Dissertation

A Virtual Reality Head Mounted Display for Underwater Training and Recreational Purpose

for the degree of

Master of Science (Research) in Computing Sciences

Wenlong Zhang

June 2017

Faculty of Engineering and Information Technology

CERTIFICATE OF ORIGINAL AUTHORSHIP

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as part of the collaborative doctoral degree and/or fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Name

Acknowledgments

This thesis would not be completed without all the people who provided me support and encouragement.

First of all, I am heartily thankful to my supervisors, Dr. Tim Chen, Dr. Chek Tien Tan and Associate Professor Yusuf Pisan, whose encouragement, supervision and support from the preliminary to the concluding level enabled me to develop an understanding of the subject.

Great thanks are due to Dr. Sam Ferguson and Associate Professor Andrew Johnston, who lent me the 3D printer and gave me precious suggestions for the 3D printing.

It is a pleasure to thank Professor Barry Jay and Dr. William Raffe for their valuable guidance for research methods, scientific writing and how to distil research ideas.

Finally, thanks to my family and friends who were always there to encourage me to pursue this research.

Table of Contents

List of Figures

List of Tables

List of Publications

Zhang, W., Tan, C.T. & Chen, T. 2016, 'A safe low-cost HMD for underwater VR experiences', *SIGGRAPH ASIA 2016 Mobile Graphics and Interactive Applications*, ACM, p. 12.

Abstract

This thesis introduces an interactive underwater virtual reality headset as an engaging and convenient tool for educational and recreational purpose.

Recreational sea diving and other related underwater activities are common exhilarating experiences for many people. However, it is dangerous, costly and time-consuming for novices to learn. Virtual Reality presents a possible approach to this problem. Most of the consumer level virtual reality headsets can only be employed under dry conditions. Through a detailed literature review of virtual reality (VR) research field, a small gap that has not been filled which refers to the use of VR in wet or underwater scenarios.

In order to fill the identified gap, a head mounted display prototype called *UnderwaterVR* was designed and implemented. The prototype is a safe and low-cost alternative for novices to learn diving in a controlled swimming pool environment, which at the same time serves as a novel entertainment platform to experience interactive underwater games. The proposed prototype is a cable-free, mask-like, waterproof VR goggles. In the virtual world, participants behave autonomously and being able to interact with the environment continuously.

To evaluate the prototype, an autoethnographic study was conducted. The prototype was reported to be engaging and that, interestingly, there was less cybersickness in the prototype than in a normal VR setup out of water. A hypothesis is presented to interpret the reason why there was less cybersickness.

This thesis presented a low cost but efficient way for making a waterproof head mounted display via 3D printing. The failures and redesigns that we had during the development contribute to the further research. Another contribution we have made in this thesis is to explore the underwater interactivity for VR/AR.