Abstract

Aim: refine vessel contours obtained from raw retinal binary maps to improve the accuracy of vessel width estimation

- Preprocessing
- Vessel centreline computation and refinement
- Vessel edge extraction
- Contour refinement using coupled splines
- Width estimation

Results show width estimate performance comparable with state-of-the-art methods

Vessel edge extraction

Two lists $Q_A$ and $Q_B$ of coupled vessel edge points

$$ L_A = \begin{pmatrix} (x_{A1}, y_{A1}) \\ (x_{A2}, y_{A2}) \\ \vdots \\ (x_{An}, y_{An}) \end{pmatrix} \quad \text{and} \quad L_B = \begin{pmatrix} (x_{B1}, y_{B1}) \\ (x_{B2}, y_{B2}) \\ \vdots \\ (x_{Bn}, y_{Bn}) \end{pmatrix} $$

$$ \downarrow \text{subsampling} $$

Two lists $L_A$ and $L_B$

Contour refinement using coupled splines

Assuming locally parallel vessel boundaries, a constraint between two parallel splines is enforced at each knot

$$ g_A = a_1(x - x_{A1})^3 + b_1(x - x_{A1})^2 + c_1(x - x_{A1}) + d_1 $$

$$ g_B = a_2(x - x_{B1})^3 + b_2(x - x_{B1})^2 + c_2(x - x_{B1}) + d_2 $$

$$ y_A(x_{A,i+1}) = y_B(x_{B,i+1}) $$

This system is overconstrained by the parallelism constraint at knots, and is solved by least squares

Width estimation

The vessel width at $C_i$ is estimated as the Euclidean distance $w_i$ between $D_i$ and $E_i$

$$ \chi_i = w_i - \psi_i $$

$$ \text{difference mean: } \mu \quad \text{difference standard deviation: } \sigma $$

Results

The width measurement performance is evaluated using the publicly available REVIEW database: http://ReviewDB.lincoln.ac.uk

<table>
<thead>
<tr>
<th>Method</th>
<th>Measurement</th>
<th>Difference</th>
<th>$\mu$</th>
<th>$\sigma$</th>
<th>$\chi$</th>
<th>$\eta$</th>
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<tbody>
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Want to find out more? Scan with your camera phone:
VAMPIRE website - University of Dundee