

# **Analysis of the visual perception conflicts in mixed reality systems**

**Type:** oral presentation

## **Introduction**

Systems of the virtual, augmented and mixed reality are getting involved in various areas of the human live. For example, they are used in the process of an automotive or an aircraft design, allowing engineers to see how the designed object would look, feel and behave in the virtual or real environment. They get especially useful when creating training simulators. These simulators are extremely necessary for emergency situation training. All these application areas require a long-time usage of the virtual, augmented or mixed reality system that leads to the stronger requirement of the end user comfort. With release of more mixed reality system products on the market [1,2,3,4] this area would grow to cover more areas and might become a part of human daily live.

The high quality of optics, the realism of the virtual world image and the high resolution of the micro-display are not the only requirement to provide a natural perception of the virtual world, especially when designing the mixed reality system. For the naturalness of perception, it is necessary not only to ensure the reconciliation of vergence and accommodation of the human eyes, but also to ensure that light-optical characteristics of the virtual objects that are added to the real environment are naturally merged with the real objects. It means that:

- the virtual objects are naturally illuminated with the real light sources of the real environment;
- the real objects of the real environment are naturally illuminated by the virtual light sources;
- the virtual objects are reflected in the real mirrors of the real environment;
- the real objects of the real environment are reflected in the virtual mirrors;
- the shadows formed by the real objects naturally shadows the virtual objects;
- the shadows formed by the virtual objects naturally shadows the real objects.

The main goal the current research is to provide the fast, reliable and convenient way of prototyping the different ideas and solutions aimed to reduce the visual perception discomfort that may arise when using the merged reality systems.

## **Model of the visual perception conflict**

Various approaches to elimination of the visual perception conflicts may have their own specifics aimed to reduce the possible discomfort. These approaches may have their own pros and cons that should be analyzed by the mixed reality system designer. In the case of virtual reality [5] all our world is virtual one and we see only images of the virtual objects generated with the rendering system. All objects exist in the rendering system and if the virtual reality system is accompanied with the eye tracking system then all information is accessible for the synthesizing of the physically correct rendering image, which takes the specifics of the image visualization into account, which includes the vergence - accommodation conflict resolution handled by the optical system. However, as the prototyped system is a mixed reality system, the problem is more complex. There are two spaces: the real world and the virtual world. If rendering system knows all about the virtual world then the real world can be undefined (or not wholly defined) for the rendering system. Merging the virtual objects with the real world might cause additional visual perception conflict.

Considering all problems and complexity of the prototyping of the mixed reality system we propose the specific system of the virtual prototyping aimed on analyzing the visual perception conflict and steps needed to evaluate the visual perception in designed model. A virtual prototyping system that can ensure the correct display of all arising visual effects should be based on the photorealistic rendering model. It allows designer to:

- synthesize the real-world image in the form in which it is observed by a user of a mixed reality system
- synthesize the projection of a flat image of the virtual world on the retina of the eye
- merge these images on the human eye retina

The results of virtual prototyping of the mixed reality system is presented. The sources of the visual perception conflicts were analyzed and the possible solutions how to eliminate or reduce the conflict is proposed. To eliminate the sources of the visual perception conflict we used the algorithms of the light-optical characteristics restoration, which includes restoration of light sources position and objects with specular properties [6, 7].

## Results

The virtual prototyping approach was proposed to analyze the possible visual perception conflicts that may arise when using the mixed reality devices. This allows to conduct virtual experiments aimed to minimizing the possible discomfort and to estimate the results of these experiments without creating the real mixed reality device prototypes. An example of the virtual prototyping of the optical see-through and video see-through mixed reality devices was presented. The continuation of the research will be aimed to the solution of the problem of reconstruction of the full light-optical characteristics of the real environment which are required to render the realistic virtual objects image with decreased visual perception discomfort.

## References

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