ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 11, Issue 4, April 2024

A Model of Image Processing Based on Gabor Filters

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ABSTRACT: This article analyzes the algorithms for diagnosing diabetic retinopathy by means of retinal images. Based on the analysis results, an image processing algorithm using Gabor filters is proposed. The research results are shown and concluded**.**

KEY WORDS: retinal images, fundus images, Gabor functions, Gabor-based model, retinopathy, Haar function, Gaussian filter.

I.INTRODUCTION

Currently, according to the world health information, diabetes is one of the most common diseases in the world. People suffering from this disease often suffer from various complications. People suffering from this disease face several problems such as cardiovascular problems, gastrointestinal diseases, nervous system diseases and visual impairment. Diabetic retinopathy is one of the main complications of diabetes. Diabetic retinopathy is a disease characterized by dilation of blood vessels and leakage of liquid in the eye. This disease can develop with or without symptoms. Treatment and prevention of the disease in the stage of developing without symptoms is a very complicated process. Therefore, it is necessary to identify the disease as early as possible and make a correct diagnosis. Therefore, it is mandatory for patients with diabetes to undergo regular eye examinations.

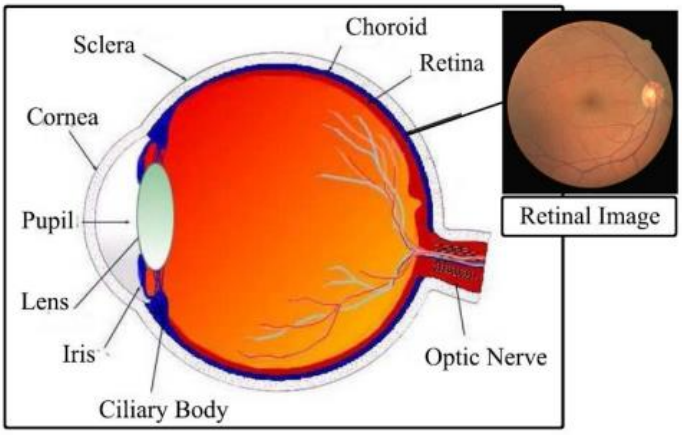


Fig. 1. Anatomy of the eye and retinal imaging

Clinical signs of diabetic retinopathy. Diabetic retinopathy is determined by the appearance of various types of lesions in retinal images. These symptoms of lesions include microaneurysms (MA), hemorrhages (HM), soft and hard exudates (EX).
- MA is the first symptom of diabetic retinopathy, which is determined by the appearance of small, red, round dots on the retina. This occurs due to the weakening of the walls of the vessels. The red dot is less than 125 microns in size and has sharp edges.
- HM - appear in the form of larger spots with an irregular border on the retina and are larger than 125 µm in width.
- HE - This is the leakage of proteins and lipoproteins from abnormal blood vessels in the retina. Their appearance is small white or yellow-white with sharp borders.
- SE - these exudates appear as white spots, usually in the form of a circle. [1]

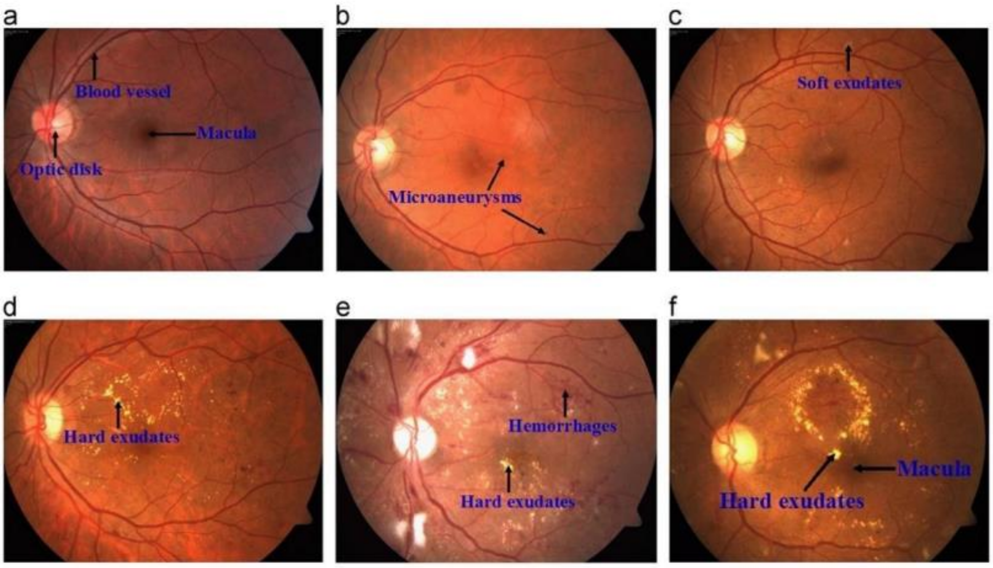


Fig. 2. Symptoms of retinopathy

Making a diagnosis manually is a process that requires a lot of effort and attention. The use of information systems in diagnosis will reduce time and cost and increase accuracy.[7] In addition, the increase of this disease leads to the development and improvement of information systems. The main reason for using Gabor filters in this research is that this function helps to better analyze the small blood vessels and cells in the retinal images.

II. LITERATURE SURVEY

In ophthalmology, the fundus apparatus allows two- and three-dimensional viewing of the image. With the help of this tool, the image of the eye can be enlarged by increasing the light intensity and using a microscope. The camera allows you to observe the retina at an angle of 30 to 50 degrees. It is possible to change the colors of the image to different colors and apply different filters to conduct the inspection. Analysis. Several approaches to the diagnosis of diabetic retinopathy have been analyzed. For example, through more than a thousand images taken from Kaggle open data source, images were brought to the same size, passed through 8 convolution layers from CNN, and softmax function was used for classification. This approach resulted in 84% accuracy. [3]

In the study of M. T. Esfahan et al., normal images and images with retinopathy were downloaded from the Kaggle database to determine diabetic retinopathy. In their research, 512x512 images were processed using Gaussian filters. The processed images are classified into classes using ResNet34 algorithm. This search result is 85% accurate. [4] Gabor filter. Gabor function uses Gaussian function modulated with sine waves to process signals and images. The Gabor function was introduced in 1946 by Denis Gabor. The Gabor function is combined with the Gaussian function and the time frequency, and it is considered optimal in minimizing uncertainties. Gabor function is particularly effective in several image processing such as compression, enhancement, restoration, segmentation and filtering. [5] Window function. Filters can be used as window functions to mathematically apply signal processing. Using these functions, it will be possible to analyze or remove certain areas of the incoming parts. [6]

A Gabor filter can be designed to scale and rotate as needed, so they are closely related Gabor wavelets. However, in general, Gabor wavelets are not scalable because this requires computing orthogonal wavelets, which can be time-consuming. As a result, a Gabor filter bank of different scales and rotations is generated. The signal is combined with filters, resulting in a Gabor field. There is a close relationship between this process and the processes that occur in it. As a result, the Gabor field is widely used in applications such as image processing, edge detection, and texture segmentation. One-dimensional Gabor filter. 1D Gabor filter was first used by D. Gabor. Gabor filters are described as sinusoidal planes modulated by Gaussian envelopes with a set of frequency and orientation.

$$h(x,y) = s(x,y)g(x,y) \quad (1)$$

s(x, y) is a complex sinusoidal function, and g(x,y) is a Gaussian function.

$$s(x,y) = e^{-2\pi j(u_0x+v_0y)} \quad (2)$$

$$g(x,y) = \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{1}{2}\left(\frac{x^2}{\sigma_{x^2}}+\frac{y^2}{\sigma_{y^2}}\right)} \quad (3)$$

where (u_0, v_0) is the spatial frequency, σ_x and σ_y are the standard deviations in x and y axes, respectively. The following figure shows a sine wave, Gaussian function and Gabor filter. Through this graph, it is possible to visualize the result of the Gabor filter on a one-dimensional signal. [6]

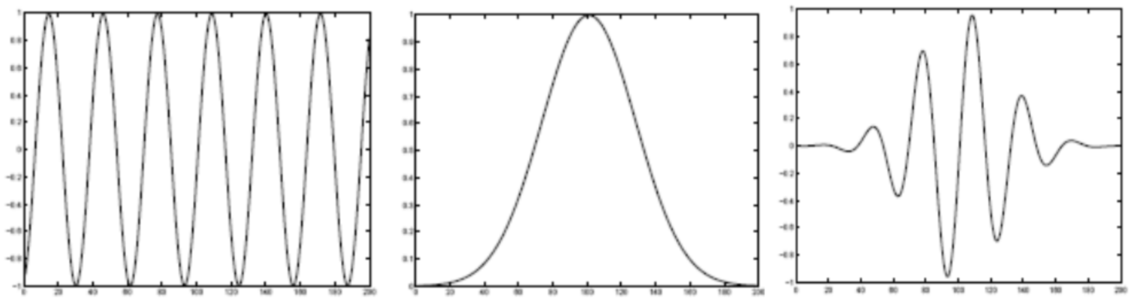
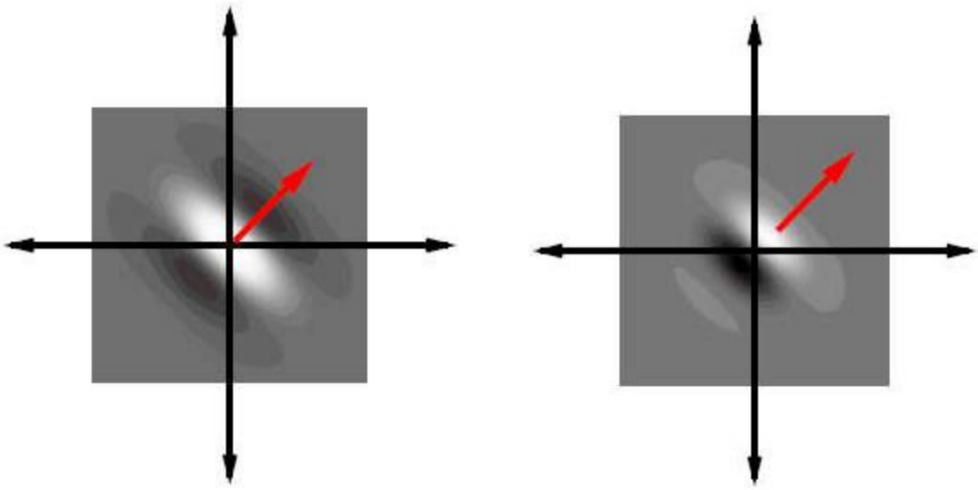


Fig. 3. Sinusoidal wave, Gaussian filter, Gabor filter

Advanced Gabor function. A complex Gabor filter can be written as:

$$g(x,y) = ke^{\left(-\pi\left(a^2(x-x_0)_r^2 b^2(y-y_0)_r^2\right)\right)} \exp\left(j(2\pi(u_0x+v_0y)p)\right) \quad (4)$$

Here:
k- scales the size of the Gaussian envelope.
(a,b)- Gaussian scales the envelope axes up and down.
(x_0, y_0)- is the peak of the Gaussian envelope.
(u_0, v_0)- Cartesian frequency space of sinusoidal carrier.
p- Sinusoidal carrier phase.
The figure below shows the real and imaginary components of the complex Gabor function.



(a) (b)

Fig. 4. α-real component, β-imaginary component

Methodology. The downloaded images will initially be resized to the same 224x224 size. Then the image is denoised and unnecessary areas are removed. [8]

(a) (b)

Fig. 5. (a) The original image, (b) The processed image

III. METHODOLOGY

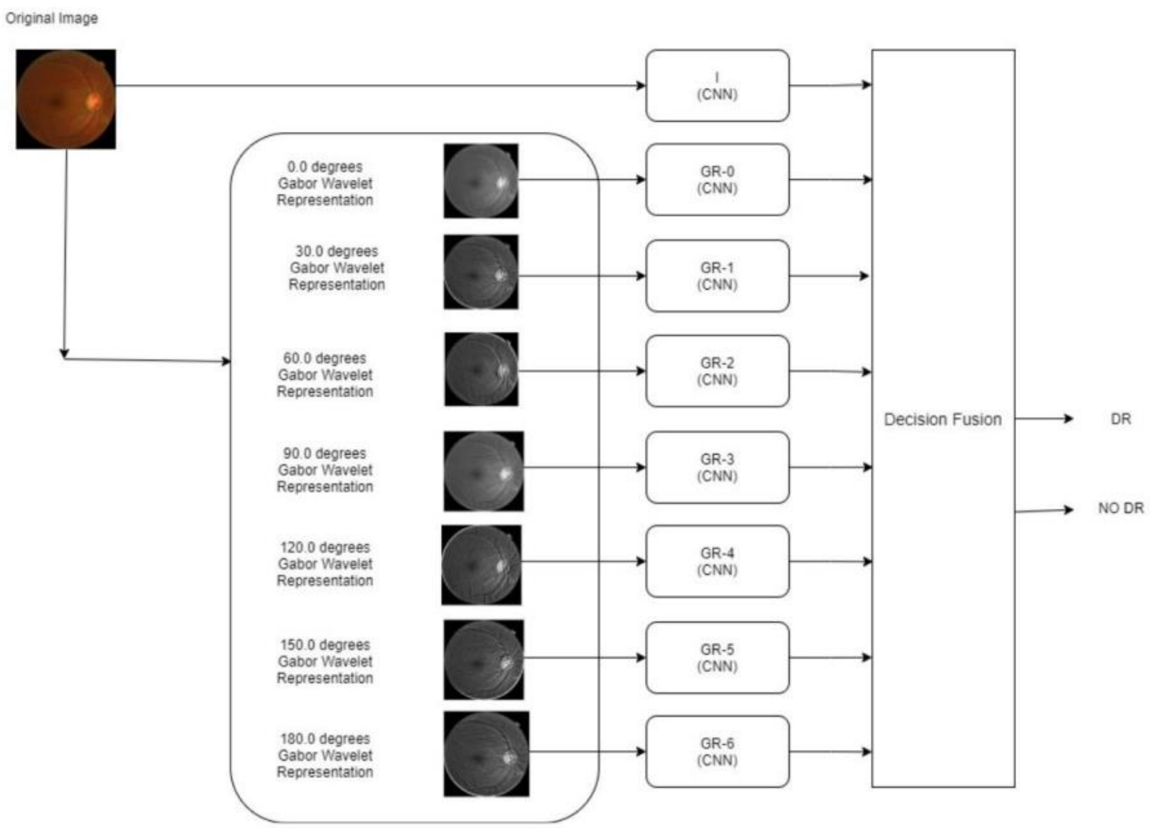


Fig. 6. retinopathy diagnosis model

In the above model, the use of Gabor filter based CNN models was proposed. An image-based CNN model for the detection of diabetic retinopathy. First, the images are pre-processed, then Gabor filters are applied to the images in different directions. is fed to the CNN and the output probabilities are collected from the model. In addition, the images without the Gabor filter are fed to a separate CNN model and the output probability is calculated from the model. As a final step, these previously accepted probabilities are incorporated into the decision synthesis and a decision is made.

Gabor filter application. The Gabor filter is applied to the images at different angles.

$$g(x,y) = \frac{1}{2\pi\sigma_x\sigma_y} e^{(-\frac{1}{2}\left(\frac{x^2}{\sigma_x^2}+\frac{y^2}{\sigma_y^2}\right))} \cos(2\pi f_0 x) \quad (5)$$

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IV. EXPERIMENTAL RESULTS

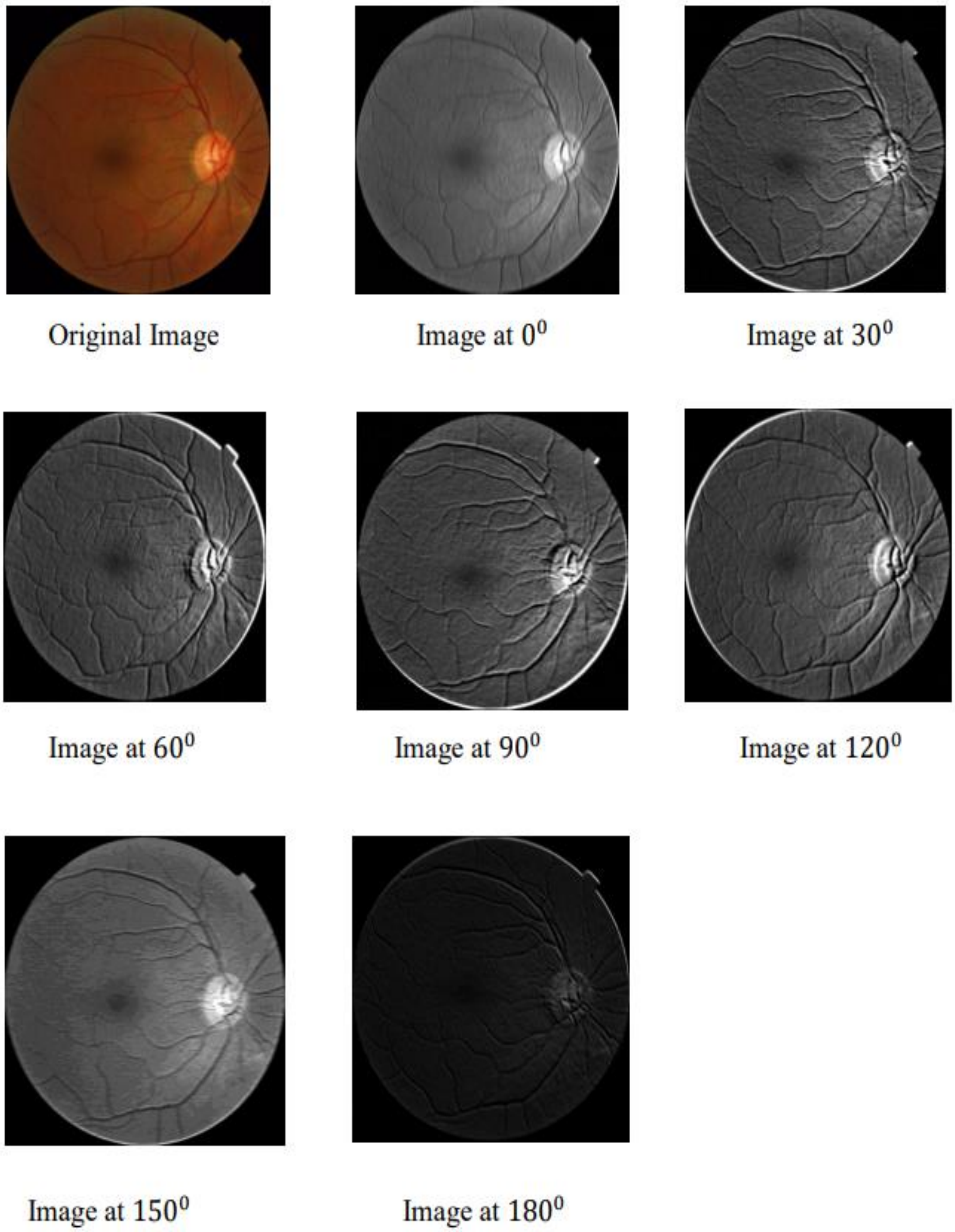

Figure 7. Applying of Gabor filter

The model is applied separately for each corner. Here, we will designate each model as G1, G2, G3, G4, G5, G6, and G7. A Gabor-based CNN model and VGG16 model, one of the original retinal image-based CNN models, were used.

CNN for G	Method	Accuracy (%)
-	I	87.39
VGG16	G0	84.45
VGG16	G30	86.55
VGG16	G60	86.97
VGG16	G90	86.97
VGG16	G120	85.71
VGG16	G150	86.55
VGG16	G180	85.71
VGG16	IGR	93.27
VGG16	IGR	**93.7**
VGG16	GR	92.85
VGG16	GR	92.43

Table 1. Results obtained using VGG 16

V. CONCLUSION AND FUTURE WORK

During this research, the use of Gabor filters with CNN was proposed to detect diabetic retinopathy from color fundus retinal images. Seven Gabor filters were used in this model, each Gabor filter separated by 30 degrees of orientation. This method is based on the traditional CNN learning algorithm. The output of each is included in the decision synthesis block, which applies the rule of the sum of probabilities of the CNN to make a final decision about the presence or absence of diabetic retinopathy in the retinal image. The results obtained are presented and compared with other approaches.

REFERENCES

[1] Kar, S. S., & Maity, S. P. (2017). Automatic detection of retinal lesions for screening of diabetic retinopathy. IEEE Transactions on Biomedical Engineering, 65(3), 608-618.
[2] Freeman, W. R., Bartsch, D. U., Mueller, A. J., Banker, A. S., & Weinreb, R. N. (1998). Simultaneous indocyanine green and fluorescein angiography using a confocal scanning laser ophthalmoscope. Archives of Ophthalmology, 116(4), 455- 463.

[3] Xu, K., Feng, D., & Mi, H. (2017). Deep convolutional neural network-based early automated detection of diabetic retinopathy using fundus image. Molecules, 22(12), 2054.
[4] Esfahani, M. T., Ghaderi, M., & Kafiyeh, R. (2018). Classification of diabetic and 73 normal fundus images using new deep learning method. Leonardo Electron. J.Pract. Technol, 17, 233-248.
[5] Hill, P. C. (2007, September). Dennis Gabor-Contributions to Communication Theory & Signal Processing. In EUROCON 2007-The International Conference on" Computer as a Tool" (pp. 2632-2637). IEEE.
[6] Farokhian, F. (2013). Blood vessels detection and segmentation in retina using Gabor filters. Eastern Mediterranean University.
[7] TQ Urazmatov, XS Kuzibayev MapReduce and Apache spark: technology analysis, advantages and disadvantages Journal of Physics: Conference Series, 2022
[8] KS Kuzibaev, TK Urazmatov, BB Nurmetova "The use of Big Data in the field healthcare: Uzbekistan and foreign experience" 2022 International Conference on Information Science and Communications Technologies (ICISCT)