Section: **Intraoperative Bildgebung**

ID: 119

Abstract-Title:
ANALYSIS OF TWO METHODS OF DISTORTION OF IMAGE DATA FOR AUGMENTED REALITY APPLICATIONSANALYSE VON ZWEI METHODEN ZUM VERZERREN VON BILDDATEN FÜR AUGMENTED-REALITY-ANWENDUNGEN

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Abstract-Text:
Purpose:
In augmented reality (AR) applications real-time video images are overlaid with additional information. Unfortunately, many cameras such as endoscopes produce distorted images. In this article two methods for distorting augmented reality content to match with the corresponding video image are presented and compared regarding speed and accuracy.
Method:
To overlay the endoscope image with the adequate distorted AR content, this content is rendered into a texture which is transferred distorted to the frame-buffer using one of the following methods: Texture Mapping and Fragment Shading. Using the distortion camera parameters obtained by a standard camera calibration procedure, a texture map for the Texture Mapping method or a distortion texture for Fragment Shading is created.
The texture map is a triangle mesh in form of a rectangle with additional texture coordinates corresponding to the vertex coordinates of the triangle corners. To achieve a distortion the vertex coordinates are displaced (see figure 1) while their corresponding texture coordinates are maintained. In order to render the texture with the AR image data to the frame-buffer, each triangle with distorted vertex coordinates mapped with undistorted texture coordinates are painted. For Fragment Shading a float texture is provided. Each pixel of this float texture contains the location information of its undistorted position. To overlay the AR content using this method, a fragment program is executed for every pixel while the texture with AR image data is rendered to the frame-buffer. The fragment program determines the color of a pixel to draw using the distortion texture as well as the texture with AR content.The two methods were tested on a desktop PC with an ATI Radeon 9800 graphic card. An AR-image with 768x576 pixels was created in order to overlay a video image distorted. First, the time required for rendering was determined for Fragment Shading and for Texture Mapping with different triangle sizes in the texture map. Following, the accuracy of the pixel displacement was analyzed.

Results:
As you can see in table 1, fragment shading is the fastest method, closely followed by texture mapping with large triangle sizes. If the size of the triangles decreases, the rendering takes too long for a real-time application. The second analyzed criterion is the accuracy of pixel displacement. The fragment shading provides an exact representation of the mathematic distortion model because the pixel shift is explicitly denoted in the distortion texture for each pixel. Because of that, the pixel displacement error of the

fragment shading method is negligible.
At texture mapping, a linear interpolation takes place within each triangle. Table 1 contains the mean and maximal pixel shift error for different triangle sizes at a typical endoscope distortion. Up to a triangle size of 32 pixels, the pixel error is in sub pixel range and can be disregarded. If the triangle size gets larger, the pixel displacement error rises and an accurate overlay is not possible.

Conclusion:
Two methods for distorting AR-images has been presented, analyzed and compared. Texture mapping with advantageously chosen triangle size is suitable for distorting AR image data for real-time application like AR supported endoscopy. The fragment shading method is a fast and accurate way but is only supported by newer graphics hardware.

Bild 1/JPG

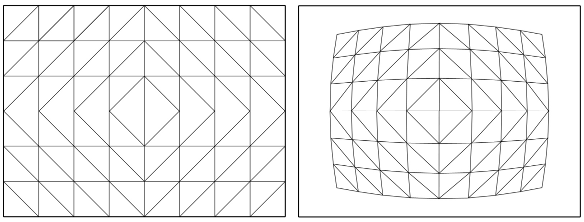

Bild 2/JPG