang, J, and Rosin, P. L., 2018. Clinical Skin Lesion Diagnosis Using Representations Inspired by Dermatologist Criteria. In *The IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 1258-1266.

Zaqout, I. S., 2016. Diagnosis of Skin Lesions Based on Dermoscopic Images Using Image Processing Techniques. in *International Journal of Signal Processing, Image Processing and Pattern Recognition*, 9(9):189-204.