

Detection and Grading of Diabetic Maculopathy Automatically in Digital Retinal Images

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Abstract: Diabetic Retinopathy (DR) is a critical eye disease which can be regarded as manifestation of diabetes on the retina the symptoms can blur or distort the patient's vision and are a main cause of blindness. Exudates are one of the signs of Diabetic Retinopathy. If the disease is detected early and treated promptly many of the visual loss can be prevented. This paper explains the development of an automatic fundus image processing and analytic system to facilitate diagnosis of the ophthalmologists. The algorithms to detect the optic disc; blood vessels and exudates are investigated. The proposed system extracts macula from digital retinal image using the optic disc location. Many common features such as intensity, geometric and correlations are used to distinguish between them. The system uses GLCM for feature extraction. The system uses a SVM based classifier to differentiate the retinal images in different stages of maculopathy by using the macula co-ordinates and exudates feature set.

Keywords: Fundus image, exudates, macula, diabetic retinopathy.

I. INTRODUCTION

Diabetes is one of the common disease all over the world, in which the lack of insulin causes high blood sugar in human. Diabetic Maculopathy (DM) is a complication from diabetic retinopathy that causes gradual and irreversible loss of central vision. This condition damages the retinal blood vessels causing them to leak which ultimately leads to blindness. DR is characterized by the development of retinal micro aneurysms, haemorrhages, cotton wool spots (CWS) and hard exudates. Micro aneurysms are weak red spots developed on blood vessels that bulge outward. They are the first detectable change in the retina due to DR. Haemorrhage is usually round or oval in shape and formed by the rupture of micro aneurysms. They are also red in colour and can be located within the mid-retina. Hard exudates and CWS are collectively known as exudates. Hard exudates are yellowish deposits of protein present in the retina. CWS are the soft exudates which are white and fluffy lesions.

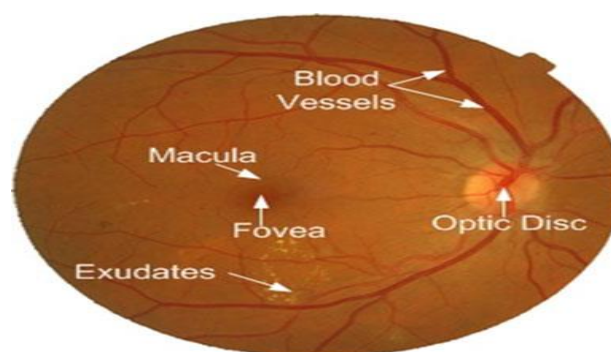


Figure: 1. Main components of the human retina along with exudates

There are several stages of DR such as non-proliferative DR(NPDR), proliferative(PDR), and maculopathy or macular edema(ME). Diabetic maculopathy occurs if exudates appear on or near the macula affecting central vision. The central portion of the retina which is usually darkest and rich in cones is called the macula. The centre of macula is called fovea.

The importance of detecting the macula is that it is used for early detection of various diseases. Figure 1 shows the main component of human retina and also the exudates present on the surface of the retina.

II. PROPOSED METHODOLOGY

Automated screening of human retina and detection of early signs can save patient's vision so it is important to develop CAD systems for retinal diseases. This paper proposes a complete system for grading of maculopathy to save sudden vision loss. The proposed system consists of preprocessing, macula and exudates detection, feature extraction and finally grading of maculopathy using a SVM based classifier. The algorithm improves the quality of automated system by eliminating blood vessels and optic disc pixels to ensure the reduction in false positives in detailed feature set for accurate detection of exudates. Figure 2 shows the complete flow diagram of our system starting from input retinal image to its final grading.

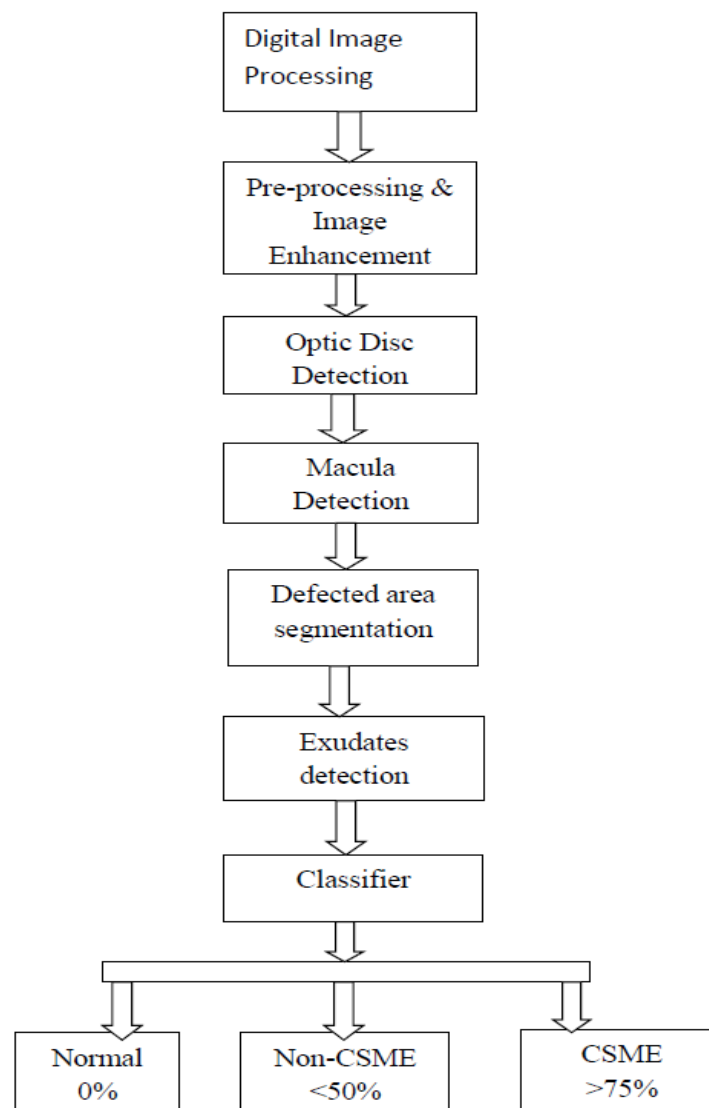


Figure: 2. Flow diagram of proposed system

Pre-processing:

The acquired retinal image may contain extra background pixels which are not required for further processing and add more time in overall processing. The purpose of pre-processing is to remove the background by differentiating between background and foreground pixels. Once the background is detected, the smallest window containing foreground pixels

is retain by eliminating all other unnecessary pixels. Pre-processing consists RGB to Gray conversion, contrast enhancement, histogram equalisation.

Exudate's Detection:

Exudates are the bright lesions which appear on the surface of the retina if the leaking blood contains fats and proteins along with water. The presence of optic disc (OD) makes it difficult for an automated system to detect the exudates with high accuracy. The proposed system detects and removes OD pixels for accurate detection of exudates. The following steps are used for the exudates detection.

1. Take pre-processed image as an input and apply morphological closing to remove the effect of blood vessel and dark lesions.
2. Apply adaptive contrast enhancement technique to improve the contrast of exudates on retinal surface.
3. Optic disc detection AND Macula detection

Macula detection is an important module for developing the computerized system for grading of diabetic maculopathy. It is the macular area of the eye that is affected in diabetic maculopathy upsetting the central vision of the eye and in severe cases leading to blindness. In the macula detection technique, the macula is first localized with the help of localized optic disk and enhanced blood vessels. Finally, the macula is detected by taking the distance from the centre of optic disk along with enhanced blood vessels image to locate the darkest pixel in this reason and making clusters of those pixels. The largest cluster formed is the macula. The outputs of the different modules that is pre-processing, exudates and macula detection is shown in GUI.

Feature Extraction:

The exudates region (i.e. the region of interest) detection phase extracts as many possible regions as it can for possible exudates. Feature extraction is the procedure of data reduction to find a subset of helpful variables based on the image. In this work, seven textural features based on the gray level co-occurrence matrix (GLCM) are extracted from each image. The seven Haralick texture descriptors are extracted from each co-occurrence matrices which are computed in each of four angles.

- Angular Second Moment (ASM) / Energy.
- Contrast.
- Inverse Difference Moment (IDM) / Homogeneity.
- Dissimilarity.
- Entropy
- Maximum Probability
- Inverse

SVM Classifier:

Support vector machine are supervised learning model with associative learning algorithm that analyses data and recognize pattern, used for classification. This will classify images (0-25%) as healthy, (25-50%) as non-CSME and CSME in two parts (50-75%) and (75-100%). In order to classify ROI as exudate and non-exudate region, we use a SVM classifier using Gabor filter. Gabor filter extract

III. RESULT

The evaluation of automated diagnostic system is very important and should be done carefully. Hence we have used image database from a reputed eye institute, through which evaluation and validation of the proposed system is been done successfully. This system is able to provide about 87.33 % accurate results when tested with 100 such input fundus images.

IV. CONCLUSION

Diabetic maculopathy is an advance level of retinal abnormalities which may be present in diabetes sufferers. This may cause total blindness if not detected and treated in time. We presented a computerised diagnostic system for automated screening of diabetic maculopathy and providing an expert advice. The proposed system performed retinal image analysis for grading of maculopathy using SVM based classifier. Our proposed system consists of pre-processing, exudates region detection followed by macula detection. This system is a unique software solution where in a doctor does not need to be an ophthalmologist, but still can give a proper advice with this support system.

REFERENCES

- [1] Junichiro Hayashi, Takamitsu Kunieda, Joshua Cole, Ryusuke Soga, Yuji Hatanaka, Miao Lu, Takeshi Hara and Hiroshi Fujita: A development of computer-aided diagnosis system using fundus images. Proceeding of the 7th International Conference on Virtual Systems and Multimedia (VSMM 2001), pp. 429-438 (2001).
- [2] Iqbal, M.I (771207-8638) Aibinu, A.M (730109-P554) Gubbal, N.S (820727-P639) Khan, A (801029-P212) AUTOMATIC DIAGNOSIS OF DIABETIC MACULOPATHY USING FUNDUS IMAGES
- [3] P. Mohanaiah, P. Sathyanarayana, L. GuruKumar Image Texture Feature Extraction Using GLCM Approach International Journal of Scientific and Research Publications, Volume 3, Issue 5, May 2013 1 ISSN 2250-3153
- [4] Angel Suero, Diego Marin, Manuel E. Gegundez-Arias, and Jose M. Bravo Locating the Optic Disc
- [5] in Retinal Images Using Morphological Techniques IWBBIO 2013. Proceedings Granada, 18- 20 pp no.593-600 March, 2013
- [6] Y. Kanagasingama, A. Bhuiyan, M.D. Abramoff, R.T. Smith, L. Goldschmidt, T. Y. Wong., "Progress on retinal image analysis for age related macular Degeneration", ELSEVIER. Progress in Retinal and Eye Research 38, pp. 20-42, 2014.
- [7] A. Sopharaka, B. Uyyanonvara, S. Barman, T.H. Williamson., "Automatic detection of diabetic retinopathy exudates from non-dilated retinal images using mathematical morphology methods", ELSEVIER. Computerized Medical Imaging and Graphics 32, pp. 720-727, 2008.
- [8] R.J. Qureshi, L. Kovacs, B. Harangi, B. Nagy, T. Peto, A. Hajdu "Combining algorithms for automatic detection of optic disc and macula in fundus images", ELSEVIER. Computer Vision and Image Understanding 116. pp. 138-145, 2012.
- [9] N. S. Datta, R. Banerjee, H. S. Dutta, S. Mukhopadhyay., "Hardware based analysis on automated early detection of Diabetic-Retinopathy", ELSEVIER. Procedia Technology 4, pp. 256 - 260, 2012.
- [10] P. Chowriappa, S. Dua, U. R. Acharya, M. Muthu Rama Krishnan. "Ensemble selection for feature-based classification of diabetic maculopathy images", ELSEVIER Computers in Biology and Medicine 43., pp. 2156-2162, 2013.
- [11] Neijer M, Ginneken BV, Russell SR, Suttorp-Schulten MS, Abramoff MD: Automated detection and differentiation of drusen, exudates and cotton-wool spots in digital color fundus photographs for diabetic retinopathy diagnosis. Invest Ophthalmology Vis Sci 48(5): pp.2260-2267, 2007.
- [12] Akram MU, Khan MU: Automated detection of dark and bright lesions in retinal images for early detection of diabetic retinopathy. J Medical Systems 36(5): pp.3151-3162, 2012.
- [13] Alireza O, Shadgar B, Markham R: Computational-intelligence based approach for detection of exudates in diabetic retinopathy images. IEEE Transactions on Information Technology in Biomedicine 13 (4): pp.535-545, 2009.
- [14] Lim ST, Zaki WMBW, Hussain A, Lim SL, Kusalavan S: Automatic classification of diabetic macular edema in digital fundus images. 2011 IEEE Colloquium on Humanities, Science and Engineering (CHUSER), pp. 265-269, 2011.
- [15] Tariq A, Akram MU: An automated system for colored retinal image background and noise Segmentation. IEEE Symposium on Industrial Electronics and Applications (ISIEA 2010), Pp.405-409, 2010.