Augmented Reality under water

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1 Introduction

Fascinated by a stunning variety of corals and fishes or mysterious wrecks more and more people are attracted by snorkeling and diving adventures. Virtual Reality scenarios like the virtual oceanarium [Froehlich 2000] try to satisfy this interest by allowing for discovery of underwater worlds in a riskfree and comfortable way, but a realistic feeling of diving is never achieved by virtual submarine worlds.
In this paper we present a system allowing users to sense virtual corals and fishes even physically under water. We developed a mobile prototype using Augmented Reality techniques to enhance a regular swimming pool with virtual objects. For demonstration purposes an underwater Augmented Reality game was created turning a swimming pool into a maritime environment (cf. fig.1).

Figure 1: User discovering the virtual underwater world

2 Our approach

The realization of the overall system required waterproof and rugged hardware as well as appropriate software to be used in a swimming pool environment. The central component of our mobile hardware prototype is an optical see-through display mounted in front of a diving mask. Rendering of the virtual objects is performed on a waterproof sealed ultra mobile PC connected to the display via a flexible tube. A hybrid tracking approach combining inertial and magnetic-field-based with optical (marker-based) tracking is used to determine position and orientation of the user. The inertial and magnetic-field-based tracking bridges the gap if the marker tracking fails which can easily happen due to occlusion of the marker during swimming movements. To avoid reflections of the marker we developed special non-reflective, water-resistant markers that even work in direct sunlight.

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The Augmented Reality game turning the swimming pool into an attractive underwater landscape is based on our AR/VR framework Morgan. The user acts as a maritime archaeologist who is supposed to find and open a sunken treasure chest. To open it a numerical code hidden in magical shells has to be solved. Opening of the magical shells is realized by an interaction technique solely based on approaching the virtual objects. Swimming far away the shells stay closed but by getting closer they open up allowing the user to see their numbered pearl. By this intuitive technique the user is able to interact without controlling input devices that are probably difficult to handle under water as arms and legs are needed for swimming movements. We realized the mentioned interaction technique as well as different animation effects for the underwater world with an earlier approach based on interaction prototyping [Broll et al. 2008].

3 Results

We evaluated the system in an initial user study with 8 participants (6 male, 2 female). The majority found the system easy to use and rated the handling very positive. Most of the participants felt in no way handicapped by the system and were able to fully concentrate on the perception of the virtual corals and fishes. The developed tracking system worked up to a water depth of almost 4 metres. The main drawback of the system was the small field of view of the optical see-through display. Color representation and contrast as well as the occlusion of the real world with virtual objects, which sometimes is a problem of optical see-through displays, yielded good results. Additionally all users declared that the haptic influences of the water had intensified their experiences and lead to a new form of perception.

4 Conclusion

The developed system shows how Augmented Reality techniques can be used to extend a usual swimming pool with virtual objects.
Based on the positive results of the initial user study we consider the system to be a good basis for future employment of Augmented Reality under water. Prospective directions of our group include the development of more sophisticated applications and the enhancement of technical aspects of the hardware prototype. As well, we plan to extend our knowledge to support professional divers in maritime environments in different tasks.

5 References

BROLL, W., HERLING, J., AND BLUM, L. 2008. Interactive Bits: Prototyping of Mixed Reality Applications and Interaction Techniques through Visual Programming. In *IEEE Symposium on 3D User Interfaces 2008*, 109–115.
FROEHLICH, T. 2000. The virtual oceanarium. *Commun. ACM* 43, 7 (Jul. 2000), 94-101.