Vision and Virtual-based Human Computer Interaction Applications for a New Digital Media Visualization

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ABSTRACT

With the rise of smartphones and tablets interactively, human computer interaction is a very popular topic for engineers, artists, designers and computer scientists around the world in both industry and academia. This topic was studied and researched over many years ago. Nevertheless, most of previous works were studied separately between communication arts (e.g., advertising and marketing communication research) and computer science. Indeed, there has been little work giving an overview of recent integrated research of digital media and some new technologies, such as computer vision, virtual reality, and human computer interaction for visual communication. Therefore, our contribution of this paper is to discuss the recent state-of-the-art development of the digital media research work using and applying these aforementioned multimedia-based technologies. A literature review of the novel digital media and interactive augmented reality researches is also discussed. More importantly, this paper also provides a work-in-progress framework for future digital media research when applying graphical visualization, human computer interaction such as haptic, and sensor technologies into every traditional sense of human interactively, from vision to touch and from smell to taste. In general, this paper will be beneficial for any related field of interactive multimedia, communication arts and human computer interaction both industrial and educational aspects and also for any related researcher such as computer science art communicator.

Keywords

Human Computer Interaction, Robotic, Communication Arts, Taste Communication, Touch Communication, Smell Communication, Multimedia, Digital Media, Graphical Visualization, Advertising, Marketing, Visual Communication

1. INTRODUCTION

With the rise of advanced technologies in computer science such as human computer interaction and graphical visualization, the way people send information and communicate has gradually transformed in this 21st century. Since the emerging of the computer and social media revolution, the lure of the virtual communication has attracted engineers, artists, designers, communicators, computer scientists, and others with the great idea that we might someday accomplish with technologies both physically and virtually [Bai12a]. On one hand, one of the fundamental purposes of communication research is to allow two people to be in two different locations at the same time (or nearly the same time), but can communicate human-to-human smoothly and robustly in every sense of human as face-to-face interaction. For this reason, digital media expand increasingly and scientifically horizons into new sensory modalities every day. On the other hand, dealing with problems for communication perfectly for human-to-human remotely is not a trivial task. Communications in different senses of human pose different requirements of the communication challenging. The main challenge is how to reproduce the perception realistically and robustly for every five sense: sight, audition, touch, smell and taste. Even though some communication-based systems with different capabilities have been built, most of previous works were developed separately between communication arts and computer science. Over decades, studies of communication media by communication researchers were usually achieved quite separately. At the same time, studies of communication for digital media by computer scientists were studied in some limited dimensions. Rice from Department of Communication in University of California, Santa Barbara, and

Leonardi from Department of Communication Studies in Northwestern University, give a good overview [Ric12a] of research on the merging relationship between technology and communication. It now obviously makes sense to merge and integrate the two related-theoretical fields.

This paper discusses a preliminary framework for innovative technologies applying in the digital media for every sense of human. The first one is visual communication using augmented reality (AR) and computer vision (CV). Second, we discuss recent technologies used for touch communication. The third one is for smell communication technologically and chemically. The last communication we mention is taste.

For visual communication, one of the very effective tools used is augmented reality. In fact, augmented reality has, in recent decades, increasingly become an extremely popular field in computer science. It is recently utilized in wider fields, including digital media and other fields of communication arts such as marketing and advertising. As defined by many technologists, augmented reality is a technology combining the physical world and virtual media (graphical aid information) together.

Figure 1. A Mad Tea-Party augmented reality experience using media theory was designed by [Mac01a] from Georgia Institute of Technology.

One of very first works for applying augmented reality to conventional media theory in the 21st century is, in [Mac01a], implemented by a research group from Georgia Institute of Technology. They discussed the development of augmented reality as a new medium for digital media interactively. They showed two creative examples of augmented reality experiences (i.e., A Mad Tea Party and Ghosts of Sweet Auburn) using their conceptual frameworks from media studies. Figure 1 shows A Mad Tea Party augmented reality experience. They attempted to leverage the information exchange between the virtual world and the real world. It is just as the same as the concept of augmented reality and mixed reality, but for remediating traditional media, e.g. stage, film, and compact disc. After that, they built on interactively the cultural expectations of users. More recently, augmented reality is similarly used for a real-time mobile-based film scholarship as presented by Chao et al. [Cha14a]. The application gives a kinetic and aural experience for users. It lets them to conveniently access augmented multimedia content using this augmented reality technology. Also, augmented reality is recently used in the digital marketing and advertising arena. It can be seen in many recent augmented reality research works. To begin with, several concepts for augmented reality digital advertising for paper-based leaflets for attempting to bridge the digital divide were investigated in [Loc13a]. The first prototype explained by Lochtefeld et al. is the Guerrilla marketing approach (called GuerrillAR), while the second one (called PageAR) is the approach using visualizing cross-selling recommendations. Next, [Sin14a] studied reasonably why augmented reality can make an effective choice for the marketers utilized in the advertising campaigns. We, in this paper, review this augmented reality technology that is now more and more linked to digital media.

Nonetheless, in many augmented reality researches, it usually deals with only vision, specifically computer vision, often abbreviated briefly with the acronym CV. We believe that digital media are soon deemed to go beyond vision. Martin described in [Mar13a] about the future of augmented reality when extending it technologically to other senses (i.e., hearing, touch, smell, and taste), rather than just sight. However, due to many technical reasons, over past decades the sense of touch has uniquely been difficult for people's communication in term of digital media. Right now, it is true that it is more common and easier to use smartphone to connect people to people by talking, messaging and even FaceTime. But it is not obviously and widely yet for the sense of touch. This paper also studies about this possibility. Some case studies of huggable internet from Cheok's work [Che13a] and the therapeutic robot for affective touch from Massachusetts Institute of Technology (MIT) Media Lab's work [Sti06a] will be discussed and mentioned. In addition, the possibility of communication for digital media by the senses of smell and taste will be reviewed in this paper. It is true that dealing with the sense of smell and taste is obviously extremely difficult since they often require some dangerous chemical substances to interact. However, there are still some recent researches trying to achieve these goals. We review some new technologies used for the communications of smell and taste, such as [Kay08a] [Ran14a] and [Saa14a]. We define the work-in-progress framework for future digital media when applying computer vision, graphical visualization, human computer interaction such as haptic, and sensor technologies into every traditional sense of human interactively,

from vision to touch and from smell to taste. We coin this framework as 'new digital media' in this paper. In fact, this term was used once in [Jam09a] by James from Harvard University, but in different meaning. In addition, according to the very similar definition between new media and digital media, it is acceptable to call the term 'new new media' too, even though 'new digital media' is more preferable. This paper is organized as follows. We will talk about the new digital media in section 2. In section 3, we will focus on sense of sight. The next section will present technologies used in touch communication. Smell communication will be explained in section 5. Section 6 will propose technologies for taste communication. In section 7, we conclude the paper and give some possible future works.

2. NEW DIGITAL MEDIA

Digital media are defined quite widely, even though they should frequently be encoded in a computer-readable format. In today's world, the new media include increasingly countless examples, such as digital audio, e-books, databases (CD, DVD and hard drive), digital imagery and video, and web pages. Social media websites such as Facebook, YouTube and Twitter are also included in its definition. Since the smartphone revolution takes the next big leap in recent years, digital media trends continue obviously to drive innovation. Newman [New15a] from Reuters Institute predicted and explained interestingly that the new media have become one of the defining factors of society; from the political election and the country's economic power to the social ideology and the technology we use every day. In other words, people, especially young people, in 2015 have increasingly engaged more and more through digital media. For instance, social media websites via smartphones, wearable devices, or even advanced drones are included.

In a multidisciplinary context, digital media from the fields of traditional communication arts and humanities are merging with many new scientific technologies more and more every day. It is crystal clear that this integration is so beneficial for the world's innovation. In this paper, we present a work-in-progress framework for the new digital media research when applying augmented reality and other computer science technologies to communicate human-to-human using all five senses of human. We call this framework for communication of every human sense as 'new digital media'. Figure 2 represents this framework of new digital media we defined. The technologies used and applied for the new digital media can expand widely while implementing and integrating, from graphical visualization to human computer interaction, from augmented reality to computer vision, and from haptic to sensor. However, it is important to note that this paper will not focus on technologies used for hearing communication. This is because it has been widely used for long time ago. Thus, we start with visual communication in the following section.

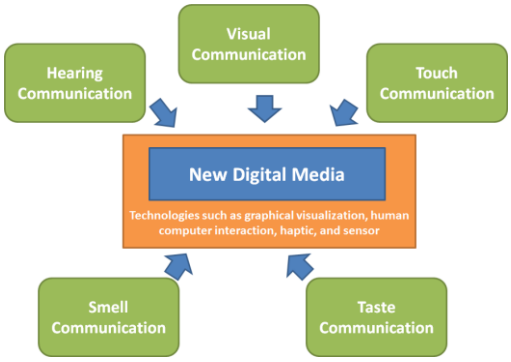

Figure 2. The framework of New Digital Media we defined in this paper

3. VISUAL COMMUNICATION

Augmented reality is a view of a natural environment (real scene) whose elements are merged by graphical digital information and media. [Wan13a] provides a good survey of the augmented reality studies in built environment in the last decade. Over time, augmented reality has been touted as an important technology of the future but has been utilized mainly in only high-end, advance and novelty settings. However, this technology [Kre10a] now intends to move from only inside research laboratories into other related-areas, such as consumer markets. According to the valuable surveys [Sin14a] and [Kim14a], it is observed obviously that augmented reality has become one of the emerging tools for another arena of digital media, games and communication arts (e.g., advertising and marketing communication research). In fact, there are many interesting research works towards augmented reality in advertising strategies [Vau09a]. For instance, Lochtefeld et al. [Loc13a] built two prototype systems of augmented reality-based advertising concepts for paper leaflets. The first system, called GuerrillAR, overlays a competing retailer's paper leaflet with one's own content in a real environment. By using this prototype, it is more convenient for a retailer to check and compare both the price and the quality of the products. At the same time, the smartphone can be used to point to leaflet of the competitor. Then, he/she can see a personal augmented overlay on the smartphone. The second system is called PageAR. It aims for cross-selling suggestions between different products inside the leaflet for advertising purpose.

In addition, augmented reality use is not just only found in advertising systems, but also in marketing

prototypes. This statement is believed to be true because we find technological marketers use this technology to promote their products online. It is deemed to change conservative marketing strategies enormously. A study of Singh and Pandey's work [Sin14a] has reaffirmed once again that augmented reality is a valuable choice in their marketing strategies for the marketers. It is noted in the study that consumers do not prefer passive monologues which are designed by the marketers anymore. They prefer to be interactively a part of the conversation with the brand to make a purchase final decision. To make the marketing strategies more interactively, augmented reality has the potential to deal with this issue, especially for new age consumer engagement.

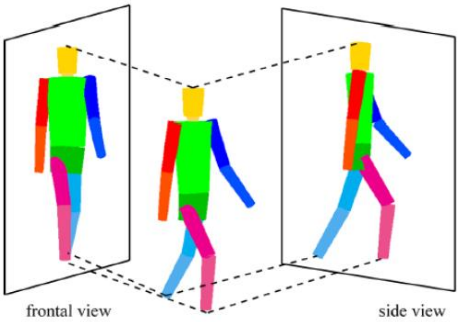

Figure 3. The virtual front and side views for 3D structural human shape analysis using computer vision was presented by [Ker14a].

It is not only augmented reality, but also computer vision that has played an important role for visual communication. Briefly speaking, computer vision is a branch of computer science for study of acquiring, analyzing, understanding and interpreting images from the physical world. For years, it has been touted as a great technology in related fields [Rus14a], such as robotics, neurobiology, solid-state physics, pattern recognition, and artificial intelligence. For example, it is used for a method for vision-based 3D structural human shape analysis by Kerdvibulvech and Yamauchi [Ker14a] to model and recognize from gait signatures, as represented in Figure 3 for the virtual front and side views for human shape analysis.

4. TOUCH COMMUNICATION

As stated earlier, communication is currently drifting away from each individual sense of human. Digital media are able to extend technologically to other particular senses. Those senses are touch, smell, and taste. They are also quite important means of communication. One of very essential senses is touch. Touch is, in fact, an obviously vital sense, as it can convey so many kinds of communicative intents. Touch can promote trust, a foundational element of interpersonal relationships, and cooperation of human, so that it is a great enabler of trust between group members, as explained in [Kra10a] by Kraus et al. from University of California, Berkeley. There is also a study of the communication of emotion via touch [Mat09a] reviewed that the sense of touch can affect emotion directly such as anger, disgust, love, fear, sympathy, and gratitude. Although it is recently common to connect people to people by talking and imaging via smartphone or any particular device, it is still not a trivial task for the sense of touch. To deal with this, Teh and Cheok [Teh08a] built a prototype system for pet, called Pet Internet, to allow human to touch his/her pet distantly by touching an interface. In fact, more recently, a similar research for pet is also conducted by Murata et al. [Mur14a] for remote haptic communication interactively. According to their pilot study, this interactive system makes human and his/her pet to communicate and feel closer to one another via haptic responses by exchange of haptic feedback.

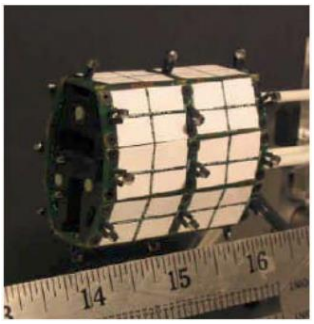

Figure 4. The arm section of Teddy Bear, used in Huggable, was built by Stiehl et al. [Sti06a] from MIT.

Rather than just the aforementioned systems of human-animal interaction, the topic of human-human interaction by touching is studied by other leading computer scientists. For example, [Che13a] presented a parent and child hugging communication wearable system, called Huggy Pajama (later called T Jacket commercially). It can allow children to hug their loved one from a remote distance by reproducing a hug between two people, focusing on a parent and child, but not specifically. This Huggy Pajama system was also featured in NHK's (Japan Broadcasting Corporation) TV program in Japanese language [Teh08a] to show its demonstration. In addition, an MIT research group, led by Stiehl [Sti06a], presented a therapeutic robotic companion (i.e., Teddy Bear) using touch interactions relationally, called similarly Huggable. It is a robotic companion for affective and relational touch-based interactions with a human. This system uses a large number of somatic sensors over the whole surface of the Huggable, as shown in Figure 4 for the arm

section of the robot. It uses a combination of electric field, temperature, and QTC (Quantum Tunneling Composite) force sensors to send affective and relational touch-based interactions.

Figure 5. A robotic platform for socially embodied telepresence was presented by [Ada10a].

A similar idea was implemented in [Ada10a] for a socially expressive telerobotic, called MeBot, as shown in Figure 5. They used the assumption that they want to build a system that is able to communicate more than just video or audio, but expressive gestures, body pose and proxemics also. They believe that their assumption can lead to be more enjoyable for human interaction. Their hypothesis is that a telerobot should embody the operator in a way that gives them with enough representation remotely. Thus, it is able to take a perfectly involved part in the interaction and is perceived by their friends as being present closely, but remotely. The MeBot can allow people to show and express several of the non-verbal behavior portably that people use in normal face-to-face interactions (e.g., gestures of each human organ, interpersonal distance, and eye contact). Although this system is not allowed people to hug a robot as Huggy Pajama system, this study has shown interestingly that a socially expressive robot is dynamically more likable and engaging than a very static telerobot. Also more recently, this idea was extended to help sick children feel less sad and blue in the ICU of Boston Children's Hospital by [Jeo15a] from MIT Media Lab. Figure 6 depicts this extended Huggable's work from the Wired Magazine. This robot is a blue fancy bear built to relieve pain for kids who are hospitalized in Boston for cancer treatment. Under their small scale preliminary study conducted in the real hospital, sick children played and interacted with this blue fancy robotic bear in their private rooms. They shook his foot and played with it positively. Rather than hugging the whole body, Choi et al. [Cho14a] designed an interactively tele-hug ring wearable system for sending various kinds of finger hug, such as mini, intense, and urgent, depending on the sender from a remote distance through subtle colored lighting and tactile expressions digitally. Also, Wang et al. reaffirmed in [Wan12a] that mediated social touch in digital manner can quite influence the sense of link between a speaker and the experience emotionally. They evaluate the assumption by using an augmented storytelling approach. Furthermore, a capacitive touch communication approach was developed interactively by Vu et al. in [Vu12a]. This approach takes advantage of the capacitive touchscreens, which are currently used in many laptops and smartphones as a signal receiver. After that, this signal is able to be produced by a transmitter embedded into their devices. The devices they used in the system are ring and watch. They designed two example prototype systems with a single transmitter. This transmitter is low-power continuous, and can communicate through the skin and a finger ring bearing a signet touched to the screen.

Figure 6. A blue fancy robotic bear was designed to relieve pain for kids in the Wired Magazine [Fal15a].

5. SMELL COMMUNICATION

The next vital sense is smell. Smell has numerous benefits, since it spontaneously and quickly informs us about the state of things in our immediate vicinity [Row09a]. However, can smell be sent by computer as safely as we send other kinds of media, such as sight and touch? The answer is simply 'No'. This is because it usually requires some chemical substances to interact, so that the safety is obviously an important issue. For smell communication, Kaye et al. [Kay08a] presented an olfaction system for computerizing smell output. More specifically, they created a smell-based system called Dollars & Scents inside the entrance to their laboratory at MIT. The system releases scents and perfumes into the air differently depending on stock market changes. For example, they emit a lemon-like fragrance if NASDAQ index is going down, while they emit a rose-like fragrance if the stock market is going up. Similarly, they also built an olfaction system, called inStink, for conveying ambient presence and activity awareness for food. Moreover, Braun and Cheok [Bra14a] designed and built a smell-based computer-dream interface for dreaming of human. They assumed that emotions, particularly during sleep, and smell are intensively interlinked. In this way, they

studied the perception of emotions, when dreaming unconsciously, and how they can be affected from outside environment via smell-based computer-dream interfaces. Moreover, Choi et al. [Cho12a] from Keio University designed and created interactively an olfactory wearable application, called Light Perfume. This application automatically tracks several factors of each user (e.g., speed of eye blinking), and then it emits a delicate fragrance from a wearable device interactively during a face-to-face talk to affect a person's impression emotionally and softly.

6. TASTE COMMUNICATION

The last one is taste, probably one of the most difficult senses for communication. Taste bud is an importantly peripheral sensory organ and has also many benefits. We say this because the sense of taste, such as salty, sour, sweet and bitter, helps people decide what to consume and influences how effectively we digest the meal. In this way, it can affect feeling, mood and emotion straightly and dramatically [Rop06a]. Nevertheless, for taste communication, it is not trivial to transmit this sense. This is because this sense will be aroused when some chemical substances activate specialized receptor cells within the mouth cavity (e.g., cheeks, lips, palate, and floor of the mouth), as explained in [Bre13a], so that it often requires some chemical compounds to interact, largely due to the physical contact unavoidably. Wei et al. [Wei13a] from National University of Singapore designed and built an interactive multimodal system, called Food Media, for the telepresent family dinner context from a remote distance. Even though it is not directly and only for taste communication, it is intuitively an interactive exploration of suitable food and food activities as a medium for communication within the family warmly. In fact, it uses multi-sensory interactions from three major senses (i.e., touch, smell and taste) to connect each family member during the dinner hour. Figure 7 depicts the settlement of integrated system in a room-like environment using two interaction screens remotely. Ranasinghe et al. [Ran14a] developed a taste-based interactive control system, called Digital Flavor Interface. It is done by using electrical and thermal stimulation methods to create different tastes virtually and digitally on the tongue. It simulates different tastes such as sourness, saltiness, and bitterness by using two utensils, a bottle and a spoon as a small box. These utensils can enhance taste sensations differently, so that taste communication can be achieved. Interestingly, rather than just transmitting a normal taste on our touch, Saadatian et al. [Saa14a] built a haptic system interactively that allows people to send and transfer kiss physically over distance. They called it Kiss-Messenger, abbreviated with the acronym Kissenger. This lovotics application consists of a pair of charming wearable robots for couples to transmit kiss from our mouth remotely. This device is paired with another similarly. The lips are controlled by motors inside the two robots which are equipped with soft silicon pads. The shape of the kiss by the first user and amount of force that appeared to be necessary can be transferred to another device for the second user that is simulated as close as possible to the real kiss using actuators.

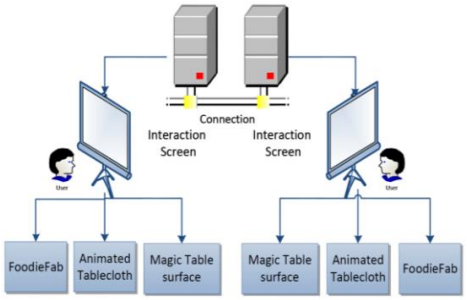

Figure 7. The Food Media's system configuration is set up by [Wei13a] from National University of Singapore.

7. CONCLUSIONS

Each of the five senses performs an important role in enhancing one's daily life experiences through moods, emotions and memory. Previously, communication was often only limited through human hearing system, such as mobile phone. However, in today's world, communication and digital media go far beyond than just audition. Augmented reality, computer vision, haptic, sensor and other new 21st century technologies expand communication into every sensory modality, from vision to touch and from smell to taste. In this paper, we propose a work-in-progress framework for new digital media research when applying modern technologies into every traditional sense of human interactively. It is done by dividing technological communications into five main categories as same as the senses of human: sight, touch, smell and taste systems. Each system has their unique difficulties. For digital sight communication, it has to deal with illumination robustness, computational speed and tracking accuracy. For digital touch communication, the main challenge is how to reproduce the perception realistically, naturalistically and correctly. For taste and smell systems, their main difficulty is usually about dealing with chemical elements. Hence, safety issue is still an essential part in these two senses. Although we believe that the communication for every sense of human has obviously so many challenges for human, it will lead to one big leap for the development of human being.

Hence, the research and development in this area is indispensable and evitable. We intend to build a robust system of the new digital media dealing with every sense to solve these aforementioned problems in the future.

8. ACKNOWLEDGMENTS

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9. REFERENCES

[Ada10a] S. Adalgeirsson and C. Breazeal, Mebot, a robotic platform for socially embodied telepresence, In Proceedings of the 5th ACM/IEEE International Conference on Human-Robot Interaction, pp. 15–22, Osaka, Japan, 2010.

[Bai12a] Diane E. Bailey, Paul M. Leonardi, and Stephen R. Barley, The lure of the virtual, Organization science: Journal of the Institute for Operations Research and the Management Sciences; bridging disciplines to advance knowledge of organizations (INFORMS), Vol. 23, No. 5, pp. 1485–1504, 2012.

[Bra14a] Marius H. Braun and Adrian D. Cheok, Towards an olfactory computer-dream interface, In Proceedings of the 11th Conference on Advances in Computer Entertainment Technology (ACE), Article No. 54, ACM New York, NY, USA, 2014.

[Bre13a] Breslin, P. A. S., An Evolutionary Perspective on Food Review and Human Taste. Current Biology : CB, 23(9), R409–R418, 2013.

[Cha14a] Joseph T. Chao, Tanxin Du, Christopher Wagenheim, Theodore Rippey, and Mise en Scène: A Film Scholarship Augmented Reality Mobile Application, Interdisciplinary Journal of Information, Knowledge, and Management, Volume 9 , 2014.

[Che13a] Adrian Cheok, "Making a Huggable Internet over" on IEEE Spectrum, January 2013.

[Cho12a] Yongsoon Choi, Rahul Parsani, Xavier Roman, Anshul Vikram Pandey, Adrian David Cheok, Light perfume: Designing a wearable lighting and olfactory accessory for empathic interactions, In Proceedings of the Advances in Computer Entertainment, Lecture Notes in Computer Science (LNCS), Volume 7624, pp 182-197, Publisher Springer Berlin Heidelberg, 2012.

[Cho14a] Yongsoon Choi, Jordan Tewell, Yukihiro Morisawa, Gilang A. Pradana, Adrian David Cheok, Ring*U: a wearable system for intimate communication using tactile lighting expressions, In the Proceedings of the 11th Conference on Advances in Computer Entertainment Technology (ACE), Article No. 63, ACM New York, NY, USA, 2014.

[Jam09a] Carrie James, Young People, Ethics, and the New Digital Media, A Synthesis from the GoodPlay Project, Project Zero, Harvard Graduate School of Education, MIT Press, Cambridge, Massachusetts, ISBN 978-0-262-51363-0, 2009.

[Fal15a] Sarah Fallon, A Blue Robotic Bear to Make Sick Kids Feel Less Blue, the Wired Magazine, March 2015.

[Jeo15a] Sooyeon Jeong, Deirdre E. Logan, Matthew S. Goodwin, Suzanne Graca, Brianna O'Connell, Honey Goodenough, Laurel Anderson, Nicole Stenquist, Katie Fitzpatrick, Miriam Zisook, Luke Plummer, Cynthia Breazeal, Peter Weinstock, A Social Robot to Mitigate Stress, Anxiety, and Pain in Hospital Pediatric Care. In Proceedings of the 10th Annual ACM/IEEE International Conference on Human-Robot Interaction Extended Abstracts, New York, NY, USA, 2015.

[Kay08a] Kaye, J., Computer-controlled smell output, Perfumer & Flavorist. Chapter 36, Fragrance for Personal Care. Allured Publishing, 2008.

[Ker14a] C. Kerdvibulvech and K. Yamauchi, "Structural Human Shape Analysis for Modeling and Recognition," In Proceedings of the Joint IAPR International Workshops on Structural and Syntactic Pattern Recognition (S+SSPR), Lecture Notes in Computer Science (LNCS), Volume 8621, Joensuu, Finland, Springer-Verlag Berlin Heidelberg, pp.282–290, August 20-22, 2014.

[Kra10a] Michael W. Kraus, Cassy Huang, Dacher Keltner. Running Head: Touch, Cooperation and Performance. Tactile Communication, Cooperation, and Performance: An Ethological Study of the NBA, University of California, Berkeley, 2010.

[Kim14a] Eugene Kim & Jaewon Choi, Fine Dust in Augmented Reality: Creating Public Service Announcement, COMPUSOFT, An international journal of advanced computer technology, 3 (11), Volume-III, Issue-XI, November-2014.

[Kre10a] V. Krevelen, D. W. F. and Poelman, R., A Survey of Augmented Reality Technologies, Applications and Limitations, International Journal of Virtual Reality, vol. 9(2), pp.1-20, 2010.

[Loc13a] Markus Löchtefeld, Matthias Böhmer, Florian Daiber, Sven Gehring, Augmented Reality-Based Advertising Strategies for Paper Leaflets, In Proceedings of the ACM Conference on Pervasive and Ubiquitous Computing Adjunct

Publication, UbiComp Adjunct, pp.1015-1022, ACM, 2013.

[Mac01a] Blair MacIntyre, Jay David Bolter, Emmanuel Moreno, and Brendan Hannigan. Augmented Reality as a New Media Experience, In Proceedings of the IEEE and ACM International Symposium on Augmented Reality (ISAR), Page 197, IEEE Computer Society Washington, DC, USA, 2001.

[Mat09a] Hertenstein, Matthew J.; Holmes, Rachel; McCullough, Margaret; Keltner, Dacher, The communication of emotion via touch. Emotion, Vol 9(4), 566-573, Aug 2009.

[Mar13a] Rick Martin, "The next step in augmented reality: Electrify your taste buds", SD Japan, June 2013.

[Mur14a] Kazuyoshi Murata, Kensuke Usui, and Yu Shibuya, Effect of Haptic Perception on Remote Human-Pet Interaction, Human Interface and the Management of Information. Information and Knowledge Design and Evaluation, Lecture Notes in Computer Science (LNCS), Volume 8521, 2014, pp.226-232, In Proceedings of the 16th International Conference, HCI International 2014, Heraklion, Crete, Greece, June 22-27, 2014.

[New15a] Nic Newman, Media, Journalism and Technology Predictions 2015, Reuters Institute for the study of Journalism, January 2015.

[Ran14a] Nimesha Ranasinghe, Gajan Suthokumar, Kuan Yi Lee, and Ellen Yi-Luen Do. ``Digital flavor interface," In Proceedings of the adjunct publication of the 27th annual ACM symposium on User interface software and technology (UIST), pp.47-48. ACM, 2014.

[Ric12a] Rice, R.E. and Leonardi, P. M., Information and Communication Technology Use in Organizations. In L.L Putnam & D. K. Mumby (Eds.) The Sage Handbook of Organizational Communication, 2012.

[Rop06a] S. D. Roper, Signaling in the Chemosensory Systems, Cellular and Molecular Life Sciences CMLS, Volume 63, Issue 13, pp.1494-1500, July 2006.

[Row09a] David J Rowe. Chemistry and Technology of Flavours and Fragrances, Wiley-Blackwell, February 2009.

[Rus14a] Olga Russakovsky, Jia Deng, Hao Su, Jonathan Krause, Sanjeev Satheesh, Sean Ma, Zhiheng Huang, Andrej Karpathy, Aditya Khosla, Michael Bernstein, Alexander C. Berg, Li Fei-Fei, "ImageNet Large Scale Visual Recognition Challenge", In Proceedings of the Computer Vision and Pattern Recognition, Cornell University Library, 2014.

[Saa14a] Elham Saadatian, Hooman Samani, Rahul Parsani, Anshul Vikram Pandey, Jinhui Li, Lenis Tejada, Adrian David Cheok, Ryohei Nakatsu, Mediating intimacy in long-distance relationships using kiss messaging, International Journal of Human-Computer Studies, Volume 72, Issue 10, pp.736-746, 2014.

[Sin14a] Poonam Singh and Mrinalini Pandey, Augmented Reality Advertising: An Impactful Platform for New Age Consumer Engagement, IOSR Journal of Business and Management (IOSR-JBM), e-ISSN: 2278-487X, p-ISSN: 2319-7668. Volume 16, Issue 2. Ver. II, pp. 24-28, Feb. 2014.

[Sti06a] Walter Dan Stiehl, Kuk-Hyun Han, Jeff Lieberman, Levi Lalla, Allan Maymin, Jonathan Salinas, Daniel Fuentes, Robert Toscano, Cheng Hau Tong, Aseem Kishore, Matt Berlin, Jesse Gray, The huggable: a therapeutic robotic companion for relational, affective touch, In Proceedings of the ACM SIGGRAPH 2006 Emerging technologies, Article No. 15, ACM New York, NY, USA, 2006.

[Teh08a] James Keng Soon Teh and Adrian David Cheok, Pet internet and huggy pajama: A comparative analysis of design issues, The International Journal of Virtual Reality, Volume 7, Issue 4, Pp. 41-46, 2008.

[Vau09a] Vaughan-Nichols, S.J., Augmented Reality: No Longer a Novelty, IEEE Computer (Volume:42 , Issue: 12), pp.19-22, Dec. 2009.

[Vu12a] Tam Vu, Akash Baid, Simon Gao, Marco Gruteser, Richard Howard, Janne Lindqvist, Predrag Spasojevic, Jeffrey Walling. Distinguishing Users with Capacitive Touch Communication, In Proceedings of the 18th annual international conference on Mobile computing and networking (Mobicom), pp.197-208, ACM New York, NY, USA, 2012.

[Wan13a] Xiangyu Wang, Mi Jeong Kim, Peter E.D. Love, Shih-Chung Kang, Augmented Reality in built environment: Classification and implications for future research, Automation in Construction, Volume 32, pp.1-13, July 2013.

[Wan12a] Rongrong Wang, Francis Quek, Deborah Tatar, Keng Soon The, Adrian Cheok, Keep in touch: channel, expectation and experience. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp.139148, ACM New York, NY, USA, 2012.

[Wei13a] Jun Wei, Adrian David Cheok, Shengdong Zhao, Food Media: Interactive Entertainment Over Telepresent Dinner, International Journal of Advanced Computer Science, Volume 3, Issue 12, 2013.