Preface

EMERGENCE OF DIGITAL REALITY TECHNOLOGIES

Digital reality technologies are often used as an umbrella term to cover an array of emerging technologies and their applications in augmented reality (AR), mixed reality (MR), virtual reality (VR), 360-degree video, and other immersive platforms (Cook, Jones, Raghavan, & Saif, 2018). Recent advances in articificial intelligence and machine learning technologies have prompted many practitioners to claim immersive digital reality technologies will be the next step in many marketing activities (Pettey, 2018). A recent report in *Forbes* (Herschman, 2017; Tourville & Forbes Agency Council, 2018) point out there has been a growing interest in experimentation and actual implementation among brand such as Ikea, Porche, Lowes, MTV, TOMS, Warner Brothers, etc. to integrate immersive AR and VR into their marketing activities and communication campaigns to create consumers' different brand experiences. Rosy and optimistic predictions have prompted the rapid spending and investment on these immersive digital reality technologies. Total spending on AR and VR products and services is expected to reach $160 billion in 2021, according to International Data Corp. (IDC) (Cook et al., 2018). On the other hand, the AR industry is also expected to reach $100 billion in 2024, according to Grand View Research (Holger, 2016). Similarly heightened interest in these digital reality technologies is found in the retailing industry (Herschman, 2017). The usage of AR and VR software among retailing enterprises is expected to reach $1.6 billion in 2025 (Herschman, 2017). The impacts of the digital reality technologies (in particular, virtual reality) have been expanded to entertainment, gaming, and sports industries (Petrock, 2018).

However, the widespread and rapid diffusion of these technologies still depends on the willingness of corporate adopters to allocate their resources. According of 2018 Gartner CIO Agenda Survey of 3,160 Chief Informatin Officers (CIOs) in 98 countries, 37% of them indicate that they have paid attention to AR and VR, but still refrain from taking any plan to implement these technologies in their business activities (Petty, 2018). For these digital reality technologies to reach the mass market, *Digi-Capital*, a technology consultation firm, has identified seven key factors that could determine the business success of AR and VR (Grubb, 2015). These are affordability, flexibility, immersion, mobility, usability, vision, wearability (Grubb, 2015). Similar determinants of AR and VR diffusion are discussed after using historical data to understand how fast these technologies could permeate the society (Fink, 2017) and at what speed. These technical attributes are claimed to be critical to the success of digital reality technologies as a mass market product by offering consumers subsidized equipment purchase (i.e., affordability), excellent immersive experiences by means of easy to use, superb image quality, ubiquitous access (Grubb, 2015). The ultimate success of AR and VR technology will rely on if the technologies can become part of consumers' culture and fashion (i.e., wearability) (Grubb, 2015). In addition to these technological

attributes to determine the adoption of digital reality technologies, the availability of reality-creating technologies also plays similarly important role (Holger, 2016). Citing a report by Perkins Coie, 37% of consumers say they are relunctant to adopt AR and VR technologies, due to concerns about content availablity to justify their expensive investment in these technologies (Holger, 2016). These two major inhibitors of widespread consumer adoption remain the same even after two years since Holger's (2016) predictions (Petrock, 2018). Other factors in affecting the success of AR/VR technologies also rely on consumers' knowledge about and interest in them. A large-scale online survey of over 8,000 consumers by Nielsen's Media Lab (2016) has observed that 18-54 years old consumers' knowledge about VR (27%) is comparable to that of 3D printers (24%), drones (24%), and wearable techologies (29%), while their interest in VR as a fan (36%) is also comparable that in Internet of Things (35%) and wearable technologies (35%) (Refer to Figure 1 below).

THE ECOSYSTEM OF DIGITAL REALITY TECHNOLOGIES

Digital reality technologies transform how human beings interact with the environment through new interfaces such as emotion, gesture, and gaze (Deloitte Consulting LLP & Consumer Technology Association, 2018) to give users a sense of presence (*eMarketer.com*, 2016). Consumers' immersive experiences are made possible through reality-creating technologies as shown in the digital reality ecosystem below to create business advantage (Figure 2) (Deloitte Consulting LLP & Consumer Technology Association, 2018).

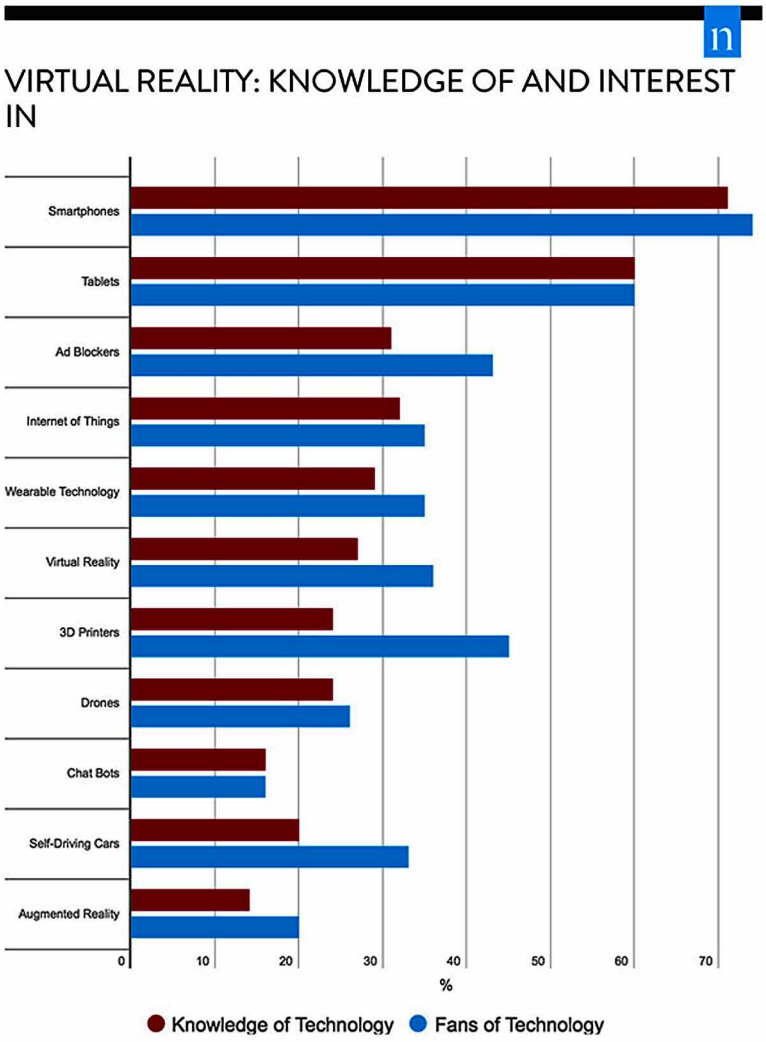
Virtual reality is a digital technology that will create a fully-immersive digital environment to replace or enhance user's experiences in a real-world environment with the ability to navigate the virtual space through the use of head-mounted display (HMD) devices connected to controllers, smartphones, and other equipment (Deloitte Consulting LLP & Consumer Technology Association, 2018; *eMarketer.com*, 2016). Some popular HMDs include Facebook's Oculus headsets, Magic Leap One, Samsung Gear VR (Patrizio, 2017).

Augmented reality enables the overlay of computer-generated contents with physical objects in users' actual environment (Deloitte Consulting LLP & Consumer Technology Association, 2018; *eMarketer.com*, 2016). For example, Google Glass employs AR through its HMD to provide users with a different experience (*eMarkter.com*, 2016). Because mobile devices have become widely adopted, major players in the mobile AR market have included well-known companies such as Alphabet, Apple, Face, and Snap that offer either embedded AR capabilities in their smartphone (such as Google and Apple), or providing AR software applications (such as Facebook and Snap) (Seitz, 2018).

The introduction of 360 degree video, on the other hand, allows users to view their environment with a surrounded perspective (Deloitte Consulting LLP & Consumer Technology Association, 2018). Other immersive technologies, such as the latest *free viewpoint video* (Collet et al., n.d.; Pagés, Amplianitis, Monaghan, Ondřej, & Smolić, 2018), also provide similarly multi-sensory experiences to users (Deloitte Consulting LLP & Consumer Technology Association, 2018). The emerging *free viewpoint video* is defined as "a scene photographically captured in real-time that can be played back in real-time and appears like video from a continuous range of viewpoints chosen at any time in playback" (Collet et al., n.d.)

Recent advances in the digital reality technologies have led to the development of mixed reality which users to interact with an environment that blends digital contents with the physical world (Deloitte

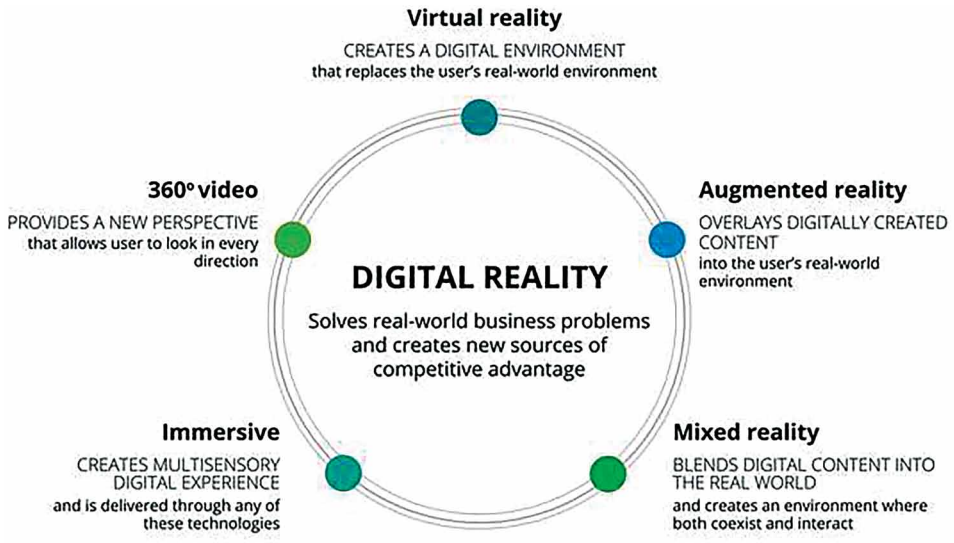
Figure 1. Results from a large-scale survey on consumers' knowledge and interest in virtual reality



Consulting LLP & Consumer Technology Association, 2018). The best definition of mixed reality is described as "experiences with real-time comingling of virtual and physical objects achieved by products like Microsoft's HoloLens" (*eMarketer.com*, 2016, n.p.). As one of the most recent innovations in the digital reality landscape, the adoption of MR is equally influenced by the corporate decision makers for adoption consideration (Arena, 2018). In a recent survey of 394 US executives in March 2018, about two-thirds of the executives indicate that they are currently testing the application of MR. However, only 20% of them express that they are current developing, producing, or deploying MR, despite the majority of them believe MR is a technology that will impact on their strategic plan in the future (Arena, 2018).

In their technical primer for digital reality technology, Deloitte Consulting LLP and Consumer Technology Association (2018) identify three areas of key players to take advantage of the ample opportunity in the emerging digital reality marketplace. These players can be broadly divided into 1) ap-

Figure 2. Digital reality ecosystem



plication content (such as industry information and analytics); 2) infrastructure providers in data system, hardware, or head-mounted devices (HMD), etc.; 3) tools and contents producers (such as apps, capture tools, platforms, etc.).

The infrastructure component of the reality technology landscape mainly covers hardware/equipment to allow users to interact with digital reality contents (RealityTechnologies.com, n.d.). For example, head-mounted displays (HMD) are worn by users to allow them to see videos or images in the embedded standard LCD screen (RealityTechnologies.com, n.d.). Some popular HMDs include Facebook's Oculus, Google Glass, Microsoft HoloLen, Magic Leap, HTC Vive, to name a few brands (Patrizio, 2017). On the other hand, input/output devices constitute another area of the landscape by allowing users to provide sensory feedbacks to the HMD through their hand, feet, and body movements (RealityTechnologies.com, n.d.). These input/output devices also create a sense of actual interactions with the digitally generated objects through forces, motions, and vibration (RealityTechnologies.com, n.d.).

The platform component of the digital reality landscape is often composed of three sub-areas of the technologies: distribution platforms to access reality contents, process and engines of contents editing and creation, and reality capture tools (RealityTechnologies.com, n.d.). First, the distribution platforms are the gateway where users can access and distribute digital reality contents through closed/specific or open/agnostic HMD (RealityTechnologies.com, n.d.). On the other hand, software-based tools allow users or content developers to edit and create digital realities through computer image generating engines, file size compression technologies, and editing and stitching software (RealityTechnologies.com, n.d.). For example, Unity Technologies offers software and tools to facilitate the development of 3D game (Patrizio, 2017).

The final domain of this digital reality landscape is formed by a variety of applications and contents in business, education, entertainment, healthcare, gaming, marketing, sports, travel, etc. (RealityTechnologies.com, n.d.). This particular area of the digital reality ecosystem has seen most burgeoning developments by many start-up companies to create apps, tools, and contents (RealityTechnologies.com, n.d.,

https://www.realitytechnologies.com/companies/) that also converge with other new media platforms. For example, ScopeAR (www.scopear.com) offers the application of AR, Remote AR, in the workplace to connect experts to collaborate, while MindMaze (www.mindmaze.com) combines neuroscience, mixed reality, and artificial intelligence to develop "intuitive human machine interfaces." Social media giant, Snapchat, similar smartphone app to allow users to access a variety of AR applications (Patrizio, 2017). The convergence of digital reality with other information-communication technologies also prompts the startup, NextVR, which cooperates with major broadcasters (such as Turner Broadcasting) and major leagues to broadcast live virtual reality professional sports and music events (Patrizio, 2017). Porn industry is expected to be the third largest VR user, followed by NFL-game applications (McEvoy, 2018).

EMERGING RESEARCH QUESTIONS RELATED TO DIGITAL REALITY TECHNOLOGIES

The exponential growth of the digital reality technologies and related applications would unavoidably lead to avid interests among the academic community to explore their impacts on various aspects of contemporary human experiences. Academic journals have been established to deal with emerging AR, MR, AND VR applications, real-time visualization, and related research topics. For example, Springer's *Journal of Virtual Reality* was established in 1995 to publish original research in "the development and evaluation of systems, tools, techniques and software" in the areas of display, haptic, and tracking and interaction management through biosensors, eye gaze, gesture control, and wearables (*Journal of Virtual Reality*, https://www.springer.com/computer/image+processing/journal/10055). The open access electronic journal, *Journal of Virtual Reality and Broadcasting* (https://www.jvrb.org/), explores the interface and interaction among digital reality and existing broadcasting technologies and applications. Related topics in this journal include human machine interfaces, computer graphics, image processing, virtual set environments, and media technology. Other academic journals (such as *Media Tropes*) also published works that deal with how the design of HMD may affect virtual reality paradigms (Stein, 2016).

The study of AR, MR, and VR technology is multi-disciplinary in nature and this edited volume intends to reflect a wide spectrum of digital reality technologies, applications, and research around the world. The original call for chapters developed by the previous editor demonstrates his forte in the engineering and computer science expertise. This edited volume has thus attracted contributions in the area of virtual reality in games and game-based learning (Chapter 9 and Chapter 10), virtual reality and education (Chapter 2, Chapter 5, and Chapter 7), virtual reality and multimodal interaction (Chapter 8), evaluation and assessment for reality-based learning in different platforms (Chapter 5 and Chapter 6), interactions with a virtual environment (Chapter 2 and Chapter 3), and AR and VR applications for non-profit causes and organizations (Chapter 3). Upon the invitation of the IGI Global Publishers, the new editor has added chapters on more social scientific aspects of AR, MR, and VR technologies in the areas of their applications in cause-related marketing (Chapter 10), and creative and oceanic cultural industries (Chapter 12), and a general chapter on the global diffusion of reality-creating technologies (Chapter 1).

THEORETICAL FOUNDATIONS FOR DIGITAL REALITY TECHNOLOGY RESEARCH

This edited volume does not contain a dedicated chapter to discuss major theoretical foundations to investigate digital reality technologies. This is attributed to the multi-disciplinary nature of digital reality research and practices. Furthermore, originally conceptualized as a book project that will be helpful for practitioners in game design, educational technology, human-computer interface, advertising and marketing applications, the discussions of relevant theories are often embedded in each individual chapter to address their discipline-specific relevance. Therefore, this preface attempts to provide an overview of theories that could be useful when studying the adoption, impacts, and designs of these digital reality technologies. This theoretical section aims to provide contextual information to better comprehend chapters written by authors from various background.

In general, the literature that provides timely research on the digital reality technologies and their applications can be broadly divided into six major areas of exploration that is often interrelated with each other to develop a successful AR, MR, or VR project: consumer-, system-, communication channel-/ modality-, message-, environment-, and product-related factors.

Studies that are written by engineers or designers to describe the planning, development, and implementation of AR, MR, and VR technologies in different contexts tend to be a-theoretical and focus more on the technical aspects of these applications (Claudio & Maddalena, 2014; Hsu, 2017; Kang, 2018).

The Technology Acceptance Model (TAM) (Davis, 1989) and its derived Extended Technology Acceptance Model (TAM2) (Davis & Bagozi, 1989) offer a useful and integrative model to explain the relationships between consumer-. system design-, and product-related factors in explaining the adoption of AR, MR, and VR technologies. TAM and TAM2, originally developed from The Theory of Reasoned Action (TRA), emphasize the role of adopters' psychological determinants in explaining the decision-making process to use a variety of information technologies in different contexts (Huang & Liao, 2015; Phan & Daim, 2011; Rese, Schreiber, & Baier, 2014; Rese, Baier, Geyer-Schulz, & Schreiber, 2017; Roberts & Henderson, 2000). For example, Phan and Daim (2011) investigate factors affecting the acceptance/ adoption of mobile data services (Phan & Daim, 2011). Rese, Schreiber, and Baier (2014) use IKEA's mobile catalog app as an example to study the usefulness of TAM in predicting consumers' acceptance of this AR mobile app, when comparing with online review textual data. Huang and Liao (2015) focus on adopters' cognitive innovativeness to examine if this user characteristics will predict behavior toward an AR interactive technology. Their empirical findings observe that online users with a high innovativeness level tend to emphasize more on the aesthetics, service excellence perceptions, and usefulness of AR.

TAM and TAM2 attempt to explain what motivate users to adopt an information technology. Relevant to this edited book will be what leads to the adoption of AR, MR, and VR technology. Davis (1989) offers three technology-related attributes; that is, they are perceived usefulness (PU), perceived ease of use (PEOU), and attitude toward use (AU) to account for intention to adopt and actual usage behavior of a technology. To address the lack of external factors (such as image, subjective norms, and voluntariness), TAM2 has included both social influence variables and cognitive factors (such as job relevance and output, and result demonstrability) to better explain people's adoption behaviors (Maillet, Mathieu, & Sicotte, 2015). An extensive review of TAM, TAM2, and other adoption decision-making models is not a feasible task in this short preface (Refer to Taherdoost, 2017, for a complete review of adoption

decision-making models). However, TAM and TAM2 have properly addressed factors related to system attributes, users' perceptions and behaviors, and technology products and services.

To explore the influence of communication modality and environment on the messages (contents) and interactions in a virtual environment created by AR, MR, or VR technologies, practitioners and researchers of digital reality technologies often employ the concept, immersion, to explain the feeling of flow and presence (Kim & Biocca, 2018), virtual presence and co-presence (Emma-Ogbangwo, Cope, Behringer, & Fabri, 2014) that are experienced by many users in a virtual space. The concept of immersion refers to "the level of physical or psychological submergence of a user within a virtual space relative to that user's consciousness of the real-world environment" (Emma-Ogbangwo et al., 2014, n.p.). Both psychological and technological immersion has been used to study its impacts on marketing applications (Queiroz et al., 2018; Yim, Chu & Sauer, 2017).

Similarly, Kim and Biocca (2018) use an experimental study to compare the effectiveness of immersive VR games with non-immersive 2D game, in the context of health-related psychical activity. They hypothesize that an immersive game will lead to better physical performance. Digital reality technologies are able to create an immersive virtual environment and offer users different levels of detachment from their physical environment, which is expected to influence human behaviors (Kim, Rosenthal, Zielinski, & Brady, 2014). For example, Kim et al. (2014) have researched different levels of immersion as embedded in technologies (i.e., low immersive desktop, HMD, to fully immersive media platforms) on users' emotional arousal and task performance among 53 college participants. Using a 3 (3 technologies with low to high immersive levels) by 2 (high- and low-stressful virtual environment), their study confirms that the fully immersive technology could induce the highest sense of presence and different emotional responses and task performance have been caused by immersive levels in the technologies. The applications of immersion in digital reality studies have been extended to the context of education and even neuroscientific research to examine the effect of fear in a virtual environment (Huff, Hernandez, Fecteau, Zielinski, Brady, & LaBar, 2011). Immersion, a characteristics of digital reality technology, continues to allow researchers and practitioners to explore its impacts on other aspects of digital reality research, such as system design, message/content creation and outcomes, and consumers' cognitive, emotional, and behavioral responses (Huff et al., 2011; Kim et al., 2014; Kim & Biocca, 2018).

ORGANIZATION OF THE EDITED BOOK

This edited volume has touched upon an important area of research and application in immersive digital reality technologies. This book has been written in a language that will be easy to read to both researchers and practitioners of immersive virtual reality technologies to better understand this emerging phenomenon around the world. Thanks to the country and organizational background of each contributing author, this edited volume has a rare strength of providing an international coverage to demonstrate the impacts of these technologies on various fields in their respective country. For example, Chapter 1 provides a thorough examination of the global diffusion of these digital reality technologies through a detailed secondary research of these technologies around the world. Chapter 2 discusses an European example, while Chapter 3 examines the digitalization of cultural objects in Canada. The potential applications of AR, MR, and VR in Taiwan's creative and oceanic cultural industries are explored in Chapter 12. This edited volume has also included three chapters to go over the applications of digital reality technolo-

gies in the U.S. Chapter 4 examines the visual pertubations effect on balance, while Chapter 5 similarly discusses a U.S. case in the relationship between communication modality, learners' satisfaction level, and mental effort. The potentialities of AR, MR, and VR technologies are not limited to the educational setting, Chapter 10 discusses the roles of these technologies in promoting social goods and cause-related marketing applications, while a similarly non-profit application of "living autism" is explored by a panel of experts in Chapter 11.

This edited volume has been conceptualized to target both technical and non-techical readers. As a result, a book with its coverage willl be also appropriate for both undergraduate and graduate classes that teach immersive digital reality technologies by focusing on their applications, social impacts, and system development. A well-rounded book like this has potential to meet the demands of audience without and with technical backgrounds in AR, MR, and VR. In addition to its potential uses in the textbook market, this volume is also useful for AR, MR, and VR practitioners and researchers who are interested in studying the global diffusion of a variety of reality creating technologies.

The editor has organized these twelve chapters into three thematic sections that explore the theoretical, academic, and practical implications of digital reality technologies around the world. The following narratives provide a summary description of each of the chapters as the authors have provided in their chapter abstracts. These summaries are modified minimally to reflect what these authors have presented in their chapters:

Digital reality technologies have become a global phenomenon that attracts immense attention from researchers and practitioners. Chapter 1 provides an overview of the global impacts of digital reality technologies. This introductory chapter aims to examine the current state of digital creating technologies around the world. Global, regional and country statistics are presented to shade lights on the diffusion of a variety of digital creating technologies such as augmented reality, mixed reality, and virtual reality.

Chapter 2 aims to fill the gap in the literature to study the integration of Multi-User Virtual Environments (MUVE) technology for teaching and practicing real sports. The justifications, possibilities, challenges, and future directions of using MUVE systems in the educational context are thoroughly scrutinized by two experts from France and Portugal. In the second part of this chapter, the necessity of evaluation, and examples on discovering the behavior of players during playing *exergames*. The authors conclude this chapter by offering their insights into the application of sports *exergames* in both teaching and practicing.

Chapter 3 shifts the focus to study the role of digital reality technologies in the context of cultural heritage visualization and education in Canada. Using the huge collection of Canadian objects from the Anishinaabe culture at Algoma University as a case study, Chapter 3 describes a research project on the VR-enabled digitization and visualization of cultural artifacts. The chapter shows technical aspects of the objects' 3D digitization process and explains a user study with students watching a 3D model displayed on a low-cost VR headset. Results from the empirical study have shown that visualization of the 3D model on the VR headset was effective, efficient and satisfactory enough to use, motivating students for continual use in the future.

The success of an AR, MR, and VR project is undoubtedly contingent on a superior system design. Chapter 4 focuses on the effect of visual perturbations on users' balance in a virtual environment. The authors investigated the effect of sudden visual perturbations on human balance in a virtual environment created by VR. This study employed the latest VR head mounted display to present visual perturbations to disturb balance as measured by double-support and single-support stance. The authors measured the

subject's center of pressure (COP) using a force plate. Their results indicated that visual perturbations presented in VR disrupted balance control in the single support condition but not in the double support condition.

Chapter 5 describes a study conducted in a semi-immersive desktop virtual reality environment. Using the popular 3-D virtual world, Second Life, among educators, this chapter investigated the relationships among three study variables: teacher trainees' perceptions of their mental effort while using Second Life, their satisfaction with the communication modalities, and their perceived social behavioral changes. Results were discussed extensively in this chapter.

Chapter 6 studied the need and potential problem of integrating motion cues as perceptual cues in VR applications. Motion cues, generated in simulators and VR applications in general, are an important and necessary design element for VR applications. The authors argue that it is of the utmost importance to analyze the requirements of each VR application before deciding upon whether and how to integrate motion cues in each specific VR application.

Chapter 7 touches upon a growing application of digital reality technologies in the higher education context. The rise of virtual learning environment is partially attributed to meet the needs of the millennial students' preference for more technology-advanced approach of learning. Chapter 7 focuses on how to optimize edutainment in the classroom by strategically using the methods of flipped classroom, team-based learning and the IDEAS method in the United Arab Emirates (UAE). An experiment study was conducted on students taking a graduate level course to empirically study the effect of virtual learning environment, the use of flipped classroom, Team-based Learning and IDEAS methods on students' academic performance.

Chapter 8 addresses the importance of developing "multiliteracy" skills and engaging in multimodal learning in the Information Age. This chapter first introduces an alternative framework for formative assessment of multimodal interactions for learning. The study continues to explore the intention is to uncover the story of culturally and linguistically diverse students' multimodal experiences and engagement in a student-generated virtual museum. The author argues that virtual museum-based multiliteracies engagement is likely to benefit students' multimodal awareness, meaning making and development as active designers of their own learning experiences.

Chapter 9 develops a list of interaction and movement techniques to guide game design students and educators to determine what will be the best techniques to use in a VR design project after taking into consideration of factors such as constraints, context, platform, users' physique, space, immersion, and user experience.

Chapter 10 deals with emerging augmented, mixed, and virtual reality platforms and their applications in cause-related marketing (CRM) campaigns. This chapter provides definitions and examples of augmented, mixed, and virtual realities and explains their importance CRM professionals. Chapter 10 surveys current discussions in the existing literature and ends with several cause-related marketing (CRM) campaigns to offer directions for emerging issues, future trends, and professional best practice recommendations.

Chapter 11 provides an extensive discussion on the use of VR in professional development to assist Teachers, Learning Support Assistants (LSAs) and Teaching Assistants (TAs) to better understand autistic children's behaviours in the classroom. This chapter reports an actual VR application to record footage through 360-degree cameras and special effects powered by Unity to better help children with autism.

The authors argue that the use of VR will be able to assist the teachers in empathising with their learners' traits and conditions and ultimately help children with special needs to enhance their school experiences.

Chapter 12 examine the role of AR and VR in promoting creative and cultural contents in Taiwan. This book chapter employs a case study approach to survey the current state of digital reality technology applications particularly in the area of creative and oceanic cultural industries in Taiwan. The author employs a detailed description of several best practices that promote Taiwanese oceanic culture to describe and discuss potential digital reality applications in the creative and cultural industry sectors in a non-Western context.

IMMINENT ETHICAL AND REGULATORY ISSUES RELATED TO DIGITAL REALITY TECHNOLOGIES

The omnipresence of digital reality technologies as part of contemporary human experiences has spurred concerns about their potential ethical and regulatory implications (Goodmann, 2016; Gunkel & Hawhee, 2003; Johansson, 2018; McEvoy, 2018; Mullin, 2016; Polgreen, 2014; Poushneh, 2018; Spiegel, 2018; Virtual Reality Society, n.d.). These ethical issues are particularly pertinent, given the widespread of AR, MR, and VR technologies in the context of broadcasting, business, gaming, education, entertainment, sports, and healthcare sectors (RealityTechnologies.com, n.d.). The same ethical concerns are likely to appear even in the creative and cultural industry sector (such as museums and art exhibitions) that rely on location-sensitive AR-guide device (Chang, Chang, Hou, Sung, Chao, & Lee, 2014). For example, McEvoy (2018) identifies 10 potential ethical concerns that are caused by the advent of virtual reality, and similarly applicable to other digital reality technologies: 1) HMDs and sensory vulnerability due to limited access to other senses; 2) potential harm due to the lack of face-to-face interactions in an isolated VR environment (i.e., social isolation); 3) a sense of desensitization among heavy VR users in an immersive VR environment**;** 4) Inability to differentiate what can be accomplished between a real- and –virtual world (i.e., overestimation of users' own abilities); 5) uncertain psychiatric effects on users; 6) potential misuse or abuse of VR technologies in unpalatable contents (such as pornography); 7) unexpected misuse by authoritarian regime, military, or criminals to torture or interrogate; 8) manipulation of consumers by advertisers from profit-making purposes; 9) ethical roaming and re-creation of the physical environment to gain sensory pleasure; 10) tracking of users' interactions with virtual objects and potential privacy-invasion risks. Particularly, the desensitization and virtual criminality issues are also mentioned by Virtual Reality Society as two major ethical concerns.

Fundamentally, these ethical issues are related to the overall impacts that information-communication technologies have created and are grounded in more philosophical questions such as meaning, truth, representation, identity, and communication behaviors (Gunkel & Hawhee, 2003). Some of these ethical concerns are also evident in professional contexts such as medical and journalism (Spiegel, 2018; Polgreen, 2014). Specific to the medical field, Spiegel (2018) discusses four types of ethical concerns related to VR technologies.

Depersonalization/Derealization Disorder is one of the potential mental health risks caused by VR use. Furthermore, heavy use of VR technologies is also likely to cause users to ignore their own body and physical environment. VR technologies often blur the distinction between the real and the virtual. Finally, data about how an individual interact with the virtual environment is likely to invade personal

privacy and manipulation (Spiegel, 2018). To address these potential issues, Spiegel (2018) and Goodman (2016) have proposed legal and policy amenties to better train health professionals to deal with the ethical impacts of VR and other digital reality technologies.

The potential impacts of digital reality technologies on journalism focus on the delimma that the technologies could create for more engaging and immersive storytelling (Polgreen, 2014). In Mullin's (2016) insightful discussion of VR applications in journalism, he raises the questions on how the use of digital reality technology could fundamentally challege conventional journalistic standards. Using the VR project, *The Displaced* (https://www.nytimes.com/2015/11/08/magazine/the-displaced-introduction.html), produced by *The New York Time Magazine*, to describe suffering children in the war-torn Ukraine, South Sudan, and Lebanon as an example, Mullins (2016) asks the following questions:

Do the technical requirements of virtual reality conflict with the long-held journalistic standards preventing photojournalists from influencing the scenes they record? Does its visceral nature require new guidelines governing explicit and traumatic imagery? Do its immersive experiences interfere with efforts to craft balanced narratives? And in the case of virtual reality that uses computer graphics to piece together scenes, how much reconstruction is permissible?

Some of his questions above also address several of McEvoy's (2018) ten ethical concerns related to digital reality technologies in terms of potential harms on unaware consumers of AR, MR, and VR technologies. To address these ethical concerns derived from these digital reality and other technologies, new regulations, international collaborations, and industry self-regulation best practices have been proposed (Barker, 2016; Horsfield, 2003; Lui & Lamb, 2018; Metivier-Carreiro & Lafollette, 1997). For example, taking a philosophical perspective, Horsfield (2003) discusses four ethical areas related to digital virtual reality: digital virtual reality contents, distraction and displacement questions, epistemological questions, and the question of power. Taken into consideration the lack of platform-specific regulations, Barker (2016) raises some pertinent issues that can also be applicable to digital reality technologies. For example, who will be responsible for the potential harms of digital reality contents (such as users' sense of desensitization and social isolation that McEvoy has discussed) since both the users and AR, MR, and VR designers "co-generate" such results?

Another equally important question may involve who should have control of users' behaviors in the virtual environment? This is also related to the question of power as brought up by Horsfield (2003). Finally, the massive amount of users' interaction and behavioral data with virtual objects in AR, MR, and VR applications unavoidably will lead to rising privacy concerns (Poushneh, 2018; Pridmore & Overocker, 2016; Spiegel, 2018). Scholars have begun to explore whether concerns about personal privacy may have effects on their satisfaction level (Poushneh, 2018). For example, using an experimental study, Poushneh (2018) examines how augmentation quality of an AR application in retailing may generate users' concerns over their access to their personal information and affect their satisfaction level. The empirical findings support that individuals do pay attention to the privacy concerns in an AR application and have significantly affect users' satisfaction level, despite the positive augmentation effects created by AR (Poushneh, 2018).

To sum up, the issue of privacy in an immersive virtual environment created by AR, MR, and VR technologies is of great relevance nowadays, when considering the advent of artificial intelligence (AI), Internet of Things (IoT), and Big Data that make personalized virtual experiences a possibility (Wortley,

2011). A recent survey by *eMarketer.com* (2018) of 260 participants from advertising agencies, brand advertisers, and tech vendors has found that data-dependent practices (such as audience targeting, audience segmentation, dynamic creative, and personalized offer) are ranked as top considerations. The growing dependence on individual personal data is likely to worsen similar privacy concerns in AR, MR, and VR applications.

CONCLUSION

To conclude, an edited book on the ever-changing digital reality technologies is less likely to keep abreast with the incessant changes in the field. However, this book hopes to open up more discussions to deal with less studied topics such as mobile multimodal system, machine learning and artificial intelligence, virtual reality datasets, fusion, representation, and validation, VR dialogue modeling, visual behaviors in social and multimodal interactions, to name a few. Issues related to the applications of digital reality technologies should be investigated to explore their impacts on various industry sectors and their convergence with gamification in game-based learning and marketing activities. As an increasingly ubiquitous technology, thanks for the popularity of smartphone, scholars should explore social, cultural, ethical, and regulatory concerns related to the applications of AR, MR, and VR that could touch upon every aspect of contemporary human experience.

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