Artifact reduction for lenslet array near-eye displays using a rendering method combined with eye tracking

Name: Bi Ye
Laboratory’ s name: Interactive Media Design Lab
Supervisor’ s name: Hirokazu Kato

Abstract: Lenslet array near-eye displays are a revolutionary technology that generates a virtual image in the observer's field of view. Artifacts occur when the user’s pupil moves out of the eye box (i.e., cross-talk) making the image look doubled. It negatively impacts the user experience. However, pupil size and human visual perception did not consider in this process. The practical pupil movable region (PPMR) was defined, which differs from eye box size because it considers pupil size and human visual perception. Undesirable artifacts still occur when the user's pupil moves outside of the PPMR. Even with dynamic image updating based on eye-tracking techniques, artifacts still be perceived when human eyes turn rapidly. To enlarge PPMR, a new rendering method is proposed. The rendering method for microdisplay images takes pupil size into account and includes the idea of pupil margin in the ray tracing process. Ray lights emitted by one microdisplay pixel (MP) enter the pupil and pupil margin area after passing through a number of lenses. Each lens at the MP corresponds to one virtual pixel (VP) on the virtual image plane. The weight of each VP is the intersection area between the ray light column and the pupil and pupil margin divided by the sum of intersecting spaces between all the ray light columns generated by the MP and the pupil and pupil margin. The value of each MP is determined by the number of VPs and the related weight. The system parameters of the incident pupil and pupil margin light columns are analyzed and evaluated to determine which optimized system can adapt to the maximum velocity of saccadic pupil movement. We optimize the rendering method to reduce memory consumption in generating microdisplay images. In addition, user studies were conducted to evaluate the effect of the technique using the optimized rendering method combined with eye tracking to reduce artifacts for fast-rotated eyes on different content of images and videos. According to the results, our method can effectively reduce artifacts via the optimized rendering method with eye tracking, which can adapt to faster human eye movements.