Towards a proposal for a Vessel Knowledge Representation Model

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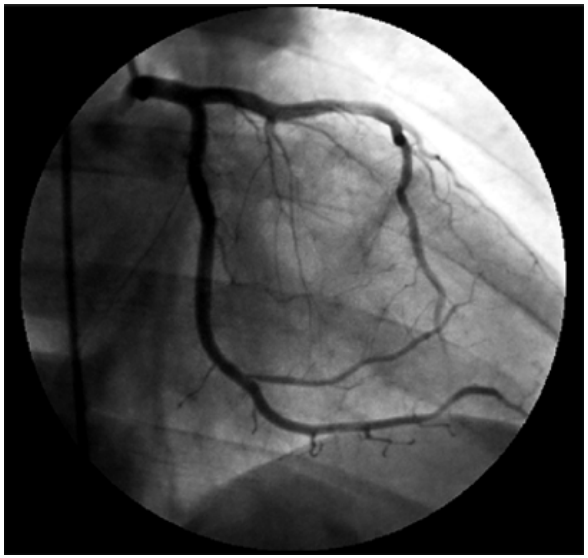
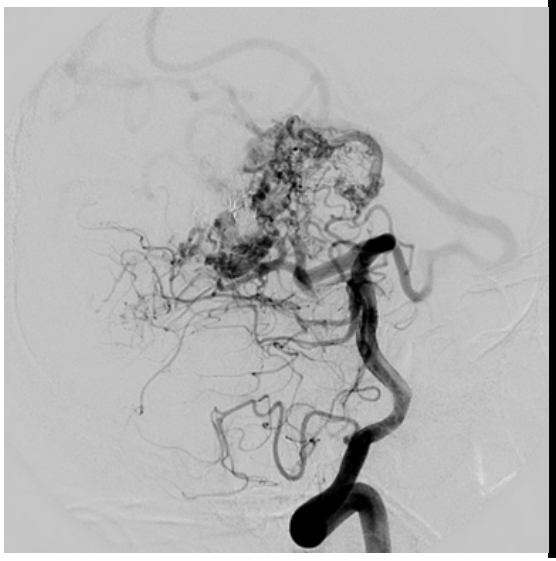
Introduction

- The vessel structure of the blood circulatory system is one of the most complex structures of the body.
- Recent advances on medical imaging provide high resolution images of the vessel structures, allowgin the generation of accurate patient- specific geometric in-vivo vessel models

Introduction



coronary



brain

Abdominal Aneurism

Introducion

- We aim towards a Vessel Knowledge Representation (VKR) model,
  - efficient and versatil,
  - may be used for a wide variety of image-based vessel extraction schemes and vessel analysis applications.

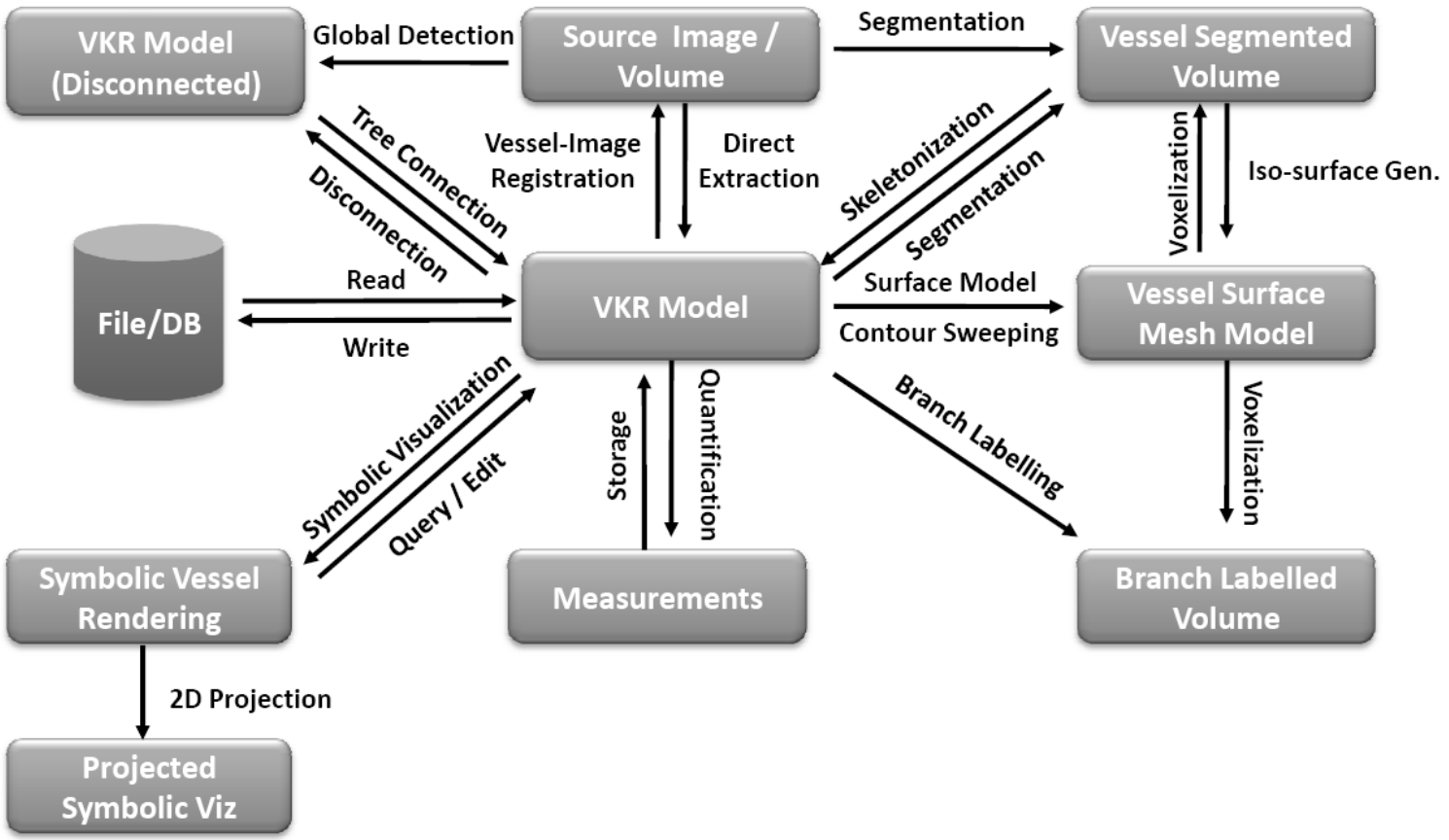
Requirements of the VKR

- Versatility:
  - Modelling of low level entities compatible with higher level structures
  - Coexisting representations
  - Decoupling algorithms from data structures
- Efficiency: low computational time and need of resources

- Usefulness: take into account constraints from actual applications
- Hierachical: provide levels of complexity and abstraction
- Integrability: embedded into state of the art software developments, (ITK)

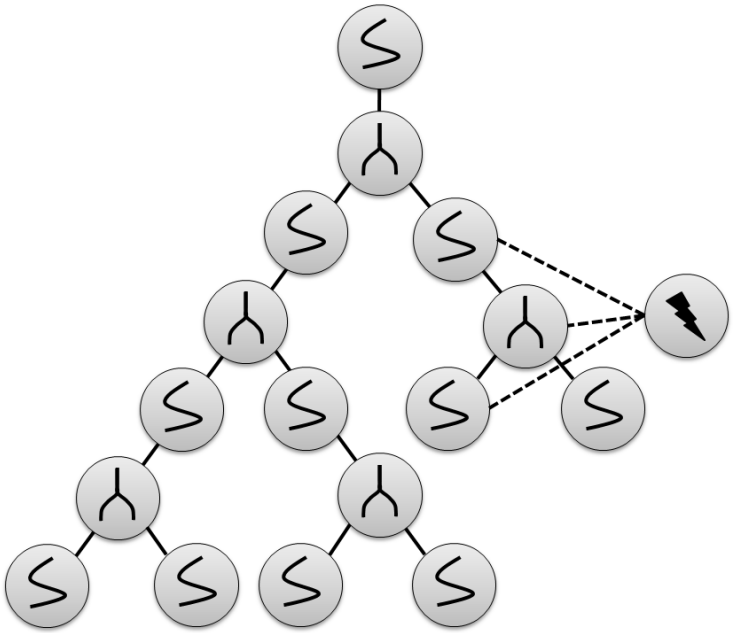
Model Description

- The boxes correspond to data types of some kind,
- the labeled arrows correspond to transformations or manipulations of the data.

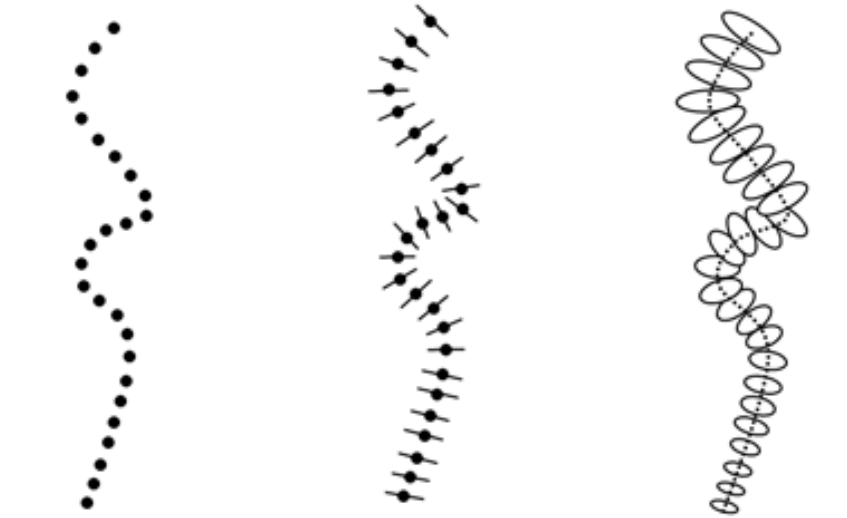

VKR Model (Disconnected)
Global Detection
Source Image / Volume
Segmentation
Vessel Segmented Volume
Tree Connection
Disconnection
Vessel-Image Registration
Direct Extraction
Skeletonization
Segmentation
Voxelization
Iso-surface Gen.
File/DB
Read
Write
VKR Model
Surface Model
Contour Sweeping
Vessel Surface Mesh Model
Symbolic Visualization
Query / Edit
Storage
Quantification
Branch Labelling
Voxelization
Symbolic Vessel Rendering
Measurements
Branch Labelled Volume
2D Projection
Projected Symbolic Viz

Data structures

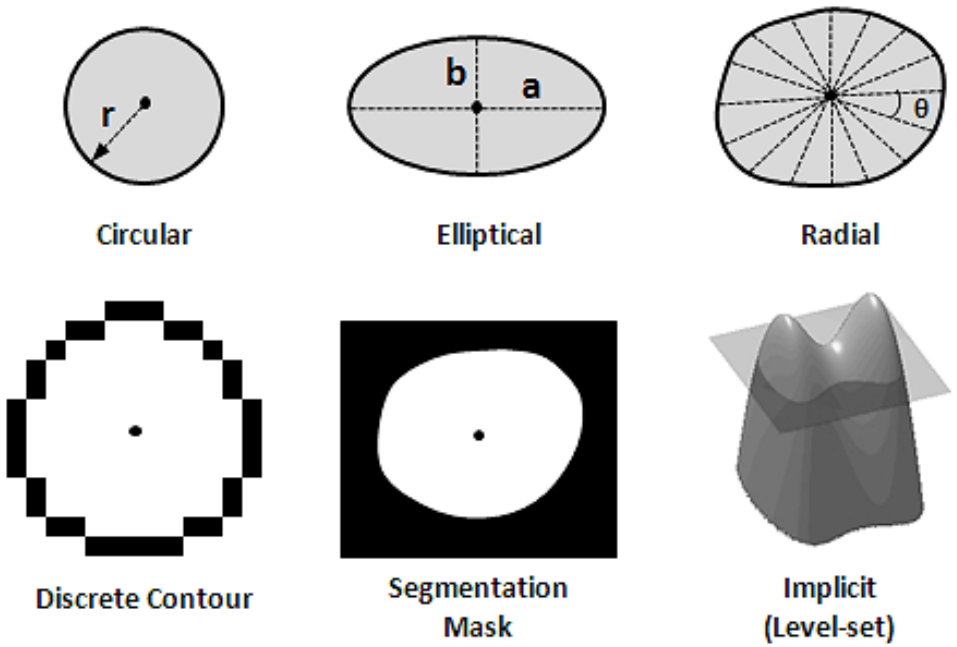
- Vessel Graph: binary tree structure



- Centerline model: captures the vessel shape



- Section model



- 3D Surface and Voxel Models of Vessels
- Vessel Bifurcations
- Vessel Features: special characteristics of the vessels that need to be highlighted
- Models of Vessel Accidents or Disease

Supported Operations

- Access Operations: graph traversal
- Edition Operations: change the internal structure and properties of the model.
- Quantification Operations: quantitative measurements over the model.
- Input/Output Operations: used to load and save the model data.
- Data Transformation Operations:
  - generation of the VKR model and
  - transformation into another representation
- Model-specific Operations: internal operations

Conclusions

- The Blood Vessel Analysis needs
  - the composition of procedures,
  - the reuse of software and
  - the comparative analysis
- The Vessel Knowledge Representation (VKR) model that may allow the exchange of data among applications and users.
  - reuse of software pieces,
  - an intermediate representation between image-based extraction schemes and clinical and research applications,
  - to perform quantitative measurements on extracted vessel structures and
  - to provide the necessary vessel representation and handling tools for the target applications.

conclusions

- In this paper we have identified,
  - some key knowledge representation items,
  - the key operations that are the building blocks for nowadays and future vessel analysis processes and applications.
- We are already applying the VKR model in vessel-related applications related to our current research areas.