Automatic screening of Diabetic Retinopathies: IT in the fight against preventable blindness

Participants (faculty)

- Jacques Wainer (UNICAMP and UNIFESP)
- Siome Goldenstein (UNICAMP)
- Michel Farah (UNIFESP)
- Paulo Schor (UNIFESP)
- Paulo Morales (UNIFESP)
- Ivan Pisa (UNIFESP)

Participants (students and physicians)

- Bruno Brandao (UNICAMP)
- Eduardo Dib (UNIFESP)

Objectives

To develop a system to automatically triage retinal images for the presence of diabetic retinopathies. The system should have the highest sensitivity possible (very few false negatives). Specificity can be low - that is there may be many false positives.

To test the system in a real tele-ophthalmology operation, first in “mock triage” and then, if possible, as a real automatic triage system.

Social economic relevance

- Diabetic retinopathies (DR) are common in diabetic patients. In the US around 40\% to 45\% of diabetic patients have DR, and after 20 years with the disease, almost all type II and more than 60\% of type II diabetics have DR.[1]
- Diabetes is a “developed world” disease. 7.8% of the American population has diabetes - 25% of them undiagnosed[2]

[1] National Eye Institute Diabetic Retinopathy, 2008.

[2] National Diabetes Information Clearinghouse 2007

Social economic relevance

- In the US DR is the leading cause of preventable blindness in persons from 24 to 74 years of age[1] but not in India[2]
- As countries develop, they tend more towards the US proportions. Brazil has around 7% of the population with diabetes. I do not know the Brazilian data on the importance of DR in blindness

[1] Fong et all. Retinopathy in Diabetes *Diabetes Care* 27, 2004.

[2] VISION 2020 - NPCB Report - Rapid Assessment of Avoidable Blindness - INDIA - 2007

Hypothesis

A telemedicine service where

- a system evaluates retinal images can discard the images that DO NOT have alterations.
- images that present some alteration are sent to an expert for evaluation, diagnostics and treatment,

is more cost effective than the alternative setups, where either the ophthalmologist is at the point of care, or where all images are sent to be evaluated.

This project

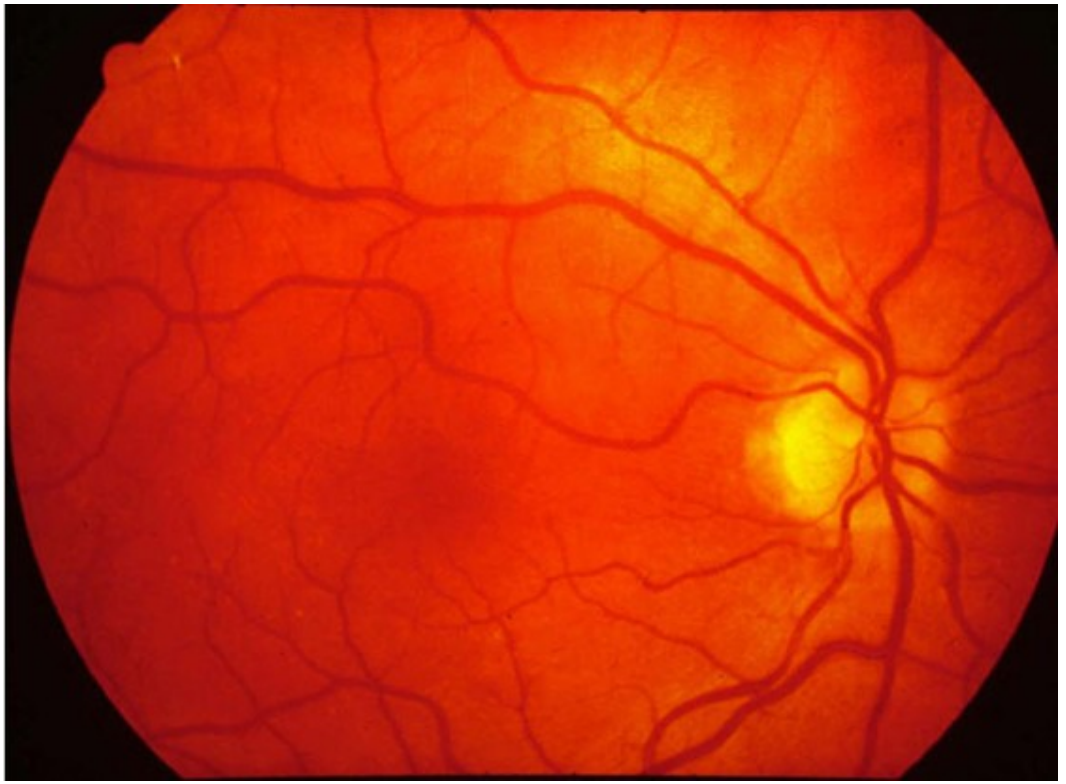
In this project we will:

- develop the triage software (first year of the project) - phase 1
- set up the tele-ophthalmology service without the automatic triage (third semester) - phase 2
- set up the service WITH automatic triage (fourth semester) - phase 3

Medical part

- Diabetes causes increased vascular permeability. This is serious in organs where there are very thin vessels - brain, kidneys, and retina
- Leakages may cause some of the non-proliferative DR - exusades and hemorrhages If this happens in the macula (high sensibility region in the retina) there is a macular edema
- Low flow of blood cause the creation of new vessels (proliferative DR). New vessels rupture easily and may cause retinal detachment.

Retinoscopy (normal)



Exusades

Hemorrhages and exusades

Proliferative

Medical part

- DR are asymptomatic and may lead to a sudden loss of vision.
- Some/most DR can be treated (in the early stages) to prevent loss of vision.

Phase 1

- Development of the triage software.
- We will use the characteristic points set of techniques in computer vision to “detect” the presence of the different retinopathies: exusades, hemorrhages, maybe proliferative DR, maybe macular edema.

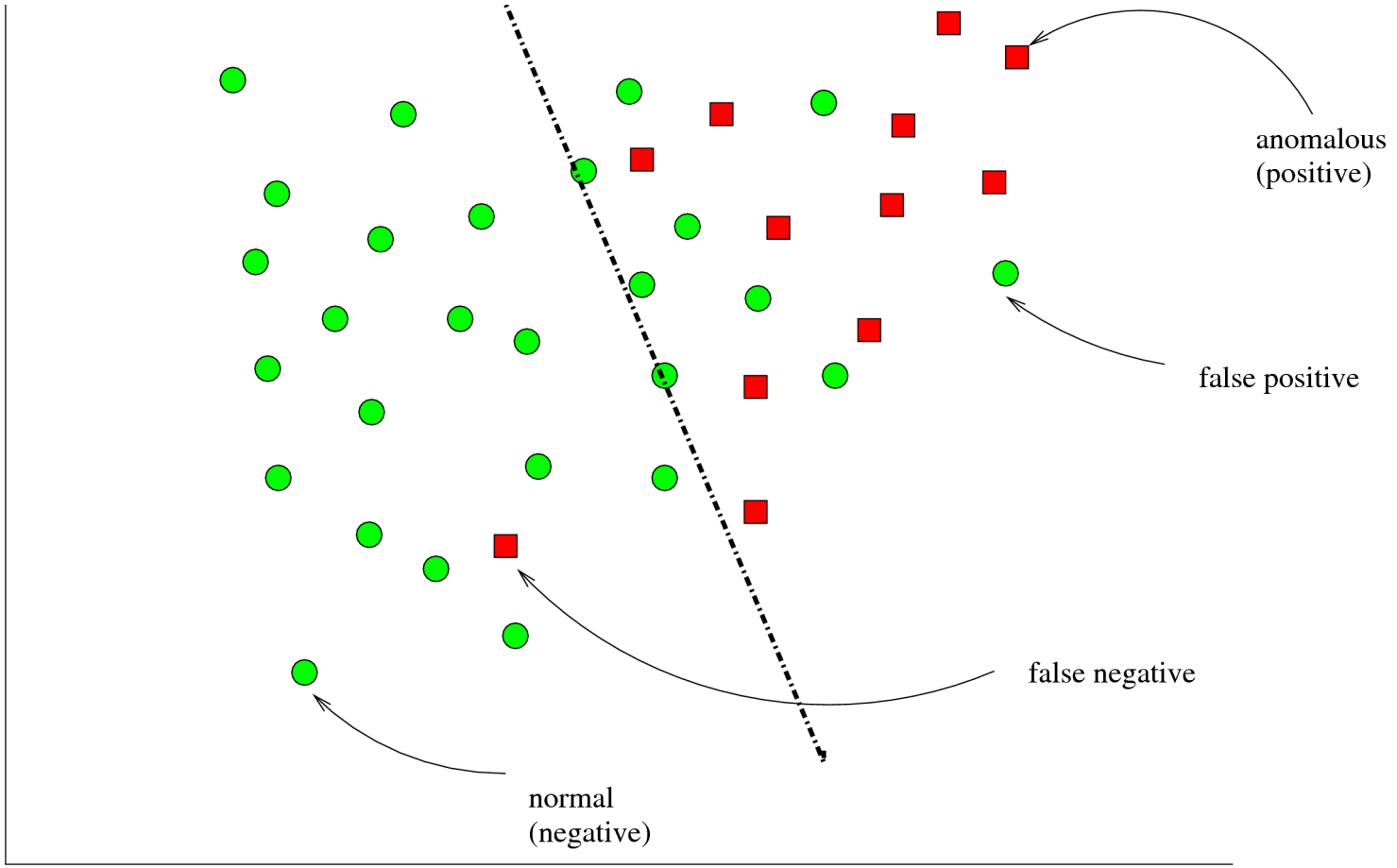
- Characteristic points find points with distributions of textures that are part of anomalies. Probably usefully in hemorrhages and exusades, but less likely to be useful in proliferative DR.
- Not the usual technique in the detection of retinopathy which is based on segmentation of the vessels (surveyed ~20 pubished papers in RD detection) .

Triage not diagnostic

- We only want to point out anomalous images, not to diagnose them. This makes the problem easier.
- But the system cannot say an image is normal when it is not (false negative) - in this case the patient will not see a specialist and will go untreated!
- Need very high sensitivity (proportion of anomalous detected over the total number of anomalous).

- If many normal images are flagged as anomalous this is not so bad - they will be sent to the specialist that will see them as normal.
- Specificity (proportion of normal images detected over the total normal images) can be low

High sensitivity



Phase 2

- System in mock operation
- 2 retinal digital cameras
- one permanently in a primary care Health Center and
- the other in a every other month “Journey of the diabetic”
- Trained technician to operate the cameras

Phase 2

- The retinal image will be send in parallel to the system and to a specialist.
- At the end of 6 month, compare the ones flagged as anomalous. All “real” DR must have been flagged as anomalous.
- Re-evaluate the specificity of the system

Phase 3

- If phase 2 gives the “appropriate results” for sensitivity, then for six months we will run the system in the specified mode.
- All images are filtered by the system, and only the ones classified as anomalous are sent to the specialist, for evaluation.

Further research

- If phase 2 is OK, we will likely search for further funding to expand the experiment.
- During phase 2 and 3, the technological research can go on: attacking different DRs, increase specificity, or detect other retinal problems.

Ethical issues

- Phase 1 - no problem. Anonymous data to train the system.
- Phase 2 - standard care for telemedicine applications. Secure transmission of the data, secure storage of the identified data.
- Phase 3 - probably requires the consent of the patient!

Expected contributions

- Experiments in using characteristic points techniques to medical images
- A good/definitive RD detector :-)
- Start collecting data on the cost effectiveness of the tele-ophthalmology service