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Automatic MA detection method for Diabetic Retinopathy

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Abstract— We have evaluated our approach for micro aneurysm detection in an online competition, where this algorithm is currently ranked as first, and also on two other databases. Since micro aneurysm detection is decisive in diabetic retinopathy (DR) grading. Grading performance of computer aided DR screening system highly depends on MA detection. In this paper we propose a MA detector that provides remarkable results from both aspect. The earlier systems used manual methods for detecting microanuersym that caused increase in obtaining wrong results. so an ensemble based system is being used which contains a combination of pre-processing and candidate extractors.

Keywords—Diabetic retinopathy (DR) grading, ensembles based systems, micro aneurysm (MA) detection.ROC (retinopathy online challenge), hemorrhages, candidate extractor , machine learning .

I. Introduction

Diabetes is disease that affect blood vessels thought the body especially on kidneys & eyes. Along with diabetes, high blood sugar level in long periods can affect small vessels in the retina. Diabetic retinopathy (DR) is complicated eye dieses which is cause blindness for human being.

MA is early sign of DR. so detection of MA is essential in an efficient screening process. MA is nothing but small circular spot on the surface of retina. MA is near thin vessel but they cannot actually lies on the vessels. DR can be prevented by earlier detection of MA & slows down progression of MA. Therefore regular eye checkup & timely treatment is needed. But due to the higher medical cost makes regular check up costly. To fill this gap development of low cost & versatile MA detection technique is needed. We develop MA detector & DR Grading which give better result.

II. Bakground information

Anatomy of human eye:

The anatomy of the human eye consists of different cellular structures which are responsible to maintain proper functioning of our vision system. Light entering the eye passes through the anterior and posterior regions before it is processed in the visual cortex. The anterior region which consists of cornea, iris, pupil, and lens mainly serves as a pre-processing step to control the amount of entering light and converges it on the retina. The posterior region contains retina

which is a multi-layered sensory tissue made of millions of photo-receptors to capture incoming light. The central area within retina is called the macula which consists of the central fovea, rich in cones, and a peripheral area, rich in rods. Cones are highly color sensitive photo-receptors and are mainly responsible for day vision. On the other hand rods are highly sensitive to contrast variations and active during night vision or dark light condition.

Dibetic retinopathy:

These dieses originate from diabetic mellitus. It causes progressive damage to the retina. The light sensitive lining at back of eye. It is serious complication of diabetes. DR damages to the tiny blood vessels that nourishes to the retina. They leak blood & other fluid that cause swelling of retinal tissue & clouding of vision. Some time patients can only differentiate between dark & light part of the image. It affects to the both eyes. There are 5 stages of progression of DR. (1) No apparent retinopathy -no abnormalities. (2) Mild non-proliferative DR- the presence of dot & blot hemorrhages & micro aneurysms (MA) in the retina. Presence of MA only. (3) Moderate non proliferative DR- In this stage some of blood vessel in retina actually blocked. It decreases the supply of nutrients & oxygen to certain areas of retina. (4) Sever non-proliferative DR- as more blood vessel become blocked retina is not getting properly nourishments. (5) Proliferative DR – the retina grows abnormal blood vessel which are fragile & tends to break easily leading & profound vision loss.

(a) Normal Vision.

(b) Vision with Diabetic Retinopathy.

Figure 2: Normal Human Vision vs. Vision affected by Diabetic Retinopathy

III. Present theories

An approach to improve micro aneurysm detection in digital color funds images. Instead of following the standard process which considers preprocessing, candidate extraction and classification, we propose a novel approach that combines several preprocessing methods and candidate extractors before the classification step. We ensure high flexibility by using a modular model and a simulated annealing-based search algorithm to find the optimal combination. Our experimental results show that the proposed method outperforms the current state-of-the-art individual micro aneurysms candidate extractors

Automated detection of lesions in retinal images can assist in early diagnosis and screening of a common disease: m. We propose a new constraint for optic disk detection where we first detect the major blood vessels first and use the intersection of these to find the approximate location of the optic disk. This is further localized using color properties. We also show that many of the features such as the blood vessels, exudates and micro aneurysms and hemorrhages can be detected quite accurately using different morphological operations applied appropriately. These compare very favorably with existing systems and promise real deployment of these systems.

A new algorithm is proposed for removing large objects from digital images. This paper presents a novel and efficient algorithm that combines the advantages of these two approaches. We first note that exemplar-based texture synthesis contains the essential process required to replicate both texture and structure; the success of structure propagation, however, is highly dependent on the order in which the filling proceeds. We propose a best-first algorithm in which the confidence in the synthesized pixel values is propagated in a manner similar to the propagation of information in inpainting. The actual color values are computed using exemplar-based synthesis. Computational efficiency is achieved by a block based sampling process

We present an approach to improve micro aneurysm detection in digital color fundus images. Instead of following the standard process which considers preprocessing, candidate extraction and classification, we propose a novel approach that combines several preprocessing methods and candidate extractors before the classification step. We ensure high flexibility by using a modular model and a simulated annealing-based search algorithm to find the optimal combination.

IV. Preprocessing methods

The pre-processing method is been selected so that from the noisy images is been removed so that the MA detection is done easily.The best methods is been selected from image processing so that the image obtained will have all the characteristics needed to detect diabetic retinopathy. These pre-processing method used can be modified for future purpose

Walter -Klein Contrast Enhancement

This method is used to improve the contrast by using the gray level transformation which is been applied to the retinal image that is been used as input image.

Contrast Limited Adaptive Histogram Equalization

The popular technique that is been used in image processing because it increases the clarity of the salient part of the image making it visible and clear.The borders between the image is been eliminated by using bilinear interpolation.

Vessel Removal and Extrapolation

The unwanted vessels is been removed from the input image and extrapolation method is been done to fill the holes that has been created during the in painting algorithm used. thus this makes the image more clear to detect the MA.

Illumination Equalization

This method is used to eliminate the uneven illuminations of the fundus image that is obtained after the extrapolation. Illumination Equalized image

No Pre-processing

Without doing the pre-processing method directly the candidate extraction method is been done.

V. Candidate extraction

Candidate extraction is the process that is to spot the characteristics of the MA image obtained after the pre-processing method. For future enhancement of the system, the new candidate extractors methods can be used.

Walter et al

This method used is to find small dark patterns on the green channel by using grayscale diameter closing.

Spencer et al

The retinal image extracts a vascular map and top-hat transformation is done .The final image obtained is then bilinear zed

Circular-Hough Transformation

This technique is used for extraction of circular objects from the image.

Zhang et al

This method is used to constructs maximal correlation response for the input image. the methods like vessel detection is done to reduce the number of candidates and to determine the size of the image.

Lazar et al

Cross-sectional profiles of pixel wise are used to construct multidirectional height map and this map set the height values that describes the distinction of the pixel that is used in the surrounding image.

VI. Ensemble creation

We provide an ensemble creation framework to select the best combination. In our framework, an ensemble E is a set of (preprocessing method, candidate extractor) pairs. The meaning this pair is that first we apply preprocessing method to the input image & then candidate extractor. Collect candidate whose Euclidian distance d is smaller than predefined constant r ∈ R from where HE is set of candidate & c is individual candidate.

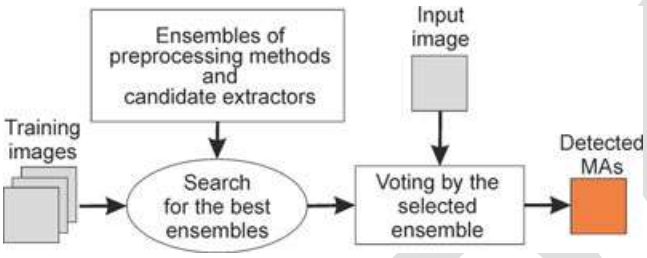

Figure 4 : Flow chart of the ensemble-based framework.

Centroid calculate by using HE & IC. Ensemble creation is process where all ensemble E from ensemble pool E is evaluated & best performing one Ebest ∈ E. select that one to find E, output candidate set HE must be compared to ground truth in the following way: for c ∈ HE there exist a point ground truth , whose Euclidian distance d from c is smaller than a predefined constant r ∈ R , the c is considered true positive otherwise c is false positive. While each ground is truth point is false negative. That does not have a a close candidate from HE .If M=N preprocessing methods and candidate extractor, then we have 25pair with 225 number os possible combination to form ENSEMBLE .It is very resource demanding. we use search algorithm : To evaluate such condition. Large number of combination. So we used stimulate annealing as search algorithm :

Algorithm 1: Selection of the optimal combination of preprocessing methods and candidate extractors.

1. $\mathcal{E} \leftarrow P(PP_i \times CE_j)$, $i = 1, \ldots, M$, $j = 1, \ldots, N$
2. $CPM_{best} \leftarrow 0$
3. $E_{best} \leftarrow NULL$
4. **for all** $E \in \mathcal{E}$ **do**
5. $\quad H_E \leftarrow \emptyset$
6. $\quad$ **for all** $p \in E$ **do**
7. $\quad\quad$ **for all** MA candidate c detected by p **do**
8. $\quad\quad\quad I_c \leftarrow \{c' | c'$ is a MA candidate found by a $p' \in E$, with $p \neq p'$ and $d(c, c') < r\} \cup \{c\}$
9. $\quad\quad\quad confidence(c) = \frac{|I_c|}{|E|}$,
10. $\quad\quad\quad H_E \leftarrow H_E \cup centroid(I_c)$
11. $\quad\quad$ **end for**
12. $\quad$ **end for**
13. $\quad$ **if** $CPM(H_E) > CPM_{best}$ **then**
14. $\quad\quad CPM_{best} \leftarrow CPM(H_E)$
15. $\quad\quad E_{best} \leftarrow E$
16. $\quad$ **end if**
17. **end for**
18. **return** E_{best}

Figure 5: algorithm to find final ensemble to find the final ensemble

VII. Implementation

It is proposed to develop new & effective detection technique of MA which use set of different algorithms for candidate extractors & pre-processing methods (pair). The corresponding energy function value is computed on the union of the candidate sets belonging to the pairs in the collection. The candidates of this collection are compared to a set of micro aneurysm centroids (ground truth) selected manually by clinical experts. If the Euclidean distance of the centroid of a candidate and a manually selected MA is smaller than a given threshold, then it is regarded as a true positive (TP), otherwise it is a false positive (FP).If an ensemble E contains more (preprocessing method, candidate extractor) pairs, their outputs are determined in the following way: Take 10 training images which are already disease affected images. Then we use the selected preprocessing methods, which we consider to be applied before executing MA candidate extraction. There may be 5 methods present in preprocessing method. Candidate extraction is present next to preprocessing method. Similar to preprocessing there are 5 techniques are present in Candidate extractors. For a single image, 25 combinations are available. Since there are 5 methods available in both preprocessing and candidate extraction, for each method in preprocessing there are 5 candidate extraction methods are processed. Likewise it repeated for 5 methods in preprocessing. So there are 25 methods are proceeded for a single image. Then we should have to calculate the entropy for all 25 results. Then after calculating the entropy for the 25 methods, we can predict the best technique or method, considering whose entropy is highest. For ex., if third method's entropy is highest means we determine that third one is the best technique. Likewise, we should calculate for a set of 10 training images, by following the procedure mentioned above we can determine best techniques for 10 images. After analyzing the best techniques whose entropies are highest for 10 images, mentioned above, we can see that third technique is repeated many times than other. So we can conclude that the third technique is the best technique.

VIII. Result

The above paper is study paper so result is as per previous paper. The practically results are obtain after completion of project. In this section, we present our experimental results for both

MA detection

The corresponding energy function value is computed on the union of the candidate sets belonging to the pairs in the collection. The candidates of this collection are compared to a set of micro aneurysm centroids (ground truth) selected manually by clinical experts. If the Euclidean distance of the centroid of a candidate and a manually selected MA is smaller than a given threshold, then it is regarded as a true positive (TP), otherwise it is a false positive (FP). After applying preprocessing methods & candidate extraction methods, in this paper we propose the approach for MA detection.

DR grading:

In DR grading, measure the performance of proposed system. Measure the specificity accuracy sensitivity of total image and false positive image. We have also evaluated our ensemble-based approach to see its grading performance to recognize DR. For this aim, we determined the image-level classification rate of the ensemble on the Messidor1 dataset containing images. That is, the presence of any MA means that the image contains signs of DR, while the absence of MAs indicates a healthy case. In other words, a pure yes/no decision of the system has been tested. In this grading we also calculate eccentricity, major axis ,minor axis, area of the MA. And finally detected MA and stage of MA on the no. MA detected.

CONCLUSION

In this paper, we have proposed an ensemble-based MA detector that has proved its high efficiency in an open online challenge with its first position. Our novel framework relies on a set of $\langle$ preprocessing method, candidate extractor $\rangle$ pairs, from which a search algorithm selects an optimal combination. Since our approach is modular, we can expect further improvements by adding more preprocessing methods and candidate extractors. However, a proper screening system should contain other components, which is expected to increase the performance of this approach, as well.

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