Automatic Detection of Retinal Anomalies

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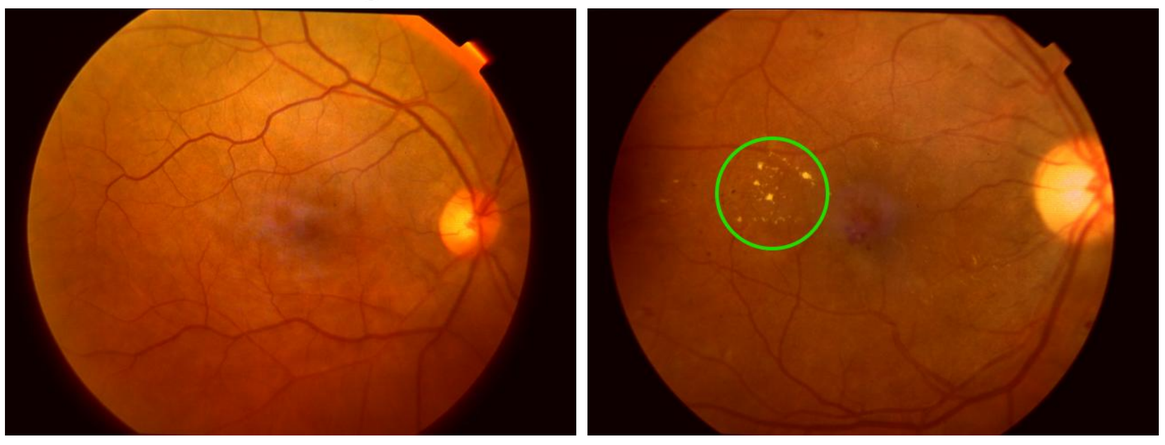
Introduction and Motivation

Diabetic retinopathy is a disease caused by complications of diabetes mellitus, which can eventually lead to blindness. It is an ocular manifestation of systemic disease which affects up to 80% of all patients who have had diabetes for 10 years or more[1].

Fortunately, an early disease diagnosis can greatly reduce the damage caused to the patient. However, identifying tiny anomalies in an image of *eye fundus* is complex given that the images are too similar.



Normal Image **Exsudato Image**

Currently, there is no computational tool to assist specialists in this type of diagnosis.

Therefore, our goal in this work, is to build a computational system that could indicate whether or not an image of *eye fundus* have any anomaly, leading to an early diagnosis.

Early Attempts to Solve the Problem

We have tested several different approaches to find and characterize anomalies in images of *eye fundus*.

Latent Dirichlet Allocation[2] (LDA) is a generative model that allows sets of observations to be described by unobserved groups which explain why some parts of the data are similar.

"Gabor Wavelets[3]" for image region characterization. It uses wavelet transforms based on the Gabor kernel to build the feature vector of each image.

The best research direction so far has been using "**Visual Dictionaries[4]**". This approach usually consists in extracting and characterizing features of an image. The approach groups similar features of an image (e.g., by means of clustering) building **"Visual Words"** to represent the image regions.

For the visual word description, we have tested several different descriptor **"patches"** up to this point. However, the descriptors **Scale Invariant Features[5] (SIFT)** and **Speeded-Up Robust Features[6] (SURF)** have been the most promising ones.

***Bibliography**

1 - *Evidence-Based Eye Care,* JAOA 79(3):116-117, 2008

2 - *Latent Dirichlet Allocation,* JMLR 3(Jan):993-1022, 2003

3 - *Image Representation Using 2D Gabor Wavelets,* TPAMI 18(10):959-971, 1996

4 - *Language Modeling for Bag-of-Visual Words Image Categorization,* ACM CIVR 2008

5 - *Distinctive Image Features from Scale-Invariant Keypoints,* IJCV 60(2):91-110, 2004

6 - *Speeded-Up Robust Features (SURF),* CVIU 110(3):346-359, 2008

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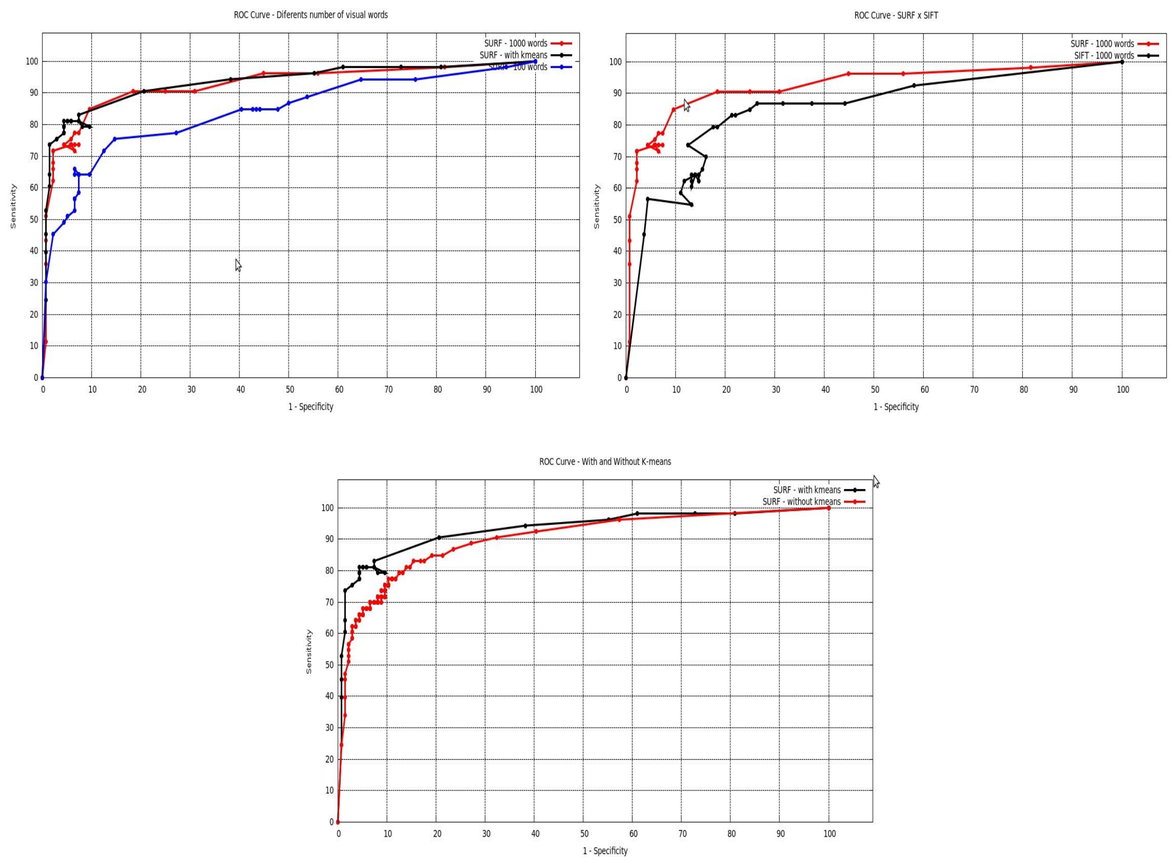
Our Method

Our method strives for finding an appropriate Hilbert space to the problem. For that, we calculate some interest points (**keypoints**) which are detected in all analyzed images (we have 2,307 images from which 687 are normal, 264 are exsudato and the remaining refers to other anomalies). These keypoints are characterized by a descriptor (e.g., SURF, SIFT). After that, we define an appropriate number of keypoints (the visual words) to represent the feature space.

We can find the visual words in two ways: (1) using a clustering algorithm such as *k-means* (the centroid of each kernel can represent the visual word); or (2) choosing random keypoints from the pool of all available keypoints in a giving training set.

The projection of an image onto this space is done by calculating a **"histogram of points"** to each image namely "**feature vectors"**. With a feature vector for each image, we can now feed this information to a Machine Learning Classifier. The **Support Vector Machine (SVM)** is the classifier with best results up to this point.

After training this classifier, for any test image that arrives to be analyzed, we calculate its keypoints, describe them using SIFT or SURF and calculate the projection of these keypoints onto our Hilbert Space. Finally, we feed the projected information to a classifier to point out whether or not this image represents a certain anomaly.



Future Work

Our next step consists of building a visual dictionary adapted to our problem, finding other descriptive features and speeding up the computation tasks.

External Research

Microsoft® Research