FovHolo: Fovea inspired holographic near-eye display

Augmented reality technology is going to change the way we interact in our personal and professional lives. The existing market solutions of head-up displays of augmented reality have fundamental drawbacks; they support the human visual perception of 3D scenes in a very limited way. On the other hand, holography does not have this limitation. It is considered the ultimate 3D imaging technology because it reconstructs optical copies of 3D objects as they appear naturally. However, a serious flaw of holography is its large computational complexity.

This project aims to overcome the technological limitations of modern holographic displays by introducing a novel concept of the holographic near-eye display, which mimics the human visual system. Human eyes, as common in the animal world, provide spatially-dependent resolution power over the field of view. For humans, the highest resolution is located at the fovea of the retinal surface. Thus, such a case of variable resolution imaging is referred as foveated imaging. This project proposes a holographic foveated near-eye display with continuously variable resolution in the field of view, which mimics the perception of human eyes. It means that the highest image resolution will be provided only at the gaze direction of the observation.

Conventional holographic and non-holographic imaging system are based on the sampling scheme were the pixel size is equal through the entire image. For near-eye holographic display this means that huge amount of pixels is required to have wide field of view (large image) and high resolution (sharp image). Proposed foveated holographic imaging concept enables large field of view and, simultaneously, resolution using a reasonably smaller number of pixels.

The hardware efficiency of the proposed near-eye display is also a key advantage for numerical solutions of the project. The high resolution image data will be computed and updated at the gaze direction only. Near-eye display requires an update of 100 frames per second, and this requirement is very difficult to achieve for computational holography. High speed hologram update will be obtained by using holographic geometrical transformations. In addition, in the project we will develop efficient methods for manipulation of 3D optical signals of large field of view, which are encoded in holograms. The efficiency of the approach is based on the idea that at the location of eye pupil the optical wave will cover a very small area.

Moreover, one of the serious bottlenecks of holographic displays is that they use laser light, which, firstly, produces coherent speckles that limit the resolution and, secondly, is potentially hazardous to the human eyes. Light emitting diodes (LED) illumination is the preferred alternative but it comes with the image blur. Smart design of imaging optics, which will consider the blur effect of the LED source, will enable higher resolutions across larger object depths.

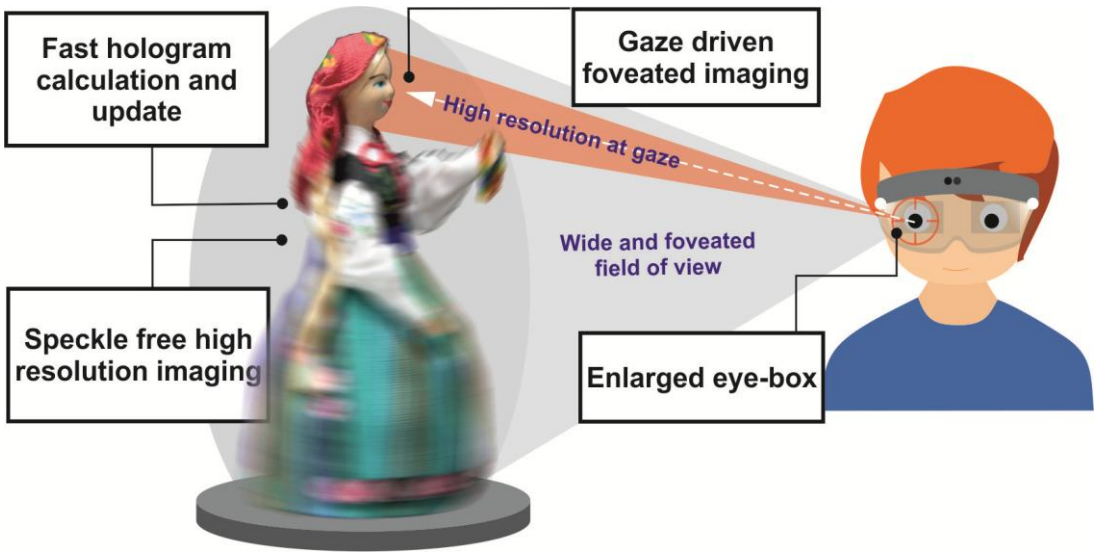

Figure 1. Envisioned objectives of FovHolo project.