Summary of "Visualising Video Sequences Using Direct Volume Rendering"

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In the course of the lecture "Visualisierung 2", conducted by the Computer Graphics Group at the Vienna University of Technology, a visualisation technique has to be implemented, based on a scientific publication. We selected the paper "Visualising Video Sequences Using Direct Volume Rendering" by Daniel and Chen [1]. This summary gives a short overview of the selected paper and further includes a first implementation idea of our project.

1 Summary

In the selected paper by Daniel and Chen [1] a visualisation technique for video sequences is presented. In their approach video sequences are summarized by visualising the whole sequence as a three dimensional object, where time is specified as the third dimension. Direct volume rendering is used to enable insights into the volumetric video block. Thus, a reasonable way to set the opacity of each voxel value has to be found.

1.1 Visualisation

A video sequence can be represented as a volumetric data set V (Eq. 1), where xn and yn represent the x and y dimensions of each frame and tn represents the number of frames of the sequence.

$$V = \{v_{x,y,t} | 1 \leq x \leq xn, 1 \leq y \leq yn, 1 \leq t \leq tn\} \tag{1}$$

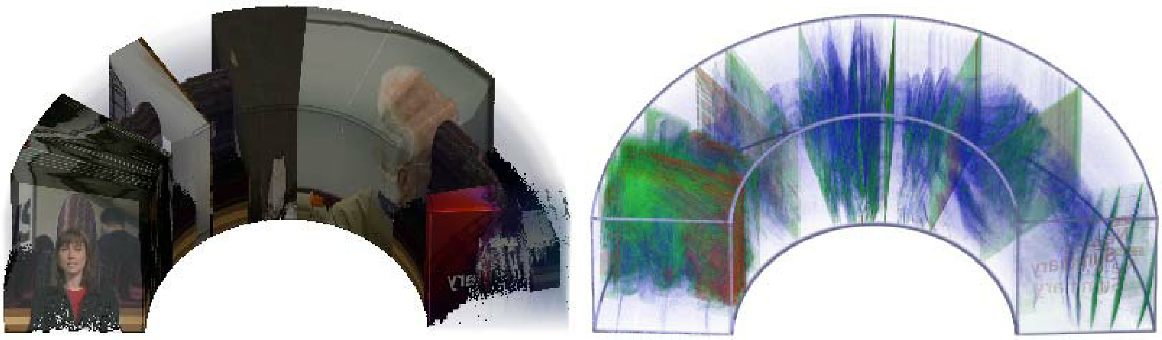
To each voxel $v_{x,y,t}$ a color value is associated. Additional image processing tasks further allow to determine opacity information for each voxel. The volumetric data set can be treated as a three dimensional spatial object, which facilitates the spatial transformation of the object for various viewing possibilities. The presented system supports five different representations for a quick decision-making process. For the so-called horseshoe view a spatial transfer function is applied.

An opacity and colour transfer function is further used to specify which information is visualised with which opacity. Daniel and Chen presented two different transfer function types in their paper. The first one simply depends on the colour of each individual voxel whereas the second approach aims to visualize differences between frames and thus more sophisticated image processing techniques are necessary.

1.2 Transfer Functions

Figure 1 depicts the visualisation of a news video with two different transfer functions. The first one is based on the hue value of each voxel: if the value is within a specified range (in this case 225-255) the opacity is set to *0.2*lightness*, otherwise opacity is set to 1. As visible in Figure 1a, this results to semi-transparent areas in the video block where the colour would be blue otherwise.

For the second transfer function a difference function is applied on the video sequence to highlight differences between consecutive frames. The relative difference between a voxel and its successive voxel (t+1) indicates the opacity of the voxel. In case of the news video (Figure 1b) these differences additionally highlight transition frames between two different scenes, since differences are highest at these instants of time. Difference functions are especially interesting for surveillance cameras in the security industry, e.g. to observe unusual motion behaviour.



(a) (b)

Figure 1: Horseshoe visualisation of a news video: (a) with hue transfer function and (b) with difference transfer function. Images taken from [1].

2 Implementation Idea

We plan to implement the project in *C++*, utilizing the libraries *OpenGL* for the visualisation and *OpenCV* for the image processing part. For direct volume rendering a raycasting approach will be implemented. Additionally the use of the framework *Volumeshop* is considered. As an alternative to the presented transfer function a saliency based transfer function is contemplated, based, for example, on the work of Ming-Ming Cheng et al. [2]. This could allow to suppress non-relevant background.

References

[1] G.W. Daniel and M. Chen. Visualising video sequences using direct volume rendering. Proc. the 1st International Conference on Vision, Video and Graphics (VVG2003), 103-110, Eurographics/ACM Workshop Series, Bath, July 2003.

[2] Ming-Ming Cheng; Guo-Xin Zhang; Mitra, N.J.; Xiaolei Huang; Shi-Min Hu. Global contrast based salient region detection. Computer Vision and Pattern Recognition (CVPR), 2011 IEEE Conference on, pp.409-416, June 2011.