Numerical Computational Modeling using Electrical Networks for Cerebral Arteriovenous Malformation

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Agenda

- Problem Statement
- Introduction – AVM & Clinical Challenges
- Methodology
- Results
- References
Problem Statement

- The problem is to identify the blood vessel in an AVM

- Why it is important:
  - Beneficial for the doctors to do improve in the therapy planning.
  - A proper Segmentation of Vessels help for correct diagnosis
Introduction – AVM & Clinical Challenges

- A cerebral Arteriovenous malformation (AVM) is an abnormal connection between the arteries and the veins in the brain.

- An Arteriovenous malformation is a tangled cluster of vessels, typically located in the supratentorial part of the brain, in which arteries connect directly to veins without any intervening capillary bed.

DSA - AVM
Introduction – AVM & Clinical Challenges

• A Nidus is the central part of AVM. It is made up of abnormal blood vessels that are hybrids between arteries and veins.

• Challenges:

  Segmentation of Complex Structure

  Clustering of Various Vessels

  NIDUS Segmentation
Methodology

1. **Acquisition of Datasets**

   Automatic Segmentation of image is performed into various compartments as Arteries, Veins at different levels [4].

2. **Design of the electrical circuit for each segmented vessel of the compartment using R,L,C – Electrical Networks [5-10]**

3. Input transient voltage will be varied parameters based on the clinical input measurements range for each compartment.
Automation Segmentation Algorithm

- OTSU Segmentation –
  - **Otsu's method** is used to automatically perform histogram shape-based image/Global image threshold,
  - Otsu's method is named after Nobuyuki Otsu
Region Growing & Threshold Technique

- Threshold based segmentation: Computation based on the appropriate threshold to use to convert the grayscale image to binary.

Region Growing: A recursive region growing algorithm for 2D and 3D grayscale image sets with polygon and binary mask output. The main purpose of this function lies on clean and highly documented code.

- Implementation difficulties:
  - Data Loading and Processing require more steps to implement in c/c++/c#
  - Issues in bridging the Managed (UI) and UnManaged Code (Algorithms)

- Advantage of using Matlab:
  - Ease of Use
  - Simple commands
  - Execution is easier than other tools
Region Growing & Threshold Technique

Results

Input Data

Output Segmentation

Input Data

Output Segmentation
Level Set Segmentation

- Implemented for 2-D interface (curve) evolution.

- Used for implementing a 2-D curve evolution or a diffusion of a 2-D function \( \phi(x,y) \), e.g. anisotropic diffusion on a gray-scale image.
Level Set Segmentation Results

Input Data

Output Segmentation
References


References


- Yubing Shi, Patricia Lawford and Rodney Hose. Review of Zero-D and 1-D Models of Blood Flow in the Cardiovascular System. Medical Physics Group, Technical report, Department of Cardiovascular Science, Faculty of Medicine, Dentistry and Health, University of Sheffield, Sheffield S10 2RX, UK.

