Assignment 5

3d Spatial Data, Volume Rendering

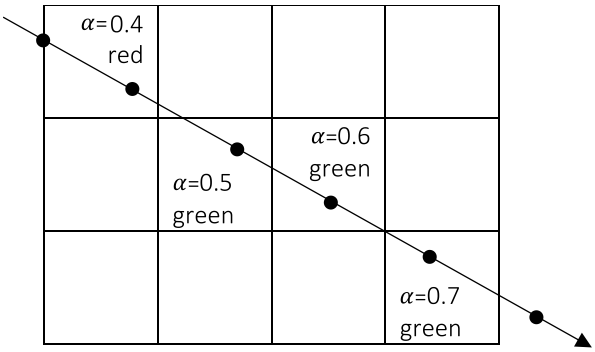
10 Points for Homework

Due Tuesday, June 18th, 23:59 (Paderborn time)

Upload your solutions to PANDA using the upload tool entitled with "Assignment 5". Your submission has to include the source code and images of your solution.

1. In class assignment:

(a) The following image represents a ray, symbolized as an arrow that goes through a volume consisting of voxels (here: boxes). Move along the ray and update the color value C_{dst} and the opacity α_{dst} for each sample. You will find the corresponding color of a voxel stated by its color name, the opacity by the float value inside each voxel. Use NN (nearest neighbourhood) to determine color and opacity of a sample.



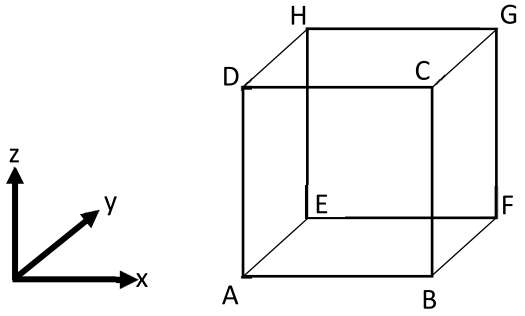
Use the following equation to update the color value C_{dst} and the opacity α_{dst} for each sample along each ray:

color: $C_{dst} \leftarrow C_{dst} + (1 - \alpha_{dst}) * (\alpha_{src} * C_{src})$

opacity: $\alpha_{dst} \leftarrow \alpha_{dst} + (1 - \alpha_{dst}) * \alpha_{src}$

(b) The unit cube below shows eight neighbouring voxels A through H with the following voxel values: f(A)=0, f(B)=100, f(C)=80, f(D)=30, f(E)=40, f(F)=90, f(G)=120, f(H)=150

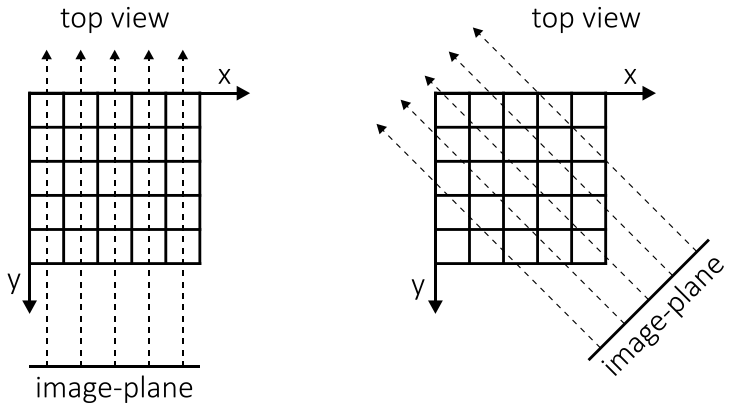
(i) Calculate the voxel value of f(0.2, 0, 0) using linear interpolation.
(ii) Calculate the voxel value of f(0.2, 0.6, 0) using bilinear interpolation.
(iii) Calculate the voxel value of f(0.2, 0.6, 0.7) using trilinear interpolation.



2. Homework:

Use the medical CT volume data set “volume.raw”. The data set is provided as zip-archive “volume.zip” under PANDA → Assignment 5. Also take note of the description files “DataCharacteristics.txt” and “TermsOfUse.txt”.

Generate 2d-images (512 x 421 pixels) of the 3d-volume from two different camera positions around the volume using volume rendering.

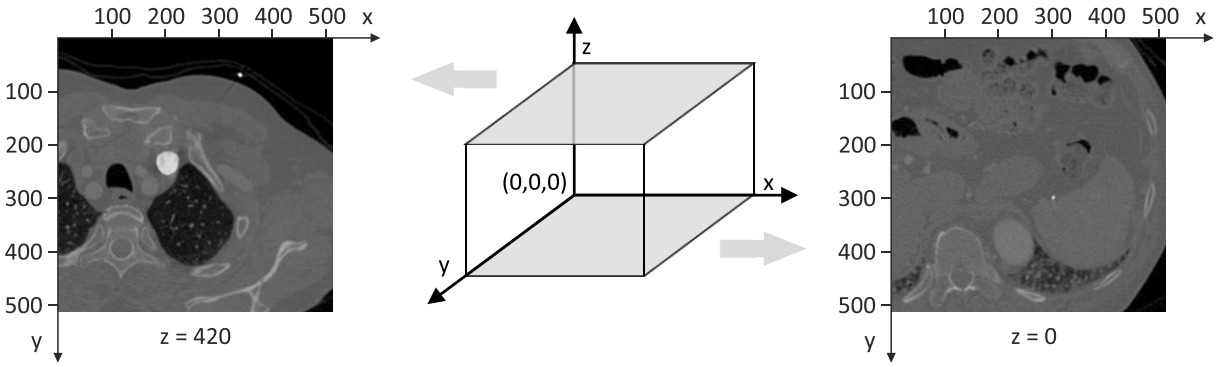


(a) (b)

(a) Create an image of the volume as depicted in the left figure (looking from the y-axis towards the x/z plane). You may keep the rays into the volume parallel to each other and along voxels. Sum values up along each ray. Use linear scaling to convert the resulting image to a byte image.

(b) Create an image of the volume as depicted in the right figure. You may keep the rays into the volume parallel to each other. Compared to subtask (a), the rays’ angle is turned by 45°.

We assume the following coordinate system. Please check the uppermost and lowest slices of your imported data set in order to ensure that you have imported the volume data accordingly. The slices should look like this:



You must code the volume rendering yourself (no libraries allowed).
However, you may use a library like “numpy” to handle the data.
Upload a PNG picture and code to PANDA for both subtasks.

The points you will receive for this assignment depend upon:

- correctness of solution
- expressiveness and effectiveness