Design of a user-friendly tool for the semi-automated connection of blood vessels in the human retina

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**Introduction**

The retina is a unique window in the vascular system. Fundus camera images (Fig. 1) can allow to evaluate, in a non-invasive way, presence of diseases.

The retinal vascular network consists of forests of arterial and venous trees. The reconstruction of this network has crucial importance.

**Materials and Methods**

The connectivity system has been implemented based on the DRIVE Segment – Junction Set. In this dataset the blood vessels tend to appear as short segments disconnected among each other [2].

At each segment end, pixel intensity, direction and width have been extracted (Fig. 3a):

Later, the segments ends have been grouped into cliques.

At this aim mutual distance and direction between segments have been considered.

After, the cliques have been automatically solved using implicit neural cost functions [3] (Fig.3b):

- a segment end can be joined to no other one;
- two segments can be joined together creating a bridge;
- three segments can be joined together creating a bifurcation.

The tool developed in this work, completely written in Matlab (The MathWorks Inc., Natick, MA, United States), gathers together the functionalities previously introduced and to post process the results.

**Results and Discussion**

The aim of this work is to implement a tool able to reconstruct semi-automatically the retinal network.

The platform must be able to import fundus images [1] (Fig. 2); to segment blood vessels, and join together the vessel segments.

The DRIVE dataset has been used to test the tool. So far 65% of the cliques are solved correctly, while 35% are only partially correct.

**Conclusions and future work**

The tool is user-friendly. The algorithm solves correctly 65% of the junctions. Unfortunately the results of the connectivity are strongly related to the quality of the segmentation, in fact after segmenting missing blood vessels or as soon as false vessels are deleted, the results of the connectivity algorithm improve.

In the next level the tool will include also a full automated segmentation algorithm.

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