Feature Extraction Process on Early Diabetic Retinopathy Identification Process

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Article Info
Page Number: 3495-3505
Publication Issue:
Vol. 71 No. 4 (2022)

Article History
Article Received: 25 March 2022
Revised: 30 April 2022
Accepted: 15 June 2022
Publication: 19 August 2022

Abstract
The clinical procedures available nowadays are mostly useful in preventing many eye related issues in human being. Various studies based on clinical reports are very clear to make a statement that, patients with diabetes has highest risk to Diabetic Retinopathy (DP). Almost 80 to 85% of patients suffering from Diabetics has highest probabilistic chance of getting Diabetic Retinopathy (DP). The collected retinal fundus images from eye are mostly used for detecting the severity level of infections and also used for analyzing the diabetic retinopathy effects. Analyzing retinal fundus images can be useful in finding different vision problems such as Strabismus, Glaucoma, Cataract, Diabetic Retinopathy, Amblyopia, Refractive Errors and Macular Degeneration. The collected retinal images from eye may has many irrelevant information, which is not needed for Diabetic Retinopathy identification process. The irrelevancy found on the collected images can affect the proper working of learning algorithm and can create problem in execution. The stage followed in pre-processing removes all the irrelevancies present in the collected retinal images and few techniques were followed for enhancing the quality of the processed retinal images. This research article is very specific in explaining the steps followed after the pre-processing stage such as feature extraction process on retinal images. The retinal fundus images collected from Kaggle are preprocessed and selected for feature extraction process. The feature extracted from database is tested and evaluated by considering mean and standard deviation value. The class difference for the collected retinal fundus images are divided into early stage, normal and severe.

Keywords: Diabetic Retinopathy, Strabismus, Glaucoma, Cataract and Amblyopia,

1. Introduction

Human Eye is most sensitive organ and can be affected easily by various diseases. The vision problems occurs due to the factor of age and few hereditary problems are mostly common and makes very difficult task for doctors to category the eye problem occurs on patients. So making a correct decision and giving a right treatment for suffering patients turns to be time constrain process. In few cases it can cause loss of sight to suffered patient without proper treatment and medication.

Many subsequence problems occurs in human body can also effect the proper functioning of eye and can cause eye defection. Measles, High Blood Pressure, Diabetes, Autoimmune Conditions, Lyme disease, Rosacea, Shingles, Liver Disease, Sickle Cell Disease and Malnutrition are denoted subsequence disease gradually affects to function of eye. The patients suffering from these diseases are increasing more in number and creates huge problem in disease identification process and treating the patient on time. This research work focuses on revealing problems occurs due to the cause of Diabetes and creates awareness about diabetic retinopathy (DR). The features necessary for the analyzing the diabetic retinopathy (DR) is selected and tested for accuracy. Diabetic Retinopathy is one of the everlasting disease type found on middle aged human and causes severe damage to tissues in eye. Diabetic Retinopathy creates slight changes in capillaries of retina, which damage the local microaneurysms of retina. This problems are known for interregional hemorrhage and commonly considered as initial stage of the Diabetic Retinopathy.

The human eye is most sensitive part of the body which is mostly affected by vascular diseases. The problem occurs due to the effect of eye fundus can be screened and treated with various imaging technique. The quality and accuracy of the acquired image extracted using image extraction approach is mostly directed using fundal image infections. Proper image processing technique is needed to carry image extraction process in eye fundal infections. Images processing is basically used for identifying abnormalities presence in fundal images.

The image processing technique are useful in finding the damaged blood vessels presence in eye fundal images. Diabetic Retinopathy infections found on the eye vessels mostly effects the eye tissues presented inside the eye. If the growth of the Retinopathy is increased in size, then it is side to be diabetic maculopathy, which infects the muscle parts of the eye and causes vision problem.

There is highest probability chance of blocks found on the retina after the retinopathy growth found on the blood vessels and causes microinfarcts in retia. The infections found on the retina are commonly known as soft exudates. Handling these abnormalities fount on the volve of the eye are encountered simultaneously for avoiding severity in eye defects. There are many techniques available for detecting Diabetic Retinopathy and classifying effectively. Fluorescein angiography, indirect ophthalmoscope, stereoscopic color film fundus photography, direct ophthalmoscope, monochromatic photography, non-mydriatic digital color and mydriatic are few techniques available for detecting the Diabetic Retinopathy.

Feature extraction process carried out in the collected eye images are most important for analyzing the Diabetic Retinopathy is later stages. There are many features available in collected and preprocessed fundal images. Blood vessel area, Exudates area, Hemorrhages area, Optimal distance area, Shannon entropy, micro-aneurysms and bifurcation points are most important features for identifying Diabetic Retinopathy in eye fundal images.

Literature Review

The existing research papers of Diabetic Retinopathy gives a key idea of uncharacterized protein of tissue growth found on the core area of retina, which gradually effects the proper working eye and even leads to vision problem in future. The main issues discussed is known as Drosophila melanogaster, which plays a major role in many old aged peoples eyesight problems. Many of research works are developed to make a full stop to many age related problems for old aged peoples. Ehen though there are lot of improvements are there in the field of diabetic retinopathy, there is lot of uncovered or uncertain regions are there in this image processing technique in identifying the diabetic retinopathy presence in collected retinal images.

The inventions for screening such diabetic retinopathy presence in eye is most challenging task, scientist started to work hard for acquiring the detailed problem discretion for diabetic retinopathy. The Harding et al. findings about the diabetic retinopathy is clear in showing the sensitivity and specificity percentage for separate normal images as well as for infected images. The features presence in fundal images are common in having fovea, disc and blood vessels as features.

The abnormalities found on the diabetic retinopathy included blot, exudates and hemorrhages features. The research work carried out by Philips et al is first attempt made for the identifying the diabetic retinopathy through exudates. The identification process followed in this research work is based on thresholding, classification and edge detection process. The infections found on exudates are separated with global and local thresholding values implemented with 100% and 71% of sensitivity and specificity respectively.

There are more research works focuses on developing the separate strategy of converting the images into green channel view in the preprocessing and taken for feature identification process. The detection range of those research work seems to be better compared with other strategy in acquiring the infected parts of the eye. Optical disk boundary extraction process followed in the research work is very useful in identifying the extra tissues formations found on the retinal of an eye. The red channel conversion and green channel conversion are two technique very useful in finding out the Optical disk on retina of an eye.

The location methodology technique implemented in identification process are very useful in using the segmentation algorithm in automatic segmentation process and optical disk detection process with high rage of accuracy. The major blood vessel and bifurcation feature identification process used by Ravishanker et al. uses a proposed methodology in optic disk detection process with basic accuracy improvement in detection process. The used approximation algorithm is also added as advantage in detection process. The data mining algorithms such as fuzzy C-mean clustering, SVM and neural networking are basically used for finding the infection levels of the eye.

PROPOSED METHODOLOGY

Feature extraction process followed in every image processing research work is mostly avoided for time consuming. But carrying feature extraction process in image processing can be useful in accurate identification process in analyzing stage. Basically, the inputs are collected from the preprocessed eye fundal images and processed with applying certain rules for feature identification process. This research articles focuses on carrying the best suitable features for analyzing Diabetic Retinopathy in eye fundal images.

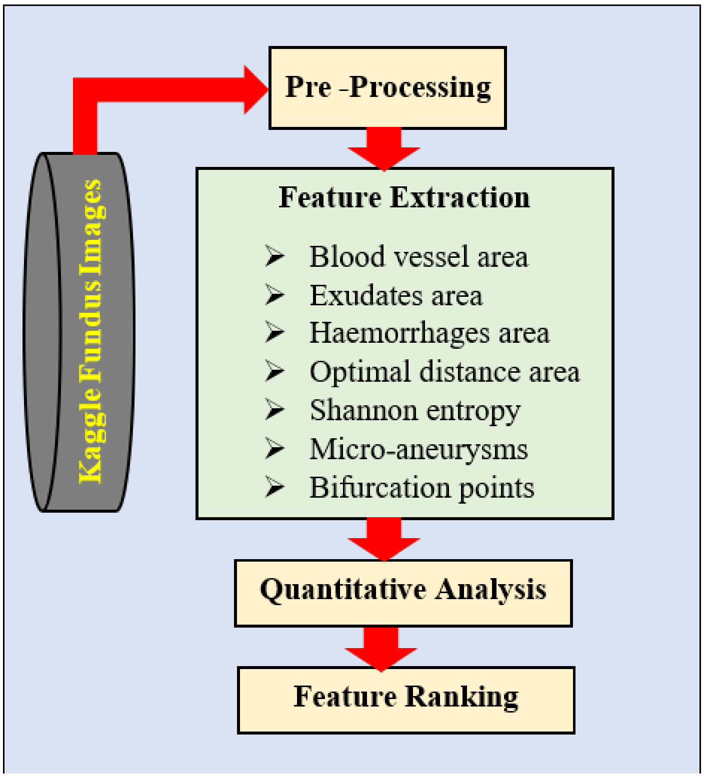


Figure 1. Fundus Images Feature Ranking Process Flow

The fundal images collected are taken for the pre-processing technique, were unnecessary information and duplicate files are removed. The missing sequence presence in images are cleared with fillers. The processed images are taken for the next feature selection process, were very relevant features are collected.

The collected fundal images are from different types of fundal cameras and vary in sizes. The process of cleaning not only clears the irrelevancy presence in given collected fundal images, it also helps in maintaining the same image size for all fundal images. Some of the collected fundal images are out of focus as well as dark in color, which may be corrected in pre-processing strategy. The dataset used for the research is collected from Kaggle and preprocessed with various technique to obtain a best suitable image for analyzing. The preprocessed images are normalized, de-noised with green channel and enhanced with Histogram equation for producing best result in feature extraction process.

The collected fundal images consist of 14 features acquired from different sources, which are mostly contains the detailed description of eye. The analyzing of previous feature extraction process followed is helpful in selecting the particular feature needed for segregating the affected parts from the un-affected parts of fundal images of eye. The most needed 7 features are arranged and collected for better understanding the Diabetic Retinopathy presence in fundal images. The segmentation and feature ranking are the next process followed after completing the feature selection process.

Feature Extraction

The Optic disk removal process and detecting exudate process are the two major tasks carried out before carrying out the feature extraction process. Exudate identification process is ϕuseful in removing the optic disc presence in eye fundal images. Fundal images are mostly has very similar color, intensity and contrast for every attributes in fundal images, which may be confused while processing analyzing stage. Basic fundal images has high contrast circular shape area known as optic disk. The vessels presented in part of eye also has high contrast, which may be collected as optical disk. So it’s very challenging task for identifying the optic disk presence in fundal images.

The conversion of green channel images make in the preprocessing can solve this issue and used for identifying the blood vessel separately, however giving the operator (ö) for grayscale converted fundal images remains an alternative solution for removing the blood vessel presence inside the optic disc regions of eye. The solution can be given with applying the flat disc structure element with the constant radius of B1 as shown in equation 1.

$$OP1 = \phi\ (B1)\ (fI) \qquad (1)$$

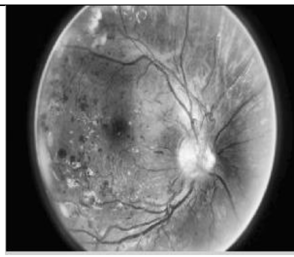
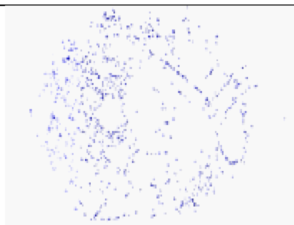
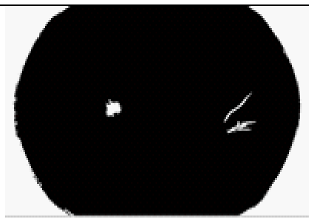
Where B1 is the linguistic structured element.

The low intensity objects presence in the fundal images are collected with fixing the threshold automatically in gray level exudates process. The neighboring pixels to threshold pixels are selected as flat disc structure element with constant radius of 6(B1) 15.

The classification techniques are involved for identifying the Micro aneurysms and Hemorrhages in collected fundal images. The segmentation process is used for separating the affected and unaffected parts of fundal images. The Support vector machine (SVM) is one of the best classifier used for classifying the affected and unaffected parts of fundal images. The filtering techniques of wrapper and filter process are also implemented for best feature selection process. After completing the classification process using the SVM algorithm the Micro aneurysms and Hemorrhages are plotted as in table 1. The sample fundal image collected and sample Micro aneurysms and Hemorrhages images are shown in table 1.

The gray level conversion and green field detection process carried out in the collected fundal images are also shown with samples. The enhanced fundal images are shown for attended advantages in classifying the affected and unaffected infected parts of fundal eye images. The blood vessels presence and fundal images are very clearly shown in table 1. The pixels found surrounding the blood vessels are very similar and difficult to identify the infections. The length of the infections minimum and maximum size of infections found on the eye is noted.

Table 1. Identification of Optic disk, Micro aneurysms and Hemorrhages fundal image

 Fundus Color image	 Fundus Gray Scale
 Colored Fundus image	 Green Channel Denoising
 Original Fundal Image	 Optic Disk Removed image
 Original Fundal Image	 Micro aneurysms fundal image
 Original Fundal Image	 Hemorrhages fundal image

The collected fundal images are classified with SVM and data rating is given with separate values for different type of infections found on eye. The value range starts with 0 and end with 4. Zero is given for “No Diabetic Retinopathy”, One is given for “Mild”, Two is for “Moderate”, 3 is for “Severe” and 4 is given for “Proliferative Diabetic Retinopathy”. The trained images are measured with standard deviation and mean.

RESULTS AND DISCUSSION

The implementations are carried out with different set of feature values for infected retinal images and not infected retinal images. The MATLAB software is useful in computing the normal images and diabetic retinal images. The normal images and diabetic retinal affected images are tableted with considering the mean and standard deviation combined in the bellow table 2.

Table 2. Identified Features standard range of values

Fundal Features	**Normal**	**Diabetic Retinopathy**
Exudates area	0±0	1025.24±1071.37
Blood Vessel Area	37255.57±196.374	33570.57±5524.93
Bifurcation point count	325.51±78.2737	334.6559±102.8090
Shannon entropy	7.350±1.3418	7.0390±1.2626

The mean and standard deviation performed in the research work suggest that the feature value of exudates, hemorrhage and Micro aneurysms are decremented to zero. This decrement in those values happens because of its absence in normal retinal images. Based on the feature ranking parameters, all the mean difference of the images are arranged based on the ranking and weightage of the image.

Table 3. Standard Deviation and mean for normal and Diabetic Retinal fundal images

Identified 7 Features	**Standard Deviation**		**Mean Value**	
	Normal	**Diabetic**	**Normal**	**Diabetic**
Exudates area	0	13.247	0	1030.81
Blood Vessel Area	2840.40	2312.87	38487.80	34673.63
Bifurcation point count	21.13	13.35	333.2457	316.089
Shannon entropy	0.228	0.10	6.5010	5.8562
Optic Distance	11.7470	20.354	929.803	926.363
Hemorrhage area	28385.46	390002	79325.51	90743.16
Micro aneurysms area	23628	23762	86190	63437

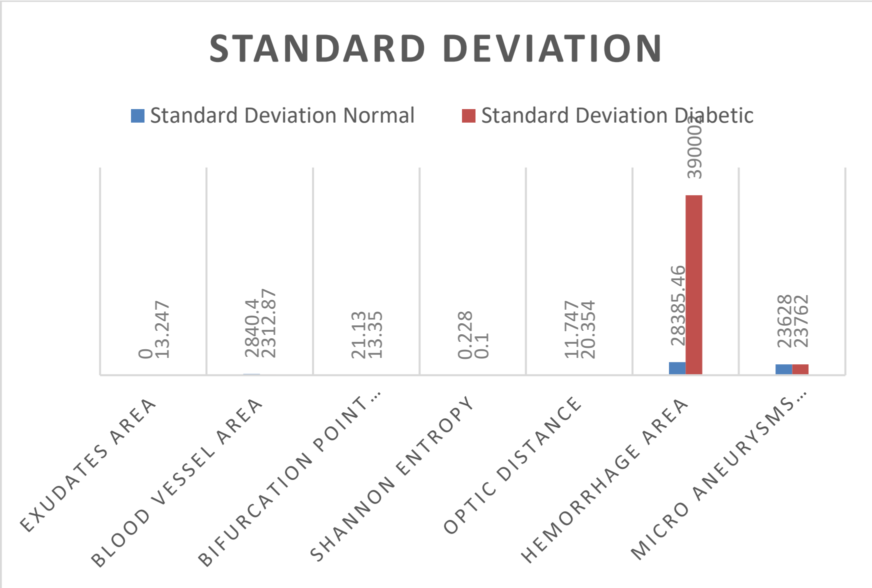


Figure 2. Standard Deviation for normal and infected eye

The figure 2 is very clear in showing the feature exudates are very low compared with other feature identified with range values. Hemorrhage area features are identified as highest in concern with the standard deviation.

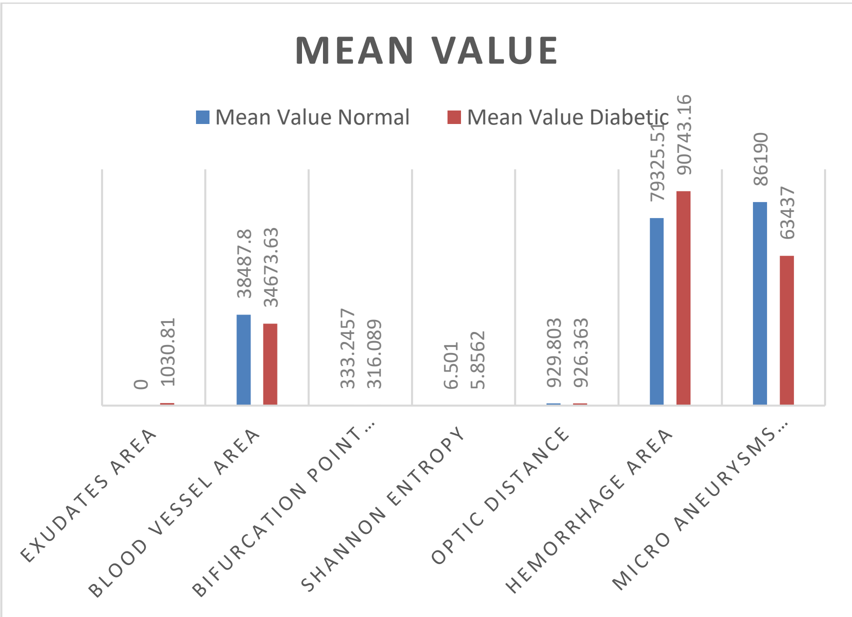


Figure 3. Mean value for normal and infected eye

The figure 3 is very clear in showing the feature exudates are very low compared with other feature identified with range values. Hemorrhage area and Micro aneurysms area features are identified as highest in concern with the mean value.

The normal range for all the individual features are shown in Table 3. The Exudates area presence in the normal images are always zero because of its absence in normal images. The standard deviation and mean values of the seven features are tabulated after various iterations and making consolidations.

The standard deviation of blood vessel area in normal images is 2840.40, which is higher than diabetic affected images 2312.87. The calculated mean for the normal images is 38487.80 which is higher than diabetic affected images 34673.63. The standard deviation of Hemorrhage area is 28385.46, which is lower than diabetic affected images 390002. The calculated mean for the normal images in diabetic affected images is 79325.51, which is lower than diabetic affected images 90743.16.

The table 3 is very clear in explaining that the exudates are highest ranked feature because of its complete absence in normal retinal images. The blood vessels features has high mean difference in affected images because of its impact is more in Diabetic Retinopathy presence is more. The extracted micro features from exudates features may be useful in detecting the Diabetic Retinopathy identification process.

CONCLUSION

The infections found on the retinal part of eye may affects the proper working of eye. The subsequence problems related to eye infections are mostly affecting the working of the vision. The infections found on the core tissues of retina are mostly considered as the symptoms of diabetic retinopathy. This research paper focuses on feature extraction process followed during the Diabetic Retinopathy infection identification process using machine learning techniques. The pre-processing techniques followed for Diabetic Retinopathy is completed and collected data is taken for the feature identification process using MATLAB engineering tool. The collected images are divided into two divisions such as normal eye images and diabetic affected eye images. Basic available features in collected eye images are numbered as 14 based on the type and significance. The total extracted features for identifying the Diabetic Retinopathy needed 7 exclusive features listed in the research paper. These relevant features are compared with each other and ranked very simple for identification of infected parts as well as for uninfected parts. The implementations are made with the proposed model and results are obtained in considering mean and standard deviation for each and every feature selected. Among the selected features exudate area remains a best feature for identifying the Diabetic Retinopathy presence in retinal fundal images.

REFERENCES

1. Zhang X, Saaddine JB, Chou CF, et al. Prevalence of diabetic retinopathy in the United States, 2005e2008. JAMA. 2010;304(6):649e656.
2. Early Treatment Diabetic Retinopathy Study Research Group. Grading diabetic retinopathy from stereoscopic color fundus photographsdan extension of the modified Airlie House classification. ETDRS report number 10. Ophthalmology. 1991;98(5 Suppl):786e806.

3. Lin DY, Blumenkranz MS, Brothers RJ, Grosvenor DM. The sensitivity and specificity of single-field nonmydriatic monochromatic digital fundus photography with remote image interpretation for diabetic retinopathy screening: a comparison with ophthalmoscopy and standardized mydri-atic color photography. Am J Ophthalmol. 2002;134(2): 204e213.
4. Detry-Morel M, Zeyen T, Kestelyn P, et al. Screening for glaucoma in a general population with the non-mydriatic fundus camera and the frequency doubling perimeter. Eur J Ophthalmol. 2004;14(5):387e393.
5. Mookiah MRK, Acharya UR, Chua CK, et al. Computer-aided diagnosis of diabetic retinopathy: a review. Comput Biol Med. 2013;43(12):2136e2155.
6. Winder RJ, Morrow PJ, McRitchie IN, et al. Algorithms for digital image processing in diabetic retinopathy. Comput Med Imag Graphics. 2009;33(8):608e622.
7. Singh A, Dutta MK, ParthaSarathi M, et al. Image processing based automatic diagnosis of glaucoma using wavelet features of segmented optic disc from fundus image. Comput Methods Prog Biomed. 2016;124:108e120.
8. Bock R, Meier J, Nyúl LG, et al. Glaucoma risk index: auto-mated glaucoma detection from color fundus images. Medical Image Analysis. 2010;14(3):471e481.
9. Issac A, Partha Sarathi M, Dutta MK. An adaptive threshold based image processing technique for improved glaucoma detection and classification. Comput Methods Prog Biomed. 2015;122(2):229e244.
10. LeCun Y, Bengio Y, Hinton G. Deep learning. Nature. 2015;521(7553):436e444.
11. Annan L, Jun C, Damon Wing Kee W, Jiang L. Integrating holistic and local deep features for glaucoma classification. Conf Proc IEEE Eng Med Biol Soc. 2016;2016:1328e1331.
12. Abràmoff MD, Folk JC, Han DP, et al. Automated analysis of retinal images for detection of referable diabetic retinopathy. JAMA Ophthalmol. 2013;131(3):351e357.
13. Gulshan V, Peng L, Coram M, et al. Development and vali-dation of a deep learning algorithm for detection of diabetic retinopathy in retinal fundus photographs. JAMA. 2016;316(22):2402e2410.
14. Abramoff MD, Lou Y, Erginay A, et al. Improved automated detection of diabetic retinopathy on a publicly available dataset through integration of deep learning. Invest Ophthalmol Vis Sci. 2016;57(13):5200e5206.
15. Prasanna Porwal SPRK, Kokare M, Deshmukh G, et al. Indian Diabetic Retinopathy Image Dataset (IDRiD). IEEE Dataport (The Institute of Electrical and Electronics Engineers) Data-port; 2018. Available at: https://idrid.grand-challenge.org/ Rules/.
16. Decencière E, Cazuguel G, Zhang X, et al. TeleOphta: machine learning and image processing methods for tele-ophthalmology. IRBM. 2013;34(2):196e203.
17. Son J, Bae W, Kim S, et al. Classification of findings with localized lesions in fundoscopic images using a regionally guided CNN. Computational Pathology and Ophthalmic Medical Image Analysis, Lecture Notes in Computer Science 11039. 2018:176e184. Available at: https://link.springer.com/ chapter/10.1007/978-3-030-00949-6_21.

18. Kottas M, Kuss O, Zapf A. A modified Wald interval for the area under the ROC curve (AUC) in diagnostic case-control studies. BMC Med Res Methodol. 2014;14:26.
19. Decencière E, Zhang X, Cazuguel G, et al. Feedback on a publicly distributed image database: the Messidor database. Image Analysis & Stereology. 2014;33(3):231e234.
20. Bae JP, Kim KG, Kang HC, et al. A study on hemorrhage detection using hybrid method in fundus images. J Digit Im-aging. 2011;24(3):394e404.
21. Rapantzikos K, Zervakis M, Balas K. Detection and segmen-tation of drusen deposits on human retina: potential in the diagnosis of age-related macular degeneration. Med Image Anal. 2003;7(1):95e108.
22. Sasaki M, Kawasaki R, Noonan JE, et al. Quantitative mea-surement of hard exudates in patients with diabetes and their associations with serum lipid levels. Invest Ophthalmol Vis Sci. 2013;54(8):5544e5550.
23. Kose C, Sevik U, Ikibas C, Erdol H. Simple methods for segmentation and measurement of diabetic retinopathy lesions in retinal fundus images. Comput Methods Programs Biomed. 2012;107(2):274e293.
24. Kottas M, Kuss O, Zapf A. A modified Wald interval for the area under the ROC curve (AUC) in diagnostic case-control studies. BMC Med Res Methodol. 2014;14:26.
25. Decencière E, Zhang X, Cazuguel G, et al. Feedback on a publicly distributed image database: the Messidor database. Image Analysis & Stereology. 2014;33(3):231e234.
26. Bae JP, Kim KG, Kang HC, et al. A study on hemorrhage detection using hybrid method in fundus images. J Digit Im-aging. 2011;24(3):394e404.
27. Rapantzikos K, Zervakis M, Balas K. Detection and segmen-tation of drusen deposits on human retina: potential in the diagnosis of age-related macular degeneration. Med Image Anal. 2003;7(1):95e108.
28. Sasaki M, Kawasaki R, Noonan JE, et al. Quantitative mea-surement of hard exudates in patients with diabetes and their associations with serum lipid levels. Invest Ophthalmol Vis Sci. 2013;54(8):5544e5550.