AUTOMATED SCREENING FOR DIABETIC RETINOPATHIES: IT IN THE FIGHT AGAINST PREVENTABLE BLINDNESS

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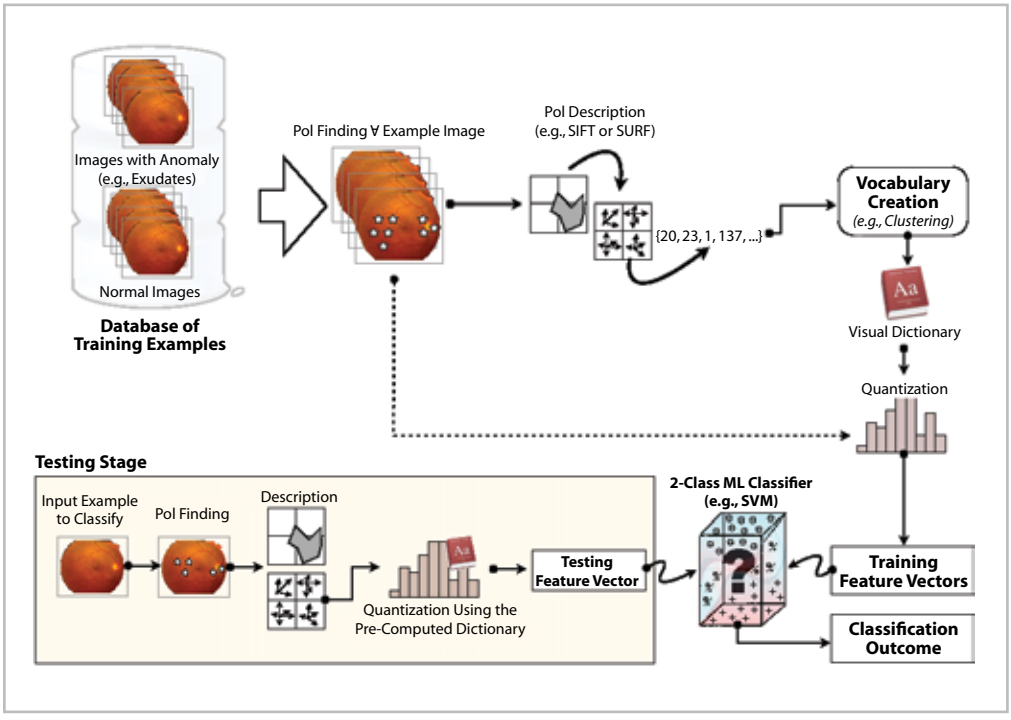

Figure 1

This study has the following objectives:

1) To develop a system for screening patients that will accurately detect cases of diabetic retinopathy through dilated eye examination – The system will be used as an automated retinopathy classification system, distinguishing between normal images (patients who do not require further attention) and images suggestive of retinopathy (patients who require the attention of a specialist). Therefore, specialists will not need to examine patients in whom no change in the *fundus oculi* is expected, allowing the specialists to do their job more efficiently. The expectation is that this system will produce few false-negative results (i.e., not detecting retinopathy when it is present), because an indication that there is no change in the *fundus oculi* would exclude the patient in question from receiving the attention of a specialist. The system should detect the following changes, all of which are suggestive of diabetic retinopathy: hemorrhage, exudates, vascular changes, scarring, hyperpigmentation, and hypopigmentation. The initial version of the system will not detect macular edema, which is also associated with diabetes.

2) To implement the system in a true teleophthalmology service, in which only images suggestive of disorder will be referred to specialists – This deployment is aimed at assessing the system "in production" and assessing the needs of infrastructure and organizational requirements for maintaining a diabetic retinopathy teleophthalmology service with automated support.

MAIN RESULTS

Detectors of the three most common abnormalities in diabetic retinopathy were developed. These detectors use a technique that is unusual in medical image processing: they detect "feature points" of the image (points at which there is textural discontinuity) and group the characteristics of those points into "visual words". Although this point characteristics/visual words technique (the so-called "bag-of-words" approach) has been used for image retrieval by similarity in other fields, it has not previously been applied to the classification of medical images. In comparison with the results obtained with state-of-the-art detectors, those achieved through the use of this technique were slightly less accurate for exudates etc., and comparable for microaneurysm and deep retinal hemorrhage. The advantage of this technique is that, in contrast with the state-of-the-art detectors, it does not appear to be specific to any one anomaly. The system can be "taught" to detect exudates and other anomalies with greater accuracy.

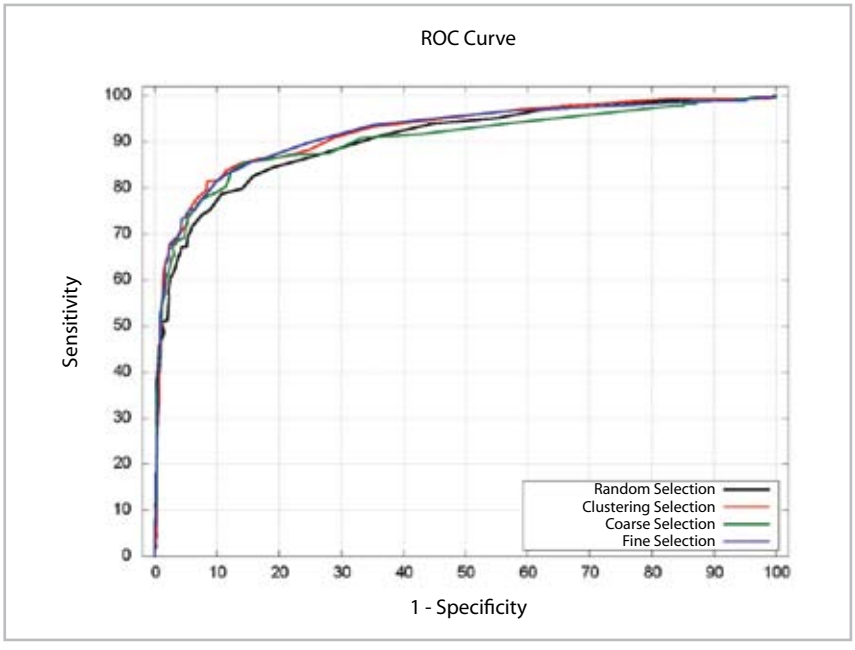

Figure 2

Using the three detectors in parallel, we can detect the three targeted abnormalities with a false-negative rate of less than 0.5% and a false-positive rate of approximately 20%. Unfortunately, these three detectors are not yet capable of detecting, at such rates, any other abnormality associated with diabetic retinopathy. Therefore, efforts are being made to develop detectors that can identify the next three leading anomalies.

In the first year of the project, we classified the 8,000 *fundus oculi* images initially available, and we are using those images in order to "train" and validate the detectors. Since September 2010, new images have been collected at a primary health center specializing in diabetes, where the imported retinal imaging system was made available for use, at an average rate of 20 per day. These new images have not yet been classified.

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