The Virtual Liver Surgery Planner -- New Attacks to Old Problems

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Introduction:
Liver tumors accounts for a considerable number of death every year [1]. There are primary malignant liver tumors like hepatocellular carcinoma, most often arising as a complication of diseases leading to liver cirrhosis. Additionally almost any tumor can seed metastasis within the liver, colorectal cancer being on top of the list. For many patients suffering from liver tumors surgery may represent the only curative approach, for the others only palliative, interventional techniques are available for local tumor control – eg cryotherapy, chemoembolisation, ethanol injection, radio frequency ablation just to name a few.

Individual treatment plans are based on laboratory results and imaging modalities like ultra sound, spiral computed tomography (S CT), Magned Resonance Imaging (MRI) and Nuclear Medicine studies. Meticulous interpretation of the available imaging modalities is neces sary in order to assess all aspects of the disease. Unfortunately liver tumors exhibit complex patho anatomical relationships to surrounding vessels and bile ducts. Additionally the involved Couinaud segments are mandatory to know, but the correct identification represents difficult task [2, 3, 4]. 3D reconstructions can help in this situation but hardly extract quantitative information. It has to be considered, that whenever surgery is not regarded to represent a suitable therapeutic approach, there will be not other curative treatment option.

Therefore an interdiscipli nary team of radiologists, surgeons and engineers started the development of a system, which should enhance and augment the therapeutic decision process. Moreover, the system should not only allow to use new visualization technologies like augmented reality but should deliver quantitative data like number of involved segments, total liver volume and tumor volume too.

This was the birthday of the "Virtual Liver Surgery Planning System" (VLSPS).

Syst endescription:
Helical CT forms the basis for all postprocessing steps -- the workflow can be found at Fig.1.

![Liver Surgery Planning System](image)

Fig. 1: VLSPS work flow -- the left hand stack of Spiral – CT images represent data acquisition, the pink part in the center of the green outlines the different data processing steps. The blue part on right lower corner symbolizes the quantitative results generated by the VLSPS and all parts together lead to a decision regarding the suited approach.

For visualization an augmented reality system is used, details and components are given in Fig. 2. The head mounted display consists of two "see through" monitors (800x600 pixels each). Both monitors act as part of the graphic system, which is feed by the corresponding computer with two stereoscopic images.

These monitors are fixed on a helmet, which contains the tracking targets too. The cameras emit infrared flashes, which are reflected by the tracking targets. Based on the shape of the tracking targets as well as the time as needed for reflection of the infrared flashes the system calculates the operator's position within the 3D space.

These calculations are performed in real time and after every change of the operator's position the stereoscopic images are updated and sent to the "see through" monitors.

For system interaction the operator uses the so called "personal interaction panel" (PIP), depending which side of the panel is up the action behavior is changed: a) action buttons and sliders, which are activated by the touch of a virtual pencil, allow to change the scene eg. opacity of objects, performing measurements and much more (Fig.3). b) If the panel is flipped it acts as a cutting plane in order to display the source image data (Fig.4).

Tools were implemented in order to assist the physician at the virtual liver surgery planning step (Fig.5).

Conclusion:
An interdisciplinary, international team started to a new dimension by producing the "Virtual Liver Surgery Planning System". This system exploits new emerging technologies, in order to improve patient care.

Literature:

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