Animation and Interactive Visualization of Patient Individual Data

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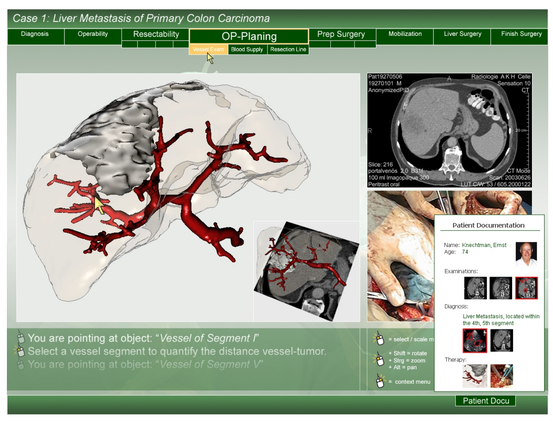
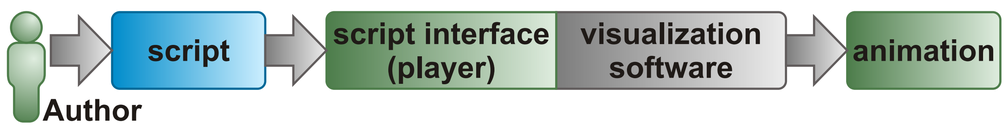
Motivation

We develop the LiverSurgeryTrainer—a multimedia system—to support living-related liver transplantation and tumor surgery training with the focus on preoperative decisions and therapy planning. For this purpose it is necessary to provide facilities to enable interactive handling and didactical presentations of patient individual data.
In didactical presentations, animations play an important role to explain complex issues as well as to enable viewers to keep track of changes in visualizations. However, the common way of creating complex animations by hand scales not well with the need of didactical and visual pleasing animations of varying patient individual data.
In those cases a representation of the desired animations is required that can be adapted to different data sets in a straightforward manner.



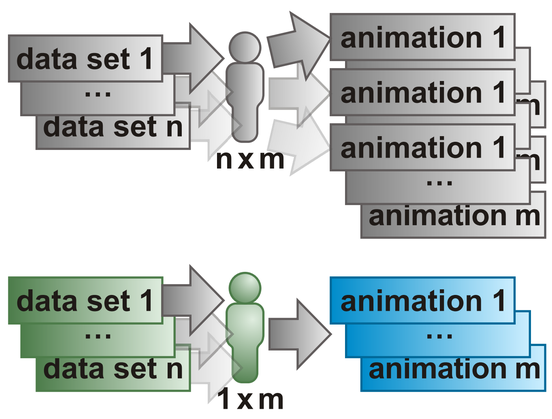
Screenshot of the LiverSurgery Trainer: a highly interactive learning environment to support liver surgery training with the focus on preoperative decisions and therapy planning. It is based on patient individual CT data, image analysis results, such as liver and tumor segmentation, information concerning clinical examinations, intraoperative video sequences, and histologic examinations.

Method



To describe and represent animations, we apply a novel script-based approach that:

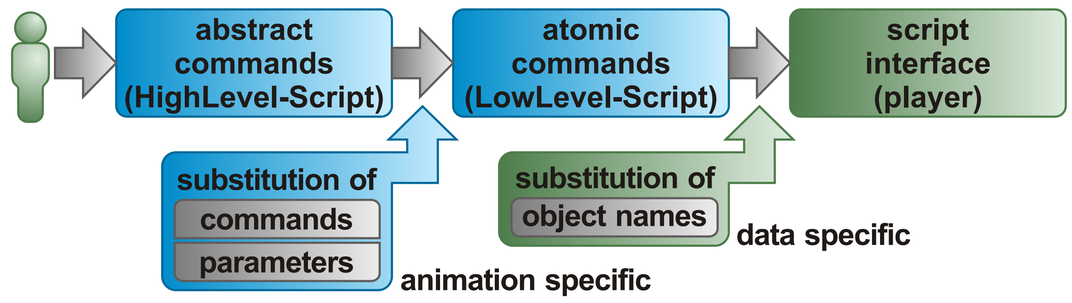
- avoids manual authoring of all desired animations for each data set
- adapts to different data sets and user interaction
- ensures automated and reproducible animations on a high level of equality and consistency for patient individual data



Script Concept

Concept Features:

- script commands of different abstraction levels
- simultaneous use of commands of different abstraction levels (fast and precise authoring)
- relative positions and motions (adaptation to varying data)
- mapping of abstract to atomic commands (easy animation playback)



Script Substitution in Detail

Script:

- script syntax: `[start time, end time] object command {parameters}`
- substitution rules declaration in an animation and a data specific XML file

Substitution Rules:

- nesting of commands
- pass on parameters
- easy reuse of complex command sequences

```
<?xml version="1.0" encoding="iso-8859-1"?>
<!-- View sagittal/axial/coronal -->
<command commandStr ="view">
    <command>T O on</command>
    <command>T 'Cam' move O P</command>
</command>
```

Command Replacement:

- by one or more commands
- at any nesting depth
- reuse of parameters

```
[0,10] 'Liver' view sagittal 1
```

```
[0,10] 'Liver' on
[0,10] 'Cam' move 'Liver' sagittal 1
```

Object Replacement:

- by one or more objects
- at any nesting depth

```
[0,10] 'Lung' on
```

```
[0,10] 'Lung_left'  on
[0,10] 'Lung_right' on
```

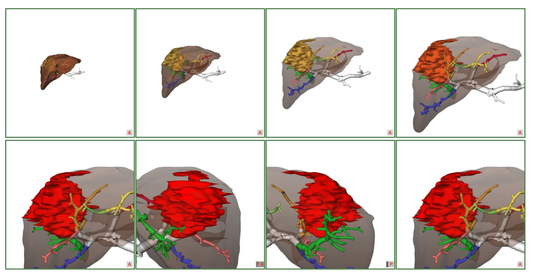
Parameter Replacement

```
[5,10] 'Tumor' setColor tumorColor
```

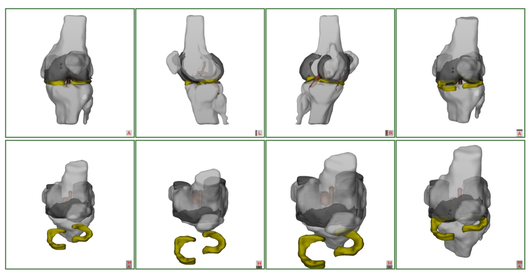
```
[5,10] 'Tumor' setColor 198,171,67
```

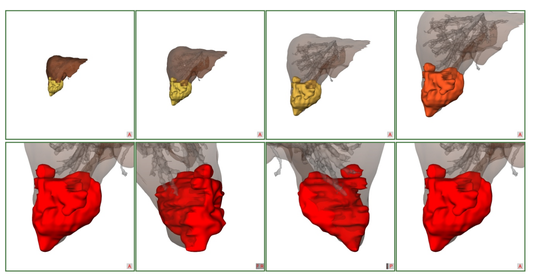
Animation Examples

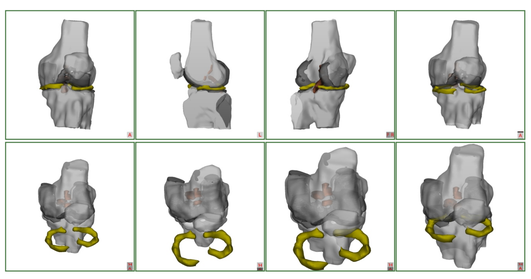
```
[Script]
[0]     'System' init
[0,2]   'Liver' view front 1
[0,2]   'Liver' setTransparency high
[4,6]   'Tumor' emphasize
[7,13] 'Cam' rotate 'Tumor' axial 360
```



```
[Script]
[0]     'System' init
[0,10]  'Cam' rotate 'All' axial -360
[10,14] 'Meniscus' explodeOn ¬
        frontTop 0.65
[27,33] 'Meniscus' explodeOff front 1
```







Results and Conclusion

We extended the LiverSurgeryTrainer by the opportunity to generate reproducible and highly automated animations of patient individual data. Animations (e.g. to introduce or explain objects in the visualization) can now be described independently of the underlying precise patient individual data and can be reused for all data sets in the learning environment.

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Previous systems for surgery education focused on interactive 3d visualization. Animation sequences, which continuously change viewing position and appearance of objects in focus and context, improve such systems. This combination of interaction and animation has been applied to liver surgery training. The integration of interactive dynamic visualizations with other media, such as videotaped surgical interventions turned out to be useful.

Publications:

Bade, R.; Mirschel, S.; Haase, T.; Krüger, A.; Hindennach, M.; Oldhafer, K.J.;Preim, B.: Visualisierungstechniken für die fallbasierte Chirurgieausbildung. In Rechnergestützte Lehr- und Lernsysteme in der Medizin, Shaker-Verlag, pp. 13-24, 2004.

Bade, R.; Mirschel, S.; Oldhafer, K.J.;Preim, B.: Ein fallbasiertes Lernsystem für die Behandlung von Lebertumoren. In Bildverarbeitung für die Medizin, Informatik aktuell, Springer, pp. 438-442, 2004.

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