

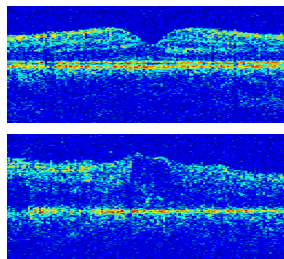


Dynamic Programming for tracking contours in OCT B-scans

Jakob Thomadsen

Vision Days 1st of June 2005

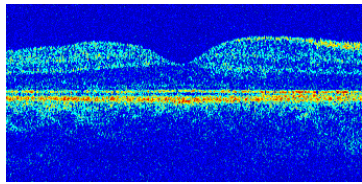
Retina



- Photoreceptors
- Fovea
- Pigment epithelium
- Neuro-retina

- Macular edema

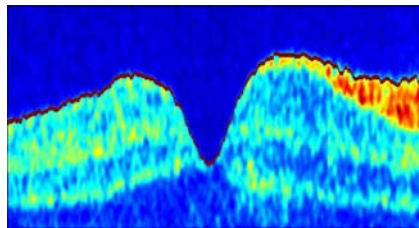
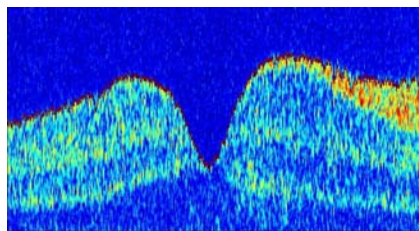
Eye from www.macular.org
OCT images taken at Herlev Hospital



- "Ultrasound with light"
- Difference in speed ~ factor 10^6
- Low coherence interferometry
- Resolution ~ $10\mu\text{m}$ in tissue
- OCT at Herlev Hospital:
- Carl Zeiss, StratusOCT

Top image of OCT system at Herlev Hospital

For further info on OCT see: D. Huang et al, "Optical coherence tomography", Science, 254, 1178-1181, 1991



Pros:

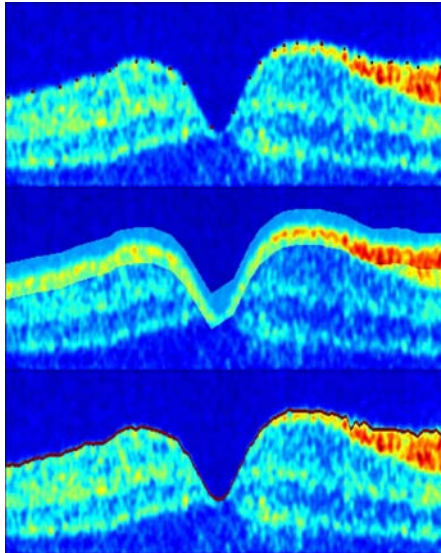
- Easy to implement
- Linear in size
- Optimal

Cons:

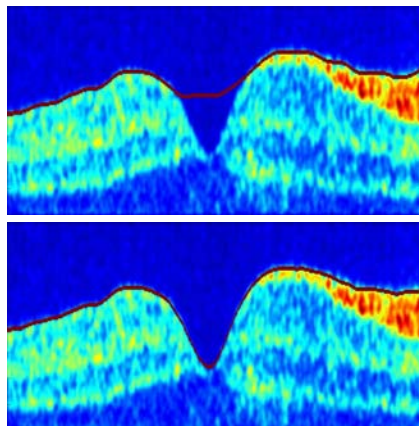
- Sensitive
- No shape
- Slow on huge images (6554x2000)

Introductory article to Dynamic Programming:

Circular Shortest Path on Regular Grids, Changming Sun and Stefano Pallottino. CMIS Report No. 01/76 May 2001.



- Initial low res solution
- Search close to this solution in high res
- Narrows down search space
- Choose highest relevant frequency by stopping rescaling



- Internal energy to total energy function:

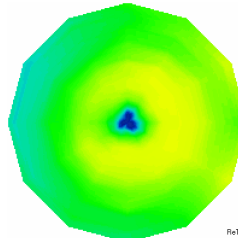
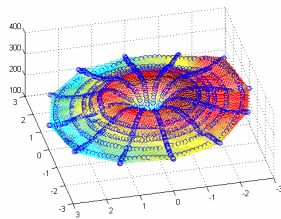
$$E_{\text{snake}} = \int_0^1 E_{\text{internal}}(\mathbf{v}(s)) + E_{\text{external}}(\mathbf{v}(s)) ds$$

$$E_{\text{internal}} = \alpha(s)|v_x(s)|^2 + \beta(s)|v_{ss}(s)|^2$$

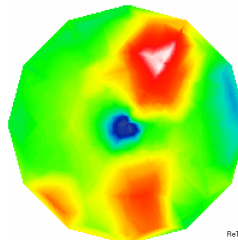
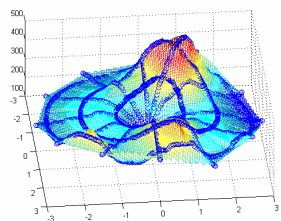
- Approximate shape of snake with BDA (Backward Difference Approximation)
- Different relevant frequencies at different positions

Used second order approximation for first and second-order derivatives:

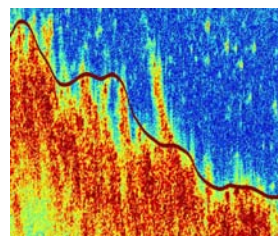
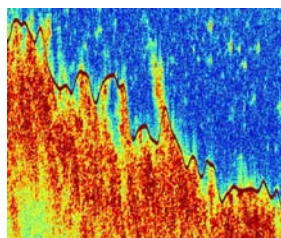
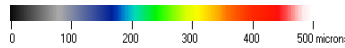
$$v_x(s_i) = \frac{3v(s_i) - 4v(s_{i-1}) + v(s_{i-2}))}{2\Delta s} \quad v_{ss}(s_i) = \frac{2v(s_i) - 5v(s_{i-1}) + 4v(s_{i-2}) - v(s_{i-3}))}{\Delta s^2}$$



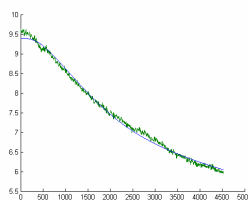
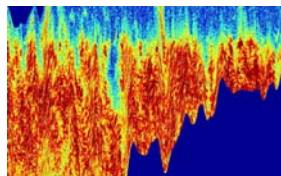
- Healthy



- Edema
- Laser treatment



- Align scans before averaging to minimise speckle noise
- Extract optical properties ie. scattering coefficient and anisotropy factor
- Distinguish between healthy and cancerous tissue



For further information see:
 K. Bizheva et. al., *Brain tumour identification by use of ultrahigh resolution optical coherence tomography and tissue optics analysis*, oral presentation at Photonics West 2005, paper 5695-24.



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- Extended DP:
 - Prefilter at relevant scale
 - Pyramid down to relevant resolution
 - Internal energy to constraint shape
 - Multiple applications within OCT

 - Assist with clamped points
 - Clinical tests



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- Coworkers:
 - Thomas Martini Jørgensen, RISØ
 - Birgit Sander, Herlev Hospital

 - Fundings:
 - Thanks to Herlev Hospital