1. Project objectives

The aim of the project is to determine and recognize the structure of renal vascular tree depicted on computed tomography kidney corrosive endocast images and assess whether such information will be suitable to support the automatic segmentation process of the vascular tree. The structure of the renal vascular tree is highly variable between individuals. There are indications suggesting the existence of connection between topology of vascular tree segments, associated with their formation process. In this context, the aim of the project is to verify whether these dependences indeed occur: both within the same structure (whether the structure of particular tree level determines the structure of subsequent levels), and between the individual vascular trees (interpatient similarities). Another research aim is to assess whether the obtained information will be useful in the context of supporting renal vascular tree extraction process from patients' computed tomography images.

2. Research project methodology

The research material consists of corrosive endocasts computed tomography data. They comprise of blood vessels (arteries, veins) and pelvicalyceal system. During the research efficient algorithms for arteries extraction and determination of their centerlines (skeletons) will be developed. It is required that the proposed methods ensure the continuity of the renal vascular tree and eliminate the possibility of false branching. Then the vascular tree will be represented in the graph-like form, whose vertices will reflect individual branches location, whereas

the edges the corresponding segments of the tree. Such representation allows investigating the vascular tree structure in terms of the number and type of branching at different tree levels, their angles and length of individual segments. Then it will be examined whether and how the structure of particular tree levels affects other levels structure and whether there are similarities between different people vascular trees. At the end, an assessment of the possibility of using this information to support blood vessels extracting process from patients computed tomography data will be undertaken.

Fig. Exemplary output of the renal vascular tree extraction process from kidney corrosive endocast computed tomography data.

3. Reasons for choosing the research topic

Renal vascular tree is a very complex structure and the possibility of its cognition seems very interesting. The algorithms that will be developed (blood vessels extraction and skeletonization) may be useful for the analysis of others tree-like structures in the human body. These techniques will aid to automatically analyze complex systems, contributing to faster and more effective recognition of their structure.

The process of extracting the blood vessels from patient computed tomography data is difficult due to the insufficient image resolution (limitations related to the dose of radiation). However, information about renal vascular tree is extremely important for pre operative planning of minimally invasive renal tumor resection surgeries. Then it is possible to avoid the irreversible consequences of ischemia caused by cutting off the blood flow to the entire organ. If the hypothesis concerning the occurrence of dependencies between the various vascular tree levels and between different vascular trees will be confirmed this research will contribute to facilitation of blood vessels extraction from patients computed tomography data. The development of this approach is considered as a milestone towards safer and more effective (in terms of functional outcome) treatments of small tumor lesions located within the kidney. The research in this scope will in future contribute to development of pre operative planning techniques supported by image analysis.