Diabetic Retinopathy

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Diabetic Retinopathy

• The leading cause of blindness in the developed world
  – Several million diabetics require annual screening in the UK alone
• Primary indictor: small “dots and spots” on special retinal photographs
• Vascular changes – beading and neovascularization
• Macula Oedema – swelling (discoloration and surface shape)
Diabetic Retinopathy
A Haemorrhage in detail
Peak points
Circular Peak Points
Lesion Growing
An algorithm to find dark lesions

- Extract *features* (measurements)
- Contrast, shape, size, blurriness, etc. etc.
- Feed these measurements to a neural network which *learns* to distinguish lesions from distractors
Feature Selection Method

• Use of sensitivity analysis for classifier inputs
• Exploits “missing value substitution” procedure
• Ratio of performance with and without available information
• Hierarchical feature selection
Optic Nerve Head segmentation

• Interesting problem in deformable modelling
• Fundamental shape is fairly simple – elliptical with vertical major axis
• Overlapping blood vessels
• Presence of pallor and peri-papillar atrophy distractors
Sample Optic Nerve Heads
The Algorithm

- Global/local deformable model
- Global model – fixed aspect ratio ellipse
- Local model – distortions away from this
- Spokes projected at 15 degree angles
- Attractor points at maximum coincident gradients (or second order local gradient)
- Balance of global, local, smoothing forces
The Deformable Model
The stages

- Fit global model against temporal sector of ONH only (temporal lock phase)
- Fit global model against whole ONH
- Let the local model loose to fit the full model
Vascular Measurement

- Changes in widths of vessels are very diagnostic
- Typical vessels no more than 6-8 pixels wide
- Require width measurements to sub-pixel accuracy
Vascular Model

• A gaussian extruded forms a reasonable shape model for a vessel
• A difference of gaussians models specular highlights
A vessel profile
Vascular Model
Sub-pixel accuracy

- Deformable models like this can fit boundaries to sub-pixel accuracy
- Exploitation of anti-aliasing effect
- Human beings do this routinely
  - That’s how a television works!
- Accurate to at least 0.34 pixels on our tests
- Used high-resolution images rescaled for the algorithm (by a factor of 4).
Algorithm at work
Real World Use?

- Sensitivity / specificity for Sight Threatening Retinopathy
  - Lesions near to the macula
- 97% sensitivity (one error), 75% specificity
- This is still insufficient! – why?
  - Unanticipated disease conditions
  - Severe disease conditions
- Planning use in audit rather than automated screening