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Viewpoint Selection for Intervention Planning

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Abstract

Viewpoint selection is crucial for medical intervention planning. The interactive exploration of a scene with 3d objects involves the systematic analysis of several anatomic structures. Viewpoint selection techniques enhance the display of the currently selected structure. For animations in collaborative intervention planning and surgical education, the authoring process may be significantly enhanced if 'good' viewpoints for important objects as well as for the whole scene are chosen automatically. We describe a viewpoint selection technique guided by parameters like size of unoccluded surface, importance of occluding objects, preferred region and viewpoint stability. The influence of these parameters may be flexibly adjusted by weights. Parameter maps indicate the influence of the current parameter settings on the viewpoints. For selected applications, the weights may be predefined and reused for other cases. We also describe an informal user study which was accomplished to understand if our viewpoint selection strategies produce adequate results from the users' point of view.

Categories and Subject Descriptors (according to ACM CCS): I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Animation J.3 [Life And Medical Sciences]: Medical information systems

1. Introduction

For complex intervention planning tasks, high-resolution medical image data (CT or MRI) are acquired. The relevant structures, e. g. pathologies and crucial anatomic structures, such as vasculature are segmented. The segmentation information is employed for generating interactive 3d visualizations and animations to support treatment decisions such as operability and the specification of a surgical strategy. Animations are relevant to enhance interactive 3d visualizations, which are primarily used for *individual* intervention planning as well as for *collaborative* intervention planning of radiologists, surgeons and other medical doctors. As an example for *collaborative* intervention planning, tumor board discussions are considered, where a complex case is presented by one medical doctor to initiate an interdisciplinary discussion to finally come to treatment decisions. This discussion may be strongly supported by carefully prepared animations.

Our specific goal, addressed in this paper, is the viewpoint selection to enhance the process of authoring animations as well as interactive exploration.

In intervention planning, we have to consider scenes with large complex geometric objects (up to 600.000 triangles) of arbitrary shape (including concave and branching objects). For medical diagnosis and intervention planning, *inner* exploration is known as virtual endoscopy, often guided by the centerline of a relevant object (Bartz [Bar05] gives a comprehensive overview). We consider *global* exploration, where the camera is placed outside the scene.

Visibility may be achieved by smart visibility techniques [VFSG06], exploded views [APH*03] and viewpoint selection. We focus on the latter approach since it does not alter the scene geometry which is an essential feature for intervention planning. Viewpoints must not only be computed for an overview of the whole scene, but especially for single objects, such as pathologies. Our viewpoint selection strategy considers several parameters for viewpoint quality. For each parameter, a weight is assigned to specify its influence. However, the trial-and-error process to adjust these weights is tedious since there is no direct mapping of these input values to the user's visualization goal. Therefore, we accomplished an informal user study to come up with useful default values. We hypothesize that such a set of default parameters can be derived for each specific intervention planning task, such as oncologic liver surgery or neck surgery. We will describe:

1. how the visibility data for each viewpoint is computed,
2. how the best viewpoint for an object of interest is calculated by using weighted parameter maps and
3. how this information is used for generating animations.

The viewpoint selection is incorporated in our script-based animation framework [MBP06], which is used for intervention planning [KTH*05] and surgical education [BRS*06].

The remainder of this paper is organized as follows. Section 2 describes related work. Subsequently, we describe the computation of viewpoints on objects with different parameters and give an example in Section 3. In Section 4 we discuss advanced viewpoint selection, like the handling of many 'good' viewpoints for one object, views for two selected objects to evaluate their minimal distances and the determination of viewpoints for the whole scene. We describe two application scenarios, which use our new viewpoint selection method in Section 5. Section 6 presents a first evaluation of viewpoints generated with the presented method. Finally, in Section 7 we conclude the paper.

2. Related Work

Camera control is an active area of research, e. g. in visibility determination or object tracking in virtual environments like computer games (see [CO06] for an overview). There is still *'no consensus about what a good view means in Computer Graphics'* [VFSH01]. Vazquez et al. [VFSH01] introduced the *viewpoint entropy measure* to characterize the quality of a viewpoint. They defined the viewpoint entropy as

$$H_v = \sum_{i=0}^{N_f} \frac{A_i}{A_t} log \frac{A_i}{A_t} \quad (1)$$

where N_f is the number of faces of a scene, A_t is the total area of the bounding sphere and A_i is the projected area of the face i. For Vazquez et al. [VFSH01] a 'good' viewpoint is one, where many polygons with the same projected area are seen. The viewpoint quality measure was refinded by Sokolov and Plemenos [SP05] by taking into account the curvature of surfaces as additional criterion. Regions of high curvature are considered as essential features which should be presented. Sokolov et al. [SPT06] aimed at finding 'good' viewpoints on a scene divided into single objects, where each object has an importance, given by the objects' bounding box size. A 'good' viewpoint is one where many objects are visible with an area proportional to the objects' importance.

The *viewpoint entropy measure* was adapted to volume rendering by [BS05] and [TFTN05]. Bordoloi and Shen [BS05] introduced a *noteworthiness factor* to describe the importance of single voxels, where opaque voxels as well as voxels colored with a rare color are important. They also introduced a *viewpoint likelihood* and compare viewpoints of a scene. To compute the similarity between viewpoints, they used the Jensen-Shannon divergence, a Kullback-Leibler distance derived measure [Lin91]. Viewpoints with a low likelihood are almost unique and may be interesting for scene exploration. Bordoloi and Shen [BS05] divided the view space into areas of similar viewpoints and connected representative viewpoints from each region to get a scene overview. Viola et al. [VFSG06] extended the *viewpoint entropy measure* for volume rendering by defining important areas in object-space (voxels near to view plane are important) and in image-space (voxels near to image center are important) and computed one good viewpoint per object in a pre-processing step.

The focus on the number of faces as a major factor of the viewpoint quality measure is still a drawback. Considering scenes as a collection of objects is essential, but the assumption, that the importance of objects is proportional to their size, is too simple. The volume rendering approaches exhibit the same drawbacks. None of these approaches supports a direct mapping of the user's visualization goal to input parameters. Furthermore, viewpoints are only estimated by their quality for whole scenes but not for single objects (except [VFSG06]). The question *'Where is the best viewpoint for a single object'* is still open and is likely too general for all application areas. Likewise, semi transparency or changes of appearances of objects during exploration (e. g. fading on or off) are still not discussed. Since the object appearance also has an influence on the visibility of other objects, it is desirable to integrate viewpoint selection with techniques to modify object appearance.

3. Methods

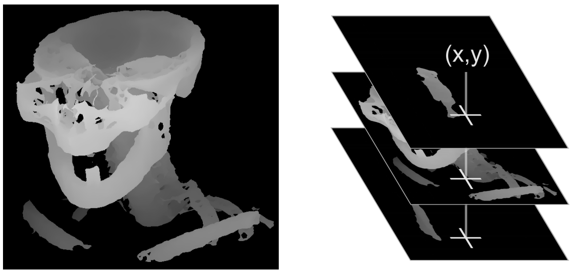
Our overall goal is to determine 'good' viewpoints on objects in a medical surface visualization. Those viewpoints are used in animations for medical discussions and presentations as well as in interactive applications as a start point for further explorations by the user. We use a parameter-based approach to estimate viewpoints. The quality of viewpoints is influenced by a range of different parameters. Some parameters are object-dependent (like the size of visible surface) while others are situation-dependent (like the distance to the current camera position). First we will explain the generation of object-dependent parameters. Afterwards, we present the estimation of viewpoints with weighted parameter maps (WPM), finishing the section with an example.

3.1. Generation of Visibility Information

As a first step we generate the visibility information for viewpoints on the bounding sphere. Because of the static character of medical scenes for intervention planning, we can compute the visibility information in a pre-processing step. The information includes: the size of visible surface for each object and the portion of each object's surface which is occluded by other objects. The names of occluding objects (occluders) are also determined. This information is useful to make the object of interest visible by removing these occluders. We sampled 4096 camera positions equally on the surface of the bounding sphere by recursively subdividing a double tetrahedron. The simplification of a surrounding sphere is appropriate since we consider compact medical scenes viewed from outside.

Afterwards, we count the visible pixels for each object, as well as the pixels of occluding areas and yield a measure of unoccluded surface area for each object along with the size of occluding areas for each camera position. This process occurs in two steps (see Figure 1):

1. Generate the z-buffer for each object and count the pixels.
2. Sorting the acquired z-values per xy-coordinate of all z-buffers and analyzing with respect to occluding objects.



(a) (b)

Figure 1: *(a) z-buffer of one segmented structure (bones), (b) selection of the z-values of all buffers at one pixel position.*

For every camera position, this information is represented in a matrix. For n objects, we obtain a $n \times n$ matrix. For every object i, column i contains how many pixels of object i are occluded by objects $\neq i$. Each row again indicates which objects are occluded by object i. On the diagonal, for object i the total number of visible pixels is stored (without consideration of occluders). An additional vector $(n+1)$ stores the number of unoccluded pixels. This information is later used for the real-time viewpoint selection process.

3.2. Weighted Parameter Maps for Viewpoint Selection

In contrast to other methods, we regard more parameters to evaluate the viewpoint quality more comprehensively. We detect several parameters that have a significant influence on the viewpoint quality in medical visualizations:

Object entropy: Considering entropy as a measure of information in a signal, we describe *object entropy* as a measure of how much information is in a view of a single object. We choose the size of the projected surface without consideration of occluding objects as representation of object entropy. From a 'good' viewpoint, as much as possible of the object's surface should be visible.

Number of occluders: If the object of interest is occluded by other objects, it can be made visible by fading off occluding structures or using techniques like cut-aways [KTH*05, VKG04]. It is preferable to choose viewpoints where only a few or no objects occlude the object of interest to keep changes of appearance low.

Importance of occluders: Some objects are only visible from a very few viewpoints or are totally enclosed by other objects. Not all occluding objects can be changed in their appearance due to their importance as anatomic context. For this, viewpoints are evaluated with respect to the occluding surfaces and the importance of occluding objects. This parameter is computed as the product of occluded surface area and inverted importance of the occluder. Thus, large areas occluded by a less important object yield a better viewpoint than areas occluded by important objects. The importance of objects depends on the surgical question and task.

Size of unoccluded surface: Even if occluders can be hidden, the size of unoccluded surface of an object is an important parameter.

Preferred region: In medical visualizations, the region of the viewpoint is important to prevent unfamiliar viewing. The *view of the surgeon* is mostly a view from front or side and rarely from top of the head or bottom. However, for specific tasks, other heuristics may exist. With this parameter, the domain knowledge of medical experts can be captured.

Distance to current viewpoint: To avoid disorientation of the user, a new viewpoint should be located preferably near to the current viewpoint.

Viewpoint stability: During interactive exploration, it is presumable that the user moves the camera in the near surrounding of the viewpoint for further exploration. Hence, the object of interest should not be occluded by small changes of the camera. We use stability measures for the *unoccluded surface* parameter and the *importance of occluders* parameter. We compute a binary parameter map by thresholding the relevant map. On the binary parameter map, we use a simple distance function to code every point's distance to the border of the originated regions. As result we obtain a new parameter map where viewpoints near the center of large regions have a better value than those near the border.

Each parameter is represented by a parameter map which includes the value of a parameter for each viewpoint (see Figure 2). The importance of the parameters differs with respect to the specific medical scenario. Therefore we calculate the weighted sum of all parameter maps to get a final distribution of viewpoints S with:

$$S(\alpha,\beta) = \sum_{i=1}^{n} w_i p_i(\alpha,\beta) \quad , \quad 0 \leq w_i \leq 1 \qquad (2)$$

where $p_i(\alpha,\beta)$ is the distribution of the parameter i on the

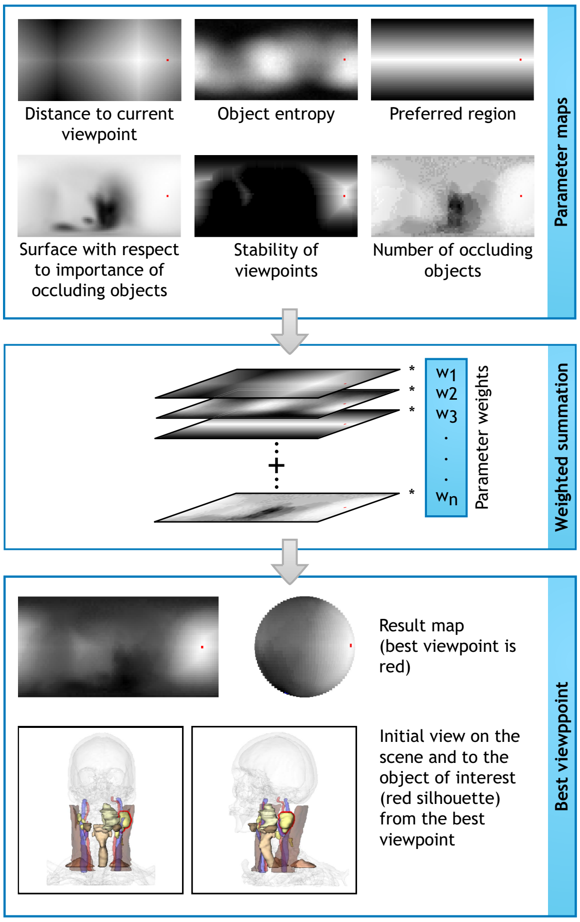


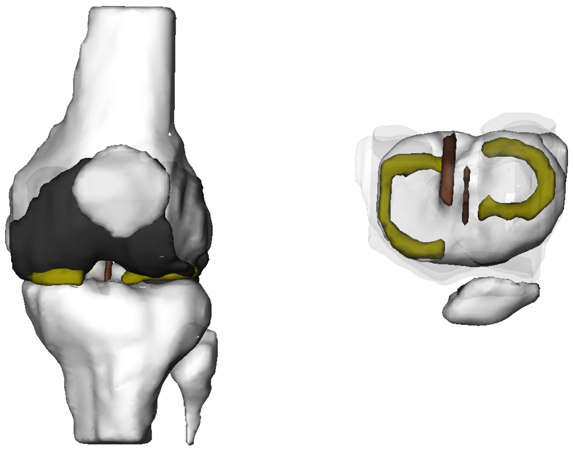
Figure 2: *This scheme illustrates the viewpoint estimation process. Several parameter maps are weighted and accumulated to a final result map. The maximum of this map is the best viewpoint for an object of interest. A Mercator projection is used to map the values from the sphere's surface to a rectangular region.*

bounding sphere's surface with α and β as spherical coordinates. The factor w_i defines the importance of parameter i. The maximum of $S(\alpha, \beta)$ is the best viewpoint for the object of interest.

Using an orthographic projection, zooming to the object of interest does not affect the visibility and occluding areas of that object. Our animation framework [MBP06] provides facilities to zoom to an object automatically, so that it fits completely in the viewport.

3.3. Example

To demonstrate our viewpoint selection process, we present a typical dataset from the clinical routine in orthopedics. Several structures in the knee like bones, meniscus, cartilage and cruciate ligament were segmented and are shown in an interactive environment for intervention planning. In orthopedics, a typical intervention planning task is the examination of the meniscus and the cruciate ligament. Both need to be examined carefully with respect to cracks. One goal of the exploration is to find a 'good' viewpoint on the meniscus as start point for further explorations. Methods that only take into account the size of visible surface get a viewpoint similar to the one in Figure 3(a), where the surface of the meniscus is unoccluded but too small. In our method, we consider domain knowledge as additional parameters:



(a) (b)

Figure 3: *Different viewpoints for the meniscus (yellow). (a): Viewpoint with respect to the largest* visible *surface of the meniscus. (b): Viewpoint from the top with respect of low importance of bones. The bones are almost completly faded out.*

1. The object entropy for this type of intervention planning tasks has the largest weight.
2. The preferred region for this type of intervention planning tasks is a view from top or bottom.
3. The bones and the cartilage have a low importance as context information, while the cruciate ligament is important.

Assigning higher weights to these parameters leads to the viewpoint shown in Figure 3(b). Because of their low importance, the low visibility of the bones does not degrade viewpoint quality.

4. Advanced Viewpoint Selection

Based on the generated visibility information and the extracted parameters, some advanced viewpoint selection techniques are possible.

4.1. Many Good Viewpoints for one Object

For automatic generation of animations it is helpful to explore an object from more than one 'good' viewpoint. One advantage of the final distribution S (see Equation 2) is the potential existence of many local maxima. Local maxima above a threshold can be used as viewpoints for a specific object exploration. The chosen viewpoints can be restricted to a definite count. Two to five viewpoints per object are suitable with respect to the size of the object. Starting with the global maximum (the best viewpoint for the object), the nearest lower maximum is chosen as additional viewpoint. To achieve a sufficient distance between the viewpoints on the sphere's surface, we set the viewpoint values in a certain distance to the last chosen maximum to zero. The resulting viewpoints are connected by a camera path. Starting with the nearest viewpoint to the current camera position, the viewpoints are connected by their distance on the sphere surface.

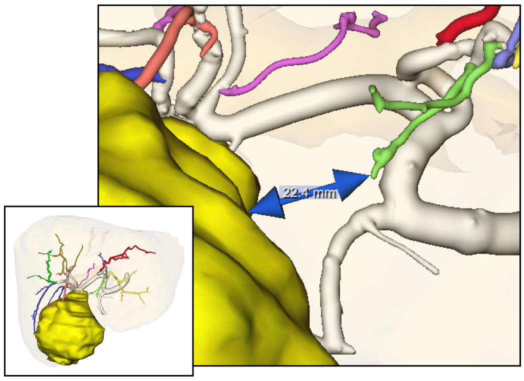


Figure 4: *View of the automatically determined minimal distance between a liver tumor and a vascular tree. The small image shows an overview of the scene.*

4.2. Viewpoints on Minimal Distances Between Objects

Besides the exploration of single objects, the evaluation of minimal distances between them is of crucial interest, in particular, if one object should be destroyed or removed and adjacent objects must be preserved. In liver surgery, the minimal distance between a tumor and surrounding vessels is important for the surgical strategy [PTSP02].

Handling the distance arrows from Figure 4 as scene objects and including them in the visibility determination is not satisfying. On the one hand, the runtime of the precomputation step heavily depends on the number of objects, on the other hand, all possibly interesting distances have to be computed in advance. Furthermore, the supplementary insertion of new objects is not possible in the employed visibility determination.

Instead, we adapt the parameters to handle minimal distances. The preferred region is perpendicular to the minimal distance vector. Additionally, the best visibility for the two objects, for which we compute the distance, is determined. With this setup, adequate viewpoints can be computed.

4.3. Good Viewpoints for Scene Introduction

Our visibility information generated in the pre-processing step can also be used to compute 'good' viewpoints for the whole scene. Such viewpoints can be connected to a camera path by our animation framework to introduce a scene. Overview animations of medical scenes should cover many important structures with a large visible surface. Because in most cases not all important structures are seen from a single viewpoint, different 'good' viewpoints are computed. We adapt an approach introduced by [BS05]. For each viewpoint, we use the pre-processing data to generate the distribution of visible surfaces for each object weighted by its importance for scene overview (which can differ from the importance of single object exploration). Like Bordoloi and Shen [BS05], we use the Jensen-Shannon divergence measure [Lin91] to find similarities between all pairs of viewpoints. The Jensen-Shannon divergence is a measure to compute the dissimilarity between two distributions p_1 and p_2:

$$JS(p_1, p_2) = D(p_1||(\frac{1}{2}p_1 + \frac{1}{2}p_2)) + D(p_2||(\frac{1}{2}p_1 + \frac{1}{2}p_2)) \quad (3)$$

where $D(a||b)$ is the Kullback-Leibler distance [Bla87] between the two distributions a and b given by Equation 4:

$$D(a||b) = \sum_{j=1}^{n} a_j log \frac{a_j}{b_j} \quad (4)$$

n is the number of objects in the scene. For every viewpoint i the distribution p_i is given by the object's surface o_i visible from the viewpoint weighted by the object's importance for scene introduction viewsλ:

$$p_i = (o_{i_1}\lambda_1, o_{i_2}\lambda_2, ..., o_{i_n}\lambda_n) \quad (5)$$

In order to differentiate the importance of an object for the introduction of a scene, we use the term *introduction importance* λ for each viewpoint.

Clustering the viewpoints weighted with the spatial distance between them on the bounding sphere, we get regions of similar viewpoints. For each region, we choose a representative viewpoint with a maximum value for *viewpoint introduction importance* u. It is computed as the summation of the components of viewpoint's distribution p (Equation 5):

$$u = \sum_{i=1}^{n} o_i \lambda_i \quad (6)$$

The viewpoints in each region are additionally weighted with their distance to the region's border to get viewpoints near the region's center. Three to five viewpoints per scene overview are considered appropriate by medical doctors.

5. Application Scenarios

Animations enable a smooth change between several viewpoints and material parameters such as transparency. We developed a framework to animate medical visualizations of individual patient data, like segmented structures, for intervention planning [MBP06]. The animations are script-based and adapt automatically to individual location, size and type of anatomic structures in polygonal scenes. Segmentation information and standardized object names are a prerequisite to reuse animations developed for one patient for another patient. This reuse of animations is not only effective, but also contributes to a reproducible process which is essential for clinical tasks. The viewpoint selection of this paper is integrated into the framework. The framework itself is part of two applications the description of which follows.

5.1. LiverSurgeryTrainer

The LiverSurgeryTrainer is an educational system to train the *planning* of oncologic liver surgery interventions [BRS*06]. In this domain, mostly a tumor needs to be resected out of the liver volume with a specific safety margin. During the intervention planning process, the surgeon has to explore the surrounding of the tumor, especially the nearer vascular trees. In the LiverSurgeryTrainer, beside other tasks, the user has to explore the liver's anatomy in a 3d scene. We support the user by computing 'good' viewpoints on selected objects. Because the liver tissue surrounds all segmented objects, we chose a parameter set, where the importance of the occluders parameter is weighted high as well as its stability. For educational purposes, it is crucial to provide an animated scene introduction. Our method supports this process by generating different viewpoints on the tumor and several vessels.

Planning a resection, the user has to take a very careful look at the distances to the vessels in the nearer tumor surrounding. This task is supported by the extension of our method, described in Section 4.2. If the user selects a vessel branch, an animation guides him to a 'good' viewpoint on minimal distance from this branch to the tumor.

5.2. NeckSurgeryPlanner

The NeckSurgeryPlanner is a software assistant for planning neck dissections [TPHS06]. Neck dissections are carried out for patients with malignant tumors in the head and neck region to remove lymph node metastases. The exploration of the dataset must be as fast as possible in the clinical routine. A lot of structures have to be taken into account (e. g. muscles, vessels, nerves and up to 60 lymph nodes). The identification of pathological lymph nodes is important. Thus, all noticeable nodes have to be identified [KTH*05].

Lymph nodes and tumors have a rather roundish shape. Hence, the object entropy is not significant. The structures are located very close to each other, so that the structure of interest is occluded from most camera positions. The view from the bottom into the neck allows a view without occlusions, but this view is never being recorded during surgical intervention. Furthermore, the structure of interest is mostly occluded by transparent context structures.

Table 1: *Parameter settings chosen in the evaluation. The values range from 0.0 to 1.0.*

Parameter	Neck setting	VPE setting
Unoccluded Surface	0.3	0.5
Unoccluded Stability	0.3	0.5
Preferred Region	0.5	0.0
Viewpoint Distance	0.0	0.0
Object Entropy	0.5	1.0
Number Occluder	0.05	0.0
Importance Occluder	0.5	0.0
Importance Stability	0.5	0.0

6. Evaluation

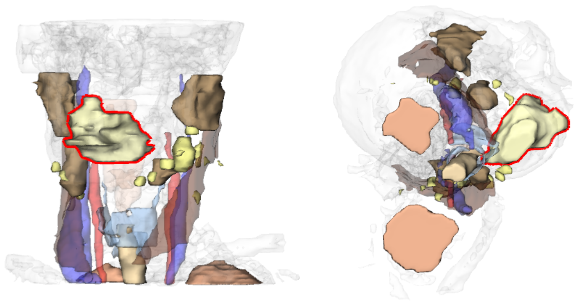
In order to get some objective results concerning the usefulness of our selected viewpoints, we carried out a user study. To obtain meaningful answers, we had to narrow down the specific application domain and chose neck surgery planning. The presented visualizations were developed for medical doctors who are familiar with the anatomy in the neck region. Therefore, we asked them to compare and evaluate the quality of the visualizations. The goal was to determine one parameter setting, which is suitable for all tumors and lymph nodes from different patients.

6.1. Methodology

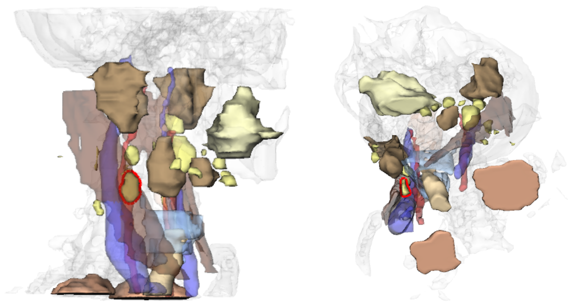
We developed a representative collection of possible viewpoint parameterizations. Besides a parameterization, that we considered appropriate for neck dissection planning (WPM-Neck), we emulated the viewpoint entropy (VPE) described by [VFSH01] with highly weighted unoccluded surface and object entropy (Table 1). We applied these settings on the tumors and lymph nodes of the neck datasets (9 structures in total). We hypothesized that the setting adapted to neck surgery planning is rated significantly better than the other settings.

6.2. Questionnaire Assembly

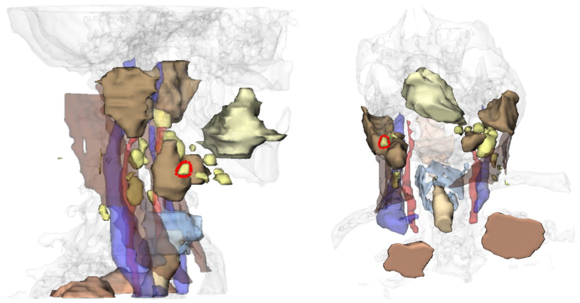
We used a web-based questionnaire for the user study. For two neck datasets we chose randomly selected lymph nodes and tumors and generated screenshots with the parameter settings. The respondent did not know how the parameters were adjusted or which kind of settings we used. In Figure



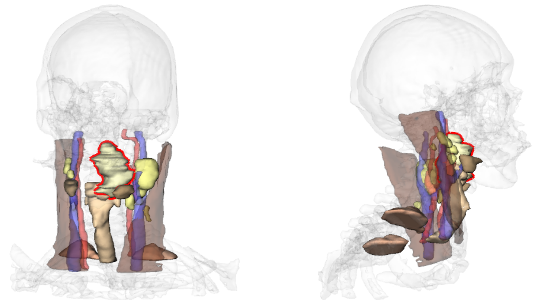
(a) WPM (left) and VPE (right) viewpoint for a tumor



(b) WPM (left) and VPE (right) viewpoint for a lymph node



(c) WPM (left) and VPE (right) viewpoint for a lymph node



(d) WPM (left) and VPE (right) viewpoint for a tumor

Figure 5: *Viewpoints on 4 structures in a scene for neck surgery planning. The structure of interest is depicted with a red silhouette. In each case, the viewpoint generated with the new weighted parameter map method (WPM) and the viewpoint using the viewpoint entropy measure (VPE) are shown. For the tumor and the lymph nodes in figure 5(a)-5(c), the VPE results in a quite unusual viewing angle. The tumor in figure 5(d) seen from the VPE viewpoint is occluded by many other structures. The WPM method always produce views where the structure of interest is seen well and from a familiar viewing angle.*

5, the neck parameterization of WPM and the VPE setting for exemplary structures are shown.

Every page of the questionnaire uses the same pattern. On one page, all four visualizations of the same anatomic structures were shown. The respondent had to rate the level of occlusion and the usefulness of the chosen viewing angle. In these questions, a specific problem had to be assessed on a five value scale (++, +, 0, −, −−) mapped to the values 1 to 5. The respondents also had the ability to give some comments for every screenshot. To classify the answers, we asked for some personal data: age, gender, education level, and personal skills with PCs as well as with 3D applications. Moreover, we asked for medical knowledge, especially in the neck region.

6.3. Analysis and Interpretation

In total, we received 44 completed questionnaires which could be evaluated. For the final analysis, only the 18 sheets from respondents with good medical knowledge were taken into account (4 female and 14 male). The average age of the respondents with good medical knowledge is 30 years (ranging from 24 to 45) and they have medium skills with PCs and 3D applications.

Table 2: *Evaluation of viewpoint quality. We received completed questionnaires from 44 persons. 18 of them have good medical knowledge. Viewpoint quality 1.0 is best, 5.0 is worst.*

All Respondents	**WPM-Neck**	**VPE**
Degree of Occlusion	2.12	2.51
Viewing Angle	2.43	3.01
Medical Experts		
Degree of Occlusion	1.78	2.18
Viewing Angle	2.07	2.63

Our results indicate that the developed setting for neck surgery planning is appropriate for all necessary structures (Table 2). In a direct comparison between the VPE and the neck parameterization, the neck parameterization is regarded as superior. The viewpoint quality is at least 0.39 degrees better. The reason for the better rating may be the consideration of the ‘importance’ of the occluding structures.

7. Conclusion and Future Work

We present a new approach for viewpoint selection in medical surface visualizations for intervention planning tasks. Our scenes consist of many pre-segmented anatomical objects of different importances. We use different weighted parameters like preferred region and importance of occluding objects to estimate the quality of viewpoints for an object of interest. Using pre-calculated visibility information, our method computes 'good' viewpoints in real-time. Those viewpoints are used in interactive environments for intervention planning as well as for generating animations, which are used in interdisciplinary discussions of medical doctors.

Furthermore, we discussed the use of our method for the computation of camera paths for several 'good' viewpoints for a single object and for the generation of views on minimal distances between objects, e. g. for risk analysis. We described an extension of our method to compute 'good' viewpoints for scene introduction animations. An informal user study was accomplished to evaluate our viewpoint results for intervention planning in the neck region.

Because the different parameters can not be directly mapped to users' visualization goals, advanced techniques to get appropriate parameter sets for several intervention planning tasks are desirable. Users could create views on single objects interactively and judge them as 'good' or 'bad'. Using machine learning techniques, parameter sets for 'good' viewpoints can be derived. Even though our user study indicated that a good parameter set was chosen for neck intervention planning, it is not clear, whether multiple parameter sets exist per intervention planning task. Providing a couple of well evaluated parameter sets might be a good strategy for other tasks.

Acknowledgment

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