博 士 学 位 論 文

内 容 の 要 旨
お よ び
審 査 結 果 の 要 旨

第41編

令 和 4 年 度

神 奈 川 工 科 大 学

はしがき

本編は、学位規則（昭和２８年４月１日文部省令第９号）第８条による
インターネットの利用により公表を目的として、令和４年度内に本学に
おいて博士の学位を授与した者の、論文内容の要旨および論文審査の結果の
要旨を収録したものである。

学位記番号に付した甲は、学位規則第４条第１項（いわゆる課程博士）
によるもの、乙は、同規則同条第２項（いわゆる論文博士）によるもので
あることを示す。

（令和５年４月　発行）

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氏名(本籍)	謝　斌／謝　レックス　(台湾)
学位の種類	博士 (工学)
学位記番号	甲第 46 号
学位授与日	令和 5 年 3 月 21 日
学位授与の要件	学位規則第 4 条第 1 項該当
研究科・専攻名	工学研究科　情報工学専攻
学位論文題目	Utilization of Virtual Reality in eLearning and its User Experience Evaluation
論文審査委員	(主査) 神奈川工科大学　佐藤　尚　　教授 神奈川工科大学　佐藤　智明　　教授 神奈川工科大学　服部　元史　　教授 神奈川工科大学　春日　秀雄　　教授 神奈川工科大学　酒井　雅裕　　准教授 東京工科大学　　近藤　邦雄　　名誉教授

内容の要旨

Advancement in technology has resulted in new ways of passing down information and the maturity of virtual reality (VR) is no different as various industry sectors embraced this technology. In recent years, the education industry's training sectors especially have come to utilize virtual reality and related technologies, resulting in the improvement of eLearning and immersive training systems (ITS). The main goal of this dissertation is to answer the question of whether a form of VR technology, vTubers (Virtual YouTubers) can be used effectively in eLearning environment. vTubers are essentially broadcasters who have digitally transformed their digital appearances into stylized digital avatars, which at times take on anime-styled avatars. Furthermore, some vTubers also utilize voice transform devices to mask their original voice, therefore hiding their original self from target audiences completely.

In addition to tackling the implementation of vTubers in eLearning courses are two previous researches, each of which no less important than the main research seeing the results drawn from them eventually led to the vTubers research. The very first PhD research is titled 'Real Baby - Real Family', a VR baby simulator that allows two players to experience what it is like to raise their own baby. The second

research, directly inspired by ‘Real Baby - Real Family’ is a QR code based VR evaluation method named ‘MasQueRade’ that can be used in large exhibitions with attendance number of up to tens of thousands.

The full name of first research, ‘Real Baby - Real Family, Age Controllable VR Avatar from 2D Facial Images’ is a project aimed at allowing players to interact with a digital baby in VR world. This digital baby’s face was created from any two photos. By pulling specific facial features from photographs, analyzing them, then merging the obtained data together, the team had successfully recreated digital baby avatars, whose faces closely resembled that of the subjects. Furthermore, baby faces can be generated not just from real-life photos, but also from illustrations and even a mixture of photos and drawings. When used in exhibition setting, the team had created a system capable of generating baby avatars from either heterosexual couples or homosexual couples. The team had also created three types of skin tone: Asian, Caucasian, and African. The selected skin tone itself does not interfere with the process of obtaining data from photos. ‘Real Baby - Real Family’ had been exhibited at international conferences such as Laval Virtual in France and SIGGRAPH 2017 in the USA. It was rated highly by attendees, with many considering the VR baby they had interacted with sharing strong resemblances to them.

The second research, ‘MasQueRade’ or MQR for short is an on-site VR application evaluation system that stores surveys inside QR codes and can be attached to a variety of devices: VR hygiene mask, name card, and cosplay devices. By attaching QR codes to devices commonly wore or carried by attendees, the research team realized a portable survey that allows users to evaluate the VR experience at their own leisure. It is motivated by the increase in number of VR applications and how almost every single digital entertainment company is investing heavily in VR systems. This increase in VR products demands improvement of evaluation methods that can speed up and free up attendees from the tedious task of waiting in line. Furthermore, some VR experiences do not look especially impressive from an onlooker’s perspective but managed to impress players during experience. In cases like these, a before and after questionnaire is needed to measure the user’s initial impression and actual VR walk-through impression. In summary, MQR was developed to lessen the work required for conducting extensive survey in a time efficient way. It had been tested in major international exhibitions such as

SIGGRAPH 2017 and Anime Expo 2017, the latter attended by over a hundred thousand attendees.

The third and main part of my research is an eLearning anime avatar video system that was in 2019 with the purpose of assisting university students in learning in-class materials. This research can be further divided into two sections, with the first-half taking place during Spring semester and the second-half during Fall semester.

The two anime-styled avatars, one male and one female were labelled 'A' and 'B' respectively. They were animated using motion tracking technology and featured the exact same upper body movements as the professor's visual, which in this research was labeled 'R' as in Real Avatar. The audio for the first eLearning class that took place during the spring semester of 2017 was also modified from the original audio 'O' to create 'T' audio. In short, there were three different visuals, 'R', 'A', and 'B' for both Spring and Fall semester classes while there was only one type of audio, 'O' in Fall semester class.

The ways students were divided were different too, with Spring semester dividing the 155 students into 15 groups and labelled from A to O. Each group, depends on their function, were tasked with watching one or two types of videos. Fall semester, on the other hand, allowed students to freely choose their desired video.

When it comes to result evaluation, the team utilized subjective and objective evaluation method where subjective evaluation are students' impressions of contents while objective evaluation consisted of undisputed grades and video watch duration.

According to the data gathered, the research team determined that the best avatar for attracting students attention was the female styled avatar, avatar 'B' while the avatar most beneficial to improving students' academic performances was avatar 'R', the professor's original avatar. Audio 'T', due to having no effectiveness in both retaining students' attentions and improving students' grades, was dropped entirely in Spring semester.

These three researches have contributed to discovering the most suitable virtual

avatar in eLearning program and coming up with an innovative way of evaluating VR experiences in large exhibition setting. In the future, the research team would like to test the effectiveness of digital avatars in international settings where students of different ethnicities and social backgrounds are present.

審査経過の要旨

1. 審査の経緯

(1) 2022 年 11 月 7 日（月）指導教員佐藤尚に対して、謝レックス氏より学位論文が提出された。

(2) 2022 年 12 月 7 日（水）情報工学専攻会議において審議を行い、予備審査の開始と、予備審査委員が承認された。

(3) 2022 年 12 月 21 日（水）の 16 時 50 分より予備審査会を開催した。その際に各審査委員から出されたコメントを受けて、論文を修正し推敲を行うことを条件に、本請求論文は本審査に十分耐えられると判断され、予備審査を終了した。その後に審査委員からの指摘に基づいて申請者は論文の修正を行った。

(4) 2023 年 1 月 11 日（水）情報工学専攻会議おいて、主査が予備審査の結果を報告し、報告論文受理の可否投票の結果、論文受理が決定された。また、上記 6 名を審査委員とすることを決定した。

(5) 2023 年 1 月 20 日（金）大学院工学研究科委員会において、提出論文を受理することを決定し、上記 6 名をその審査委員とすることを決定した。

(6) 2023 年 2 月 11 日（土）13 時から 14 時 48 分に公聴会開催を開催した（聴講者 8 名)。

(7) 2023 年 2 月 11 日(土) 14:50 から 15:25 に最終試験および審査委員全員による審査委員会を開催した。審査期間中における内容に基づいて審議した結果として審査委員全員が、申請論文は博士論文としての学術性・新規性・有効性・実用性を有していることを確認し、申請者が博士の学位に相応しい学力と語学力とを有していることを確認した。その結果、合格との判定とした。

(8) 2023 年 2 月 15 日(水)大学院情報工学専攻専攻会議における可否投票の結果、学位授与を可とした。

(9) 2023 年 3 月 2 日(木)大学院工学研究科委員会において学位授与が可と承認された。

2. 審査結果

申請者が提出した博士請求論文は、“Real Baby - Real Family”と、それから派生したから 2 つの主要な研究“MasQueRade”と“VTuber スタイルの eLearning 動画”に関する記述から成り立っている。これの 3 つの研究は VR 等の利用したバーチャル表現の影響とそれを評価するために利用されるシステムに深く関連している。“MasQueRade”においては、提案システムを実装し、実際の大規模な展示会で使用し、その有用性を示した。“VTuber スタイルの eLearning 動画”では、「女性型アバター」を利用することの有用性を示した。これらの研究成果は学術的成果だけではなく、実社会での利用においても有用性が示されている。このことか、学術的及び工学的発展に大きな寄与をしたものだと言える。事前審査では日本語で、公聴会では英語で発表を行い、日本語と英語を利用した質疑応答を行った。博士請求論文と発表論文の内容などから、申請者の学力及び外国語能力が十分あると判断して合格と判定した。