Master Thesis

Saccadic-Aware Foveated Rendering

Project Description: 3D rendering in real-time converts 3D models into 2D images. Unlike conventional real-time rendering (e.g., computer games), virtual reality (VR) mimics human perception exactly. Thus, it opens up a whole new area of rendering optimization research to represent 3D environments in a more perceptually accurate manner.

One perceptual limitation of human eyes is that during perception the eye movements are divided generally into three major states: fixation with microsaccades, smooth pursuit, and saccade [4]. The saccade allows humans to compensate for lower visual acuity in the periphery by placing features of interest at the fovea. During saccades, the human brain does not register the eye signal [2]. Moreover, the visual acuity reduces for several hundred milliseconds after a saccade [5]. Therefore, the visual fidelity can be reduced during saccades [3].

Another perceptual limitation is that, even during fixation, humans do not perceive similar graphics fidelity within the entire field of view. This phenomenon is often named foveated rendering. This technique leverages the fact that the human eye sees with high detail only in the central part of its vision (the fovea), while the peripheral vision is less detailed. In foveated rendering, graphics are rendered at full resolution only in the region of interest (fovea) where the user is directly looking. The rest of the screen, which falls into intermediate and peripheral vision, is rendered at a lower resolution, reducing the overall computational load and increasing performance, especially in VR applications.

Research Questions:

1. Robustly detect and classify eye movements.
2. Figure out the states of visual acuity during pre-saccade, saccade, and post-saccade.
3. The impact (computation and perception) of saccadic suppression over rendering.
4. Make a smooth transition between saccade and fixation.
5. Exploit saccadic suppression in the foveated setup (additional benefits and research challenges).
6. The gaze landing prediction can improvise the saccadic suppression. Based on the prediction, the rendering can start before the saccade ends [3, 6, 1].

References

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