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author={T. Blum and M. Wieczorek and A. Aichert and R. Tibrewal and N. Navab},   
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title={The effect of out-of-focus blur on visual discomfort when using stereo displays},   
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abstract={Visual discomfort is a major problem for head-mounted displays and other stereo displays. One effect that is known to reduce visual comfort is double vision, which can occur due to high disparities. Previous studies suggest that adding artificial out-of-focus blur increases the fusional limits, where the left and right image can be fused without double vision. We investigate the effect of adding artificial out-of-focus blur on visual discomfort using two different setups. One uses a stereo monitor and an eye tracker to change the depth of focus based on the gaze of the user. The other one uses a video-see through head mounted display. A study involving 18 subjects showed that the viewing comfort when using blur is significantly higher in both setups for virtual scenes. However we can not confirm without doubt that the higher viewing comfort is only related to an increase of the fusional limits, as many subjects reported that double vision did not occur during the experiment. Results for additional photographed images that have been shown to the subjects were less significant. A first prototype of an AR system extracting a depth map from stereo images and adding artificial out-of-focus blur is presented.},   
keywords={helmet mounted displays;stereo image processing;virtual reality;depth map;double vision;eye tracker;head mounted displays;out-of-focus blur;stereo displays;stereo monitor;virtual scenes;visual discomfort;Augmented reality;Cameras;Monitoring;Pixel;Stereo vision;Three dimensional displays;Visualization},   
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**Bibliography**

This is all about approaches and techniques offering good stereoscopic vision that does not lead to simulator sickness, minimizes visual discomfort and at the same time offers a realistic perception of depth. The issues like negative effect of high disparities on the ability to fuse images of stereo displays and for the human vision. The other major one is the occurrence of double vision (diplopia), when focusing on a far object while putting a finger close to the eye, a double image of the finger will be seen. There are some issues, which are not yet solved completely.

The main objective of this paper was to investigate the effect of out-of-focus blur on visual discomfort when using stereo displays. They have experimented the above for both HMD and stereo monitor. The main hypothesis was, that applying blur to no fixated layers in a scene would lead to lower visual discomfort. To do this, three issues must be addressed. Firstly, the gaze of the user must be tracked. Secondly, the depth of the gaze point should be known. The third problem is to blur the image. To overcome the issue, they have experimented with few things and they have concluded as there are several ways how such AR system could be built.

They performed an experiment on using artificial depth of field to reduce visual discomfort when using stereo displays. The main hypothesis was that out-of-focus blur would reduce visual discomfort due to double vision. Their results showed a significantly better perceived quality when using out-of-focus blur in virtual scenes. However, for photographed scenes results were not significant. Considering that many subjects reported that they did not perceive double vision at all we could not confirm our initial hypothesis without doubt.

**References:**

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"This is entirely my own work, except as disclosed in the documentation. I gave help to the following persons:  
None  
Signed Kiran C Shettar"