Evaluation of Virtual Design Prototypes in Augmented Reality with Depth Sensing Technologies

Design evaluation is a critical stage in new product development. Success of design evaluation not only helps discover design problems timely, but also identify individual customer requirements. Augmented reality (AR) provides a highly interactive environment for human users and has been applied to practical uses such as maintenance training and product demonstration. However, to position virtual objects in a real scene is still problematic, thus limiting use of AR in other occasions. The recent progress of sensing technologies offers feasible solutions for improving the functionality and usability of augmented reality. Ambient intelligence thus produced facilitates creating novel user experiences. This research aims to develop novel evaluation functions for virtual design prototypes based on the augmented reality concept. Virtual models can be precisely combined with objects in a real scene using multiple depth cameras. A data fusion method will be proposed to merge depth data captured by different cameras. The merged result helps re-construct the complete scene unable to be acquired by a single camera. The spatial arrangement of the depth cameras and their parameter setting will be studied to achieve better precision in the data fusion. In addition, we will develop simulation functions for assembly of virtual models and real objects in a video stream. The assembly features of the real objects will be recognized from the color and depth images of the scene. They allow parts assembly via mating planes and aligning axes. Assembly interferences among parts will be automatically calculated and the locations will be highlighted in the video. Lastly, we will improve processing of the occlusion effect in augmented reality with the depth data captured from the real scene. The purpose is to generate realistic visualization contents by smoothing the object profile in the occlusion and reducing jitter in the depth image. The originality of this research is high, providing both theoretical innovation as well as practical values. It opens up applications of depth sensing technologies in product design. The virtual prototyping functions proposed in this work realizes the idea of mobile design services. They can find extensive applications in design evaluation for a wide spectrum of products such as furniture, art, real estate, and manufacturing.

Keywords: *depth sensing, augmented reality, design evaluation, assembly simulation, object occlusion*