Towards instant computational support for interactive diagnosis

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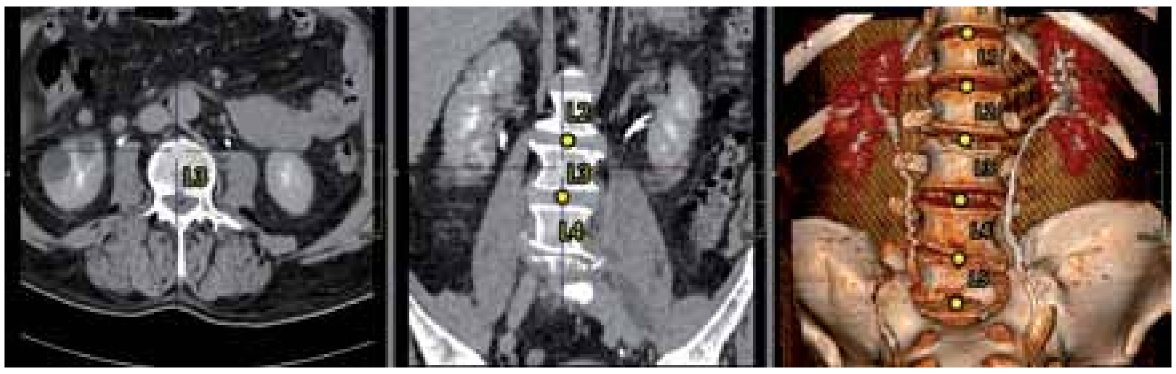

A method that automatically labels the spine on CT scans, based on a combination of a machine learning-based classification approach and iterative matching of local models, captures the appearance and morphometry around two subsequent vertebrae, presented by researchers from the VRVis centre in Vienna.

Fully automated computer-aided detection (CAD) systems are used, even today, in only a few special cases. Imaging methods and diagnostic questions are constantly evolving and demand a paradigm shift from previously envisioned static CAD systems towards more flexible interactive support systems integrating, rather than replacing, the diagnostic abilities of the radiologist. The majority of readings in daily clinical routine are still done in an interactive manner and often with just basic computational support. Although sophisticated image analysis, quantification and annotation methods have been proposed by the research community, many of them have not been integrated into common radiological workflows yet. Their hardware and time requirements are often incompatible with real world settings in a clinical environment, where results have to be delivered within seconds on standard hardware.

Our research aims at bridging the gap between academic research in medical image analysis and real world applications. We investigate methods amalgamating sophisticated, fully automated server-side image processing with the cognitive skills of the radiologist by enabling them to enhance the automatic results through online interaction within seconds, allowing them to reach a final diagnostic decision. The goal of our research is to minimise the user interaction and time required for expensive server-side image processing tasks by exploiting the time from scanner to workstation. The major challenge we face in this context is splitting the processing pipeline into parts, which can be robustly implemented in a fully automated manner and react interactively and semi-automatically, almost in real time; even under real world conditions.

During the IMAGINE session we will showcase two solutions following this paradigm: The spine provides an internal frame of reference to describe positions in the superior part of the human body. Its usage requires the semantic annotation of vertebrae and disks, which is, especially in 3D data sets, an inconvenient task. We present a method that automatically labels the spine on CT scans based on a combination of a machine learning-based classification approach and iterative matching of local models, capturing the appearance and morphometry around two subsequent vertebrae. The algorithm showed robust handling of full and partial scans of the spine. Our tests report high recall (95.5 percent) and precision (99 percent) rates. Nevertheless, the method might deliver shifted results, or even fail completely, in certain cases like the presence of extreme pathologies. For these cases we have included the ability to interactively manipulate the result delivered as an offline pre-processing step on the server. For cases of complete failure it is possible to initialise a new labelling sequence by placing a single label that delivers almost instantaneous results.

Computer-aided tracking of blood vessels in CTA images is the basis for many higher level diagnostic tasks in the context of vascular diseases. The high morphological variability of vessel systems and high variations in contrast agent saturation hamper the development of completely automatic methods. We present a hybrid solution that performs the time consuming model-based tracking of possible vessel segments as a preprocessing step on the server. Vessel tree growing, i.e. the selection and connection of relevant vessels, can be performed semi-automatically on the client within seconds. The integration of anatomical region dependent rules leads to a highly robust solution delivering, in most cases, the whole tree of relevant vessels with just one click, even in the presence of vessel gaps caused by small or medium size stenosis or soft plaque. Our method has been tuned and tested for CTA datasets of peripheral vessels of the lower limbs. Future work includes the extension of the method to other vascular systems.

We would like to invite you to share your opinion and ideas on our approaches and solutions in a personal discussion with us. Our software is on display at the VRVis booth at IMAGINE.

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VRVis is Austria's leading centre for applied research in the field of visual computing and acts as a bridge between academia and industry. The presented projects are results of a joint technology transfer project with AGFA Healthcare and are supported by FFG as part of the Austrian COMET initiative.