International

Journal of

Asia

Digital

Art and

Design

Contents

Categories for paper

· Original Article   A paper in this category has to be a logical and empirical report of the study, the review and the proposal by the author on the issue of digital art and design based on media technology. It also has to include the novelty and academic values which can be shared with ADADA members or the people who study digital art and design.
Number of pages: 6 -10

· Art Paper   A paper in this category has to consist of the author's practice, result and expository writing on the field of digital art and design. It also has to have the originality in its concepts, methods, expression techniques and making process, and the result should have some values which can be shared with ADADA members or the people who study digital art and design.
Number of pages: 6 -10

Original Paper

International
Journal of
Asia Digital
Art & Design
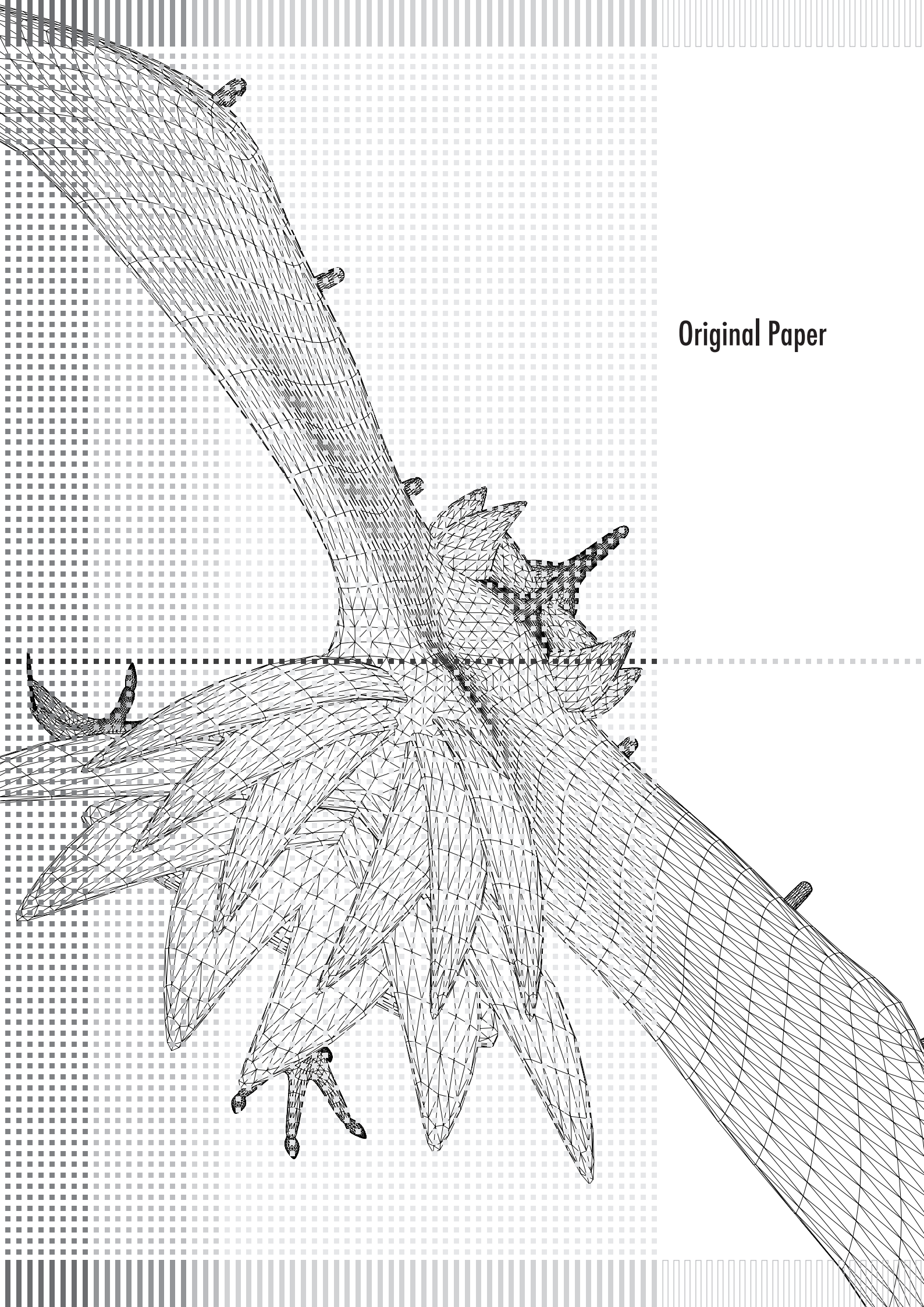
Consumer brand engagement by virtue of using Starbucks's Branded Mobile App based on grounded theory methodology

Chung, Hyeuk
Hongik University, College of Design & Art
thewisehyeuk@gmail.com

Abstract

As mobile technology continues to evolve, the new and more strategic way of communication between brands and consumers has been gained significant attention. The branded mobile app distributed directly by a brand or a company is recognized as a new effective medium to build brand engagement for the long run. Because of ever-changing information technology as well as the role of consumers, most brands set their ultimate goals as establishing brand engagement followed by brand trust and loyalty. Despite the growing interest on branded mobile app and brand engagement, previous studies have been predominantly conducted by a quantitative research that results in statistical verification, thus generating a lack of users' specific and empirical reasoning. To address literature gap, this study attempts using grounded theory which is good for the objective of revealing specific empirical reasoning and findings. The goal of this study is to investigate users' behavioral intentions for using BMA and to examine the role of them in relation to establishing brand engagement. Focusing on Starbucks's branded mobile app, this study derives 3 core categories throughout open, axial, and selective coding and reveals the factors which exercise significant influence on brand engagement. The findings suggest that the branded mobile app as a promising device for communication between brands and customers has to provide long-term value in more synergistic ways enough to be embedded in the very intimate machine, the smartphone.
.

Keywords: branded mobile app, brand engagement, behavioral intention

1 Introduction

Branded Mobile App(as referred to BMA below) is defined as "software that is downloadable to a mobile device and prominently displays a brand identity, often via the name if the app and the appearance of a brand or throughout the user experience."[1] It categorized as brand own media for it is distributed directly by a specific brand or a company itself. Real-time relationships with customers as a focal point being differentiated from web service make BMA be widely adopted to many brands and companies as their new strategy in that building a strong relationship with customers is the essence of establishing brand engagement. Another reason behind the popularity of BMA as a promising marketing strategy is its more user-centric and "consumer-instant-action-centric [2]" by which consumers can experience usefulness, convenience, entertainment, socialization and intellectual stimulation [3]. However, the fact that smartphone has been conceived as an intimate device to construct "intercorporeal relationships[4]" with users implies that capturing users' attention and being constantly embedded in their smartphones are uneasy at all.

The relationship between consumers and a brand which has been dramatically changed due to the technology is one of dynamic research areas [5]. One reason is that consumers in social media society have played great roles and showed active behaviors. In this sense of dramatic change of consumer /brand relationship, the concept of 'brand engagement' has emerged and gained great attention. According to Brodie et al, brand engagement is defined as "a psychological state that occurs by virtue of interactive, co-creative customer experiences with a brand."[6] Brand engagement has also been viewed as "a promising concept which can provide enhanced predictive and explanatory power of loyal customer behavior outcomes, including brand loyalty."[7] In sum, BMA which provides "continuous reciprocal causation [8]" can be an important antecedent for establishing brand engagement.

The goal of this study is to investigate users' behavioral intentions for using BMA and to examine the role of them in relation to establishing brand engagement.

While previous studies on mobile app and services - e.g., antecedents of mobile app usage, purchase intention of mobile app and the effects of constant usage through brand experience - provide statistical data for the results of studies, this study attempts to try qualitative research method, especially grounded theory based on in-depth interview for the objectives

of revealing specific empirical reasons and findings as well as suggesting theoretical modeling. Proposed by the American sociologists Barney Glaser and Anselm Strauss to prevent from pitfalls to be preoccupied with the use of existing theories only causing over-generalization as well as under-theorization [9], grounded theory could be developed directly from empirical work on particular spheres of phenomena[10]." By the same reason, it is familiar to those working in media and communication studies today in that current media-related studies have to deal with ongoing changes and we cannot be sure about existing theoretical framework is adequate to be applied to these changes and their consequences as well. This explains why we need to seek the middle-range theory reflecting "an ambition to develop theories that combine theoretical ambition with an empirical cautiousness [11]" by combining substantive theory with formal theory. Hepp [12] has noted that "a panorama of media and communication change as well as the existing metatheory regarding media and communication cannot be an answer, but a starting point to consider many questions relevant to media culture". Therefore, a research reliant on a meta level of mediatization to involve comprehensive phenomena applied by grounded theory methodology beyond suggesting statistical data is appropriate for media-related studies. In sum, seeking a grounded theory for studying BMA as one of cutting-edge communication media and its relationship with brand engagement is regarded as an appropriate research methodology in the sense of grasping phenomenological states as a strong framework for relevant studies. And more, it is reasonable to take a specific brand's mobile app as an object of study to attain a substantive result. Starbucks's BMA chosen for this study is one of the world's most successful BMA as well as the one widely used in Korea and it has been considered as a "trend setter" in the aspect of mobile marketing. Thus, to investigate factors and relationship with brand engagement focusing on Starbucks's BMA is appropriate to draw out further insights.

The next section provides a literature review regarding the antecedents of mobile app usage for basic questionaire of interview and dimensionality of brand engagement to examine the relationship between those two with acquiring validity and reliability.

2 Literature Review

The antecedents of mobile app usage

Investigating antecedents of BMA usage is deeply related with users' behavioral intention. According to Gentry and Calantone, technology acceptance model(TAM) seems to have explained variance in behavioral intention, especially in the context of technology usage[13]. Because this study is about the usage of sort of new technology, TAM which predicts how various factors are related with the usage of technology can be used to provide basic concept for drawing out a questionaire. TAM, especially, has been used by recent studies regarding mobile marketing [14] and behavioral intention of mobile services [15].

In TAM, Perceived Usefulness refers to "the degree to which users believe that using a particular technology would enhance job performance" and PEOU is defined as "using a particular technology would be free of effort [16]". Traditional concept of TAM, however, has been recognized to have weakness to explain other possible factors which need to be considered by constant development of technology besides PU and PEOU[17]. For this reason, revised concepts which suits for the subjects of studies have been used.

In this study, the intention to use Starbucks's BMA is defined as the behavioral intention and PU as convenience from usage of BMA and gratification of user's specific needs adopted by uses and gratification theory.[18] Uses and gratification paradigm can be appropriate to explain "users' underlying motivations and decisions regarding the use of the new communication tool"[19], which provides proper notion for revealing Starbucks's BMA users' motivation. The notion of PEOU for this study is defined as users' cognitive perception including ease of use. In addition, Perceived Saving Cost(PSC) and Perceived Innovativeness(PI) drawn from the characteristics of Starbucks can be proposed additionally.

Brand Engagement

Varey asserts that the relationship based on trust for building consistent communication with customers and design of customers' voluntary and active interactivity are core assets in considering changing consumers who act rather disruptive execution[20]. Brand engagement reflects a motivational state occurred by an individual's interactive experiences with a particular brand and represents a multi-dimensional concept comprising cognitive, emotional, and behavioral dimensions. By the fact that brand experience does not presume a motivational state and it is not an emotional relationship concept, brand engagement is assumed that it is a psychologically satisfactory state by assessments of cognitive, emotional, and behavioral interactive experiences.

Overall, this study takes three dimensionalities proposed by Holbeek as a category to examine the relationship between the antecedents of BMA usage and brand engagement.[21]

3 Research Design

Participants of in-depth interview

For the sampling, Strauss & Corbin's theoretical sampling [22] and snowball sampling were adopted. Out of Starbucks' customers who have used Starbucks's BMA for more than one year were 12 participants selected. They are from in their twenties to forties and one or one and half hours of in-depth interview was conducted individually.

Questionaire of interview and data collection

Table 1 is the sample of basic questionaire for in-depth interview based on the theory of TAM and UG as mentioned earlier. But an actual interview was delivered by semi-structured interview to evoke participants' natural and active responses. Data collection was accomplished mainly by transcripts, memoing, recording and photographing and 2nd interview over telephone and by e-mails along with research

and analysis of literature review for theoretical sensibility.

. "**Table 1** basic questionnaire for in-depth interview"

Do you like to try new digital products and to learn about new things?
Do you send and receive e-mail via your smartphone?
Do you use your smartphone for exploring SNSs?
Have you ever had any experiences of using mobile payments to make an online or offline purchase?
Have you ever used Starbucks's physical card(s) before using Starbucks's BMA?
What makes you use Starbucks's BMA?
How did know about Starbucks's BMA?
What is your motivation to keep using Starbucks's BMA?
Is there any difference after using Starbucks's BMA in the aspect of your overall life?
Do you open Starbucks's BMA when not using it?
Have you ever found any shortcomings/weaknesses while using Starbucks's BMA?
Are you willing to keep using Starbucks's BMA?

Data Analysis

Data analysis following Strauss and Corbin's methodology consists of open coding, axial coding and selective coding [23]. Open coding, by theoretical sampling and theoretical comparison, drew out phenomena, concepts, category and properties. During axial coding process, construction of paradigm coming through causal conditions, central phenomenon, action/interactional strategies, context and intervening conditions and consequences could be found. As the last step of analysis, theoretical conceptualization and conditional matrix focusing on theoretical saturation could be done by selective coding.

Theoretical sensitivity

Especially for the grounded theory building, to fulfill the rigor of study and theoretical sensitivity is way important. Strauss and Corbin has noted that "theoretical sensitivity is a multidimensional concept that includes the researchers′ level of insight into the research area, their ability to reconstruct meaning from the data generated with the participant, and a capacity to separate the pertinent from that which is not [24].″ Guba and Lincoln also emphasize true value, applicability, consistency, and neutrality [25]. To meet these prerequisites, this study conducted two times of in-depth interviews until facing theoretical saturation and 2 competent professional researchers were participated in overall coding processes for acquiring study's consistency and neutrality

4 Result

4.1 Open Coding

Seen from table 2, drawing out concepts from in-depth interview and sub categories are completed by open coding but each specific concepts representing slices of data cannot be included for this paper.

. "**Table 2** Concept & Categorization based on paradigm of Grounded theory"

Paradigm	sub categories		categories
causal conditions	smartphone as always-on device		smartphone as polymedia
	rewards from using BMA		economical benefit
central phenomenon	the usage of Starbucks' BMA		the usage of Starbucks' BMA
contextual conditions	the use of Starbucks' Mobile Wallet		convenience
	Siren Order		usefulness
	shake pay		entertainment
	free shot & extra/rewards after saving		saving cost
	differentiated rewards programs		brand affection
intervening conditions	the third space	place for study or work (community store)	Spatial Satisfaction
		place for beyond the coffee (Premier food store)	
		place for special coffee (Reserve store)	
	simple and intuitive UI design		brand involvement
strategies of action & Interaction	frequent check-up of BMA		active communication with a brand
	saving Stars for free drink		
	getting a diary from e-frequency		
	giving e-frequency to friends		social network communication
	customization of personal drink & sharing		
	buying MD Products & physical Starbucks membership cards		frequent use of BMA
	continuous charge of Starbucks membership card		
consequences	consistent and active use of Starbucks' BMA		enhancement of brand engagement
	voluntary & active participation to rewards and events programs		

	frequent checkup of Starbucks' BMA	Institutionalization of BMA

Below is the restatement the result according to axial coding along with paradigm model.

- **causal conditions**

The causal conditions can be interpreted to prerequisite of central phenomenon. As the smartphone becomes "a representation of the self to the self as well as being symbolic interpersonal communication[26]", people tend to regard the smartphone as polymedia. Thus, people want to integrate almost everything inside the smartphone which is the "always-on-you-machine[27]". This means that the branded mobile app should not just be a way of brand communication but be useful and valuable medium enough to be downloaded onto the very intimate device. Under these causal conditions, Starbucks released cutting-edge BMA called as 'mobile wallet' which provides useful convenience and cost saving benefits.

- **central phenomenon**

As regarded as an essential result, central phenomenon can be summarized as the active usage of Starbucks BMA. Most of users have previously used physical Starbucks's cards and they registered those to BMA for the free from worrying about not-having-a card when purchasing. An important finding is that whatever reasons they have for start using Starbucks BMA, they became to use the branded mobile app continuously and even very actively.

- **contextual / intervening conditions**

While contextual conditions are defined as a set or an aspect of particular factors which cause the central phenomenon, intervening conditions can be defined as broad structural conditions which facilitate or impede strategies of action/interaction. However, there is huge overlap between those two conditions this study analyzes those as one condition.

The increasing numbers of customers using Starbucks BMA are mainly caused by incompatible convenience from using mobile payments. As mentioned earlier, many people in mobile society want to bring their smartphones solely without having purses or wallets. Besides perceived usefulness and convenience as core conditions, those used to visit a busy store such as a community store located at Hyewha-dong enjoy 'siren order' for not staying in a long line. In addition, they are said to love 'siren order' for being able to make specific orders more comfortably according to their individual tastes.

Out of many empirical findings, accumulation of stars and e-frequency as differentiated rewards programs of Starbucks are highly demanding. Such rewards not only lead expansion of social communication but also serve as a representation of brand involvement followed by brand affection and trust.

- **strategies of action/interaction**

It is described as participants' habitual behaviors and strategies over the categories drawn out from central phenomenon. For the participants, they use social network communications for acquiring their wants if needed. To sell and buy e-frequency points via a SNS platform, to send e-gift or various kinds of coupons for free drinks, and to share customized drinks are widely used strategies which are voluntarily evolved and expanded. Most of participants open up Starbucks's BMA to check up balance, the numbers of starts and a new event or a notice even when not purchasing a drink. This increases the possibility of enhancing brand loyalty and ultimately, brand engagement. Another category of strategies is regarding habit of usage. Some participants have constantly used an automatic charge system to keep their balances at all time and others also keep the balance by charging whenever needed. It is important to note that once downloaded, Starbucks's BMA is hardly removed and stays as like as a default one.

- **consequences**

When it comes to as an innovative and an ease of use device, Starbucks's BMA becomes institutionalized one which is able to end up establishing brand engagement. The rationale underlying drawn categories explicitly supports that the antecedents of BMA usage can play significant roles for brand engagement.

4.2 Axial coding: Analysis based on paradigm

Axial coding is for combining category with sub categories in a new way. For this study, structuring the paradigm model from the result of open coding can be provided as a result of axial coding.
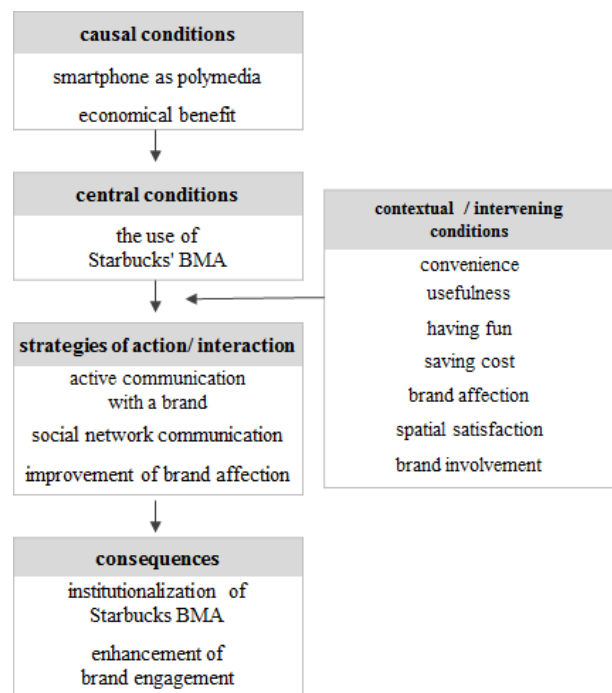
"**Figure 1** Paradigm Model"

Axial coding shows how causal conditions, contextual/intervening conditions, strategies of action/interaction, and consequences are related together toward the central phenomenon. In another word, all sub categories drawn out from open coding are inherently connected to explain the relationship between customers' behavioral intentions and brand engagement by mediated by usage of Starbucks's BMA.

4.3 Selective coding: core category and story line

The final consequence of grounded theory research can be generated from core category and theoretical integration in the stage of selective coding based on the results of open and axial coding.[28] Authors are expected to suggest a theoretical frame along with making story line according to accumulated data and building core category.

To investigate the relationship between the intention of BMA usage and brand engagement, the antecedents of Starbucks's BMA's usage and those of brand engagement defined as operationalization were tested throughout the study. The findings from theoretical modeling indicate that all antecedents of Starbucks's BMA's usage made significant contribution to customers' current usage of BMA. Further, as seen as table 3, customers who cognitively percept the usefulness and convenience of Starbucks's BMA show deeper affection toward Starbucks, which makes them lead to ceaseless usage of mobile app after downloading the Starbucks's BMA. This also means that the antecedents of Starbucks's BMA's usage play an important role to make users have strong behavioral, cognitive, and emotional intention. Further, it is regarded as that most experienced users of Starbucks's BMA have great amount of possibilities to establish brand engagement.

In summary, final theoretical modeling can be generated by three core categories;
1. Enjoying Starbucks's BMA more conveniently by virtue of mobile wallet (mobile payments).
2. Active participation to differentiated rewards and events programs
3. Constant communication with Starbucks' BMA through easy and intuitive UI design

"**Table 3** Core Category"

BMA usage	brand engagement	core category
PI PU PEOU	Cognitive processing Affection	Enjoying Starbucks's BMA more conveniently by virtue of mobile wallet(mobile payments)
PSC PU	Activation	Active participation to differentiated rewards and events programs
PU PI	Affection Activation	Constant communication with Starbucks' BMA through easy and intuitive UI design

Table 3 provides three core categories having a relationship with antecedents of brand engagement and usage of Starbucks' BMA.

First, '**Enjoying Starbucks's BMA more conveniently by virtue of mobile wallet**' means the institutionalization of Starbucks's BMA.

Almost all customers who use Starbucks's BMA commented nothing other than the convenience of mobile wallet. They had experienced any inconveniences from keeping a physical card which has to be shown whenever they made payments. Like Madianou puts the smartphone as "polymedia which shifts our attention to how users treat media as integrated environments of affordances"[29], people need simple and convenient lifestyle with the smartphone. The mobile wallet of Starbucks's BMA has truly changed the patterns of consumption of coffee culture by making consumers go to the Starbucks store favorably with their smartphones which are always in their hands.

One of significant differences to other mobile apps is that Starbucks's BMA running through 2D barcode system instead of NFC(Near Field Communication) shows how successfully IT(Information Technology) is combined with mobile marketing. 'Siren Order' system is an example of hybridization of mobile order and payment. Recently revised version of Starbucks's BMA after the first release in 2011 attracts customers strongly with more convenience including easy-to-use UI(User Interface) design and multi-touch gesture feature along with GPS(Global Positioning System) and QR code for searching near stores. Through Siren Order, one can place his/her order and pay for it on his smartphone before getting to the store and simply pick his/her drink up when the order is ready.

Equally meaningful fact is that Starbucks's BMA is not just an app but also a card, by which those who are using Starbucks's BMA have tendency to charge their cards continuously to keep using Starbucks's BMA. Further, many of participants choose automatic charge system to keep enough amount of balance at all times. This, indeed, has contributed heavily to choose Starbucks solely out of other coffee stores, which eventually leads them to have positive attitude toward Starbucks Company as the prominence of the brand loyalty and engagement as well.

Second. '**Active participation to differentiated rewards and events programs**'

Having been credited with revolutionizing coffee industry, Starbucks has put great effort to have customer loyalty by making itself being differentiated from others. 'My Starbucks Rewards(MSR)' is often regarded as one of the best retail loyalty programs currently in existence. A star is a kind of point to get a free drink accumulated with 12 stars after receiving 'the gold card'. But one of the compelling features of

Starbucks's BMA is to make customers voluntarily interact with Starbucks's BMA. One of the features many customers told is the motion with a text on the top of home screen which shows how many stars one has.

All participants replied that the physical gold card coming with free shot or extra and other credits was a true motivator to get a gold status. They also regularly open their Starbucks's BMA to check up their rewards. Another revealing one is e-frequency program through which one can get a new year's diary by purchase of 17 cups of drinks. Some active participants have tried to get more than 2 diaries every year. The more astounding fact is they don't need those diaries that much and they only eager to get exclusive products from Starbucks.

> "I used to collect all kinds of diaries every year and
> this year's too. I love to treat as many friends
> as possible at Starbucks during e-frequency times."

> "I actually don't use free drink coupon effectively,
> because I only drink Americano which is
> comparatively cheap. I am rather used to
> give my coupons to my friends who like frappuccino
> or other blended drinks."

This shows they participate in rewards or event programs based on emotional affection called as brand affection or brand loyalty that is prerequisite for building brand engagement. Along with these rewards programs, various MD products from tumblers and mugs to physical Starbucks cards are also very attractive to many customers.

> "Even though I know the physical card is not
> necessary any more, the design of Starbucks's
> cards always makes me be eager to purchase
> and keep them."

Third, **'Constant communication with Starbucks' BMA through easy and intuitive UI design'**
According to Gupta's research, BMA can be a totally new way of brand communication tool for building brand engagement because it is not regarded as a traditional advertisement or promotion. However, the success of BMA cannot be estimated simply by the numbers of download, because users are free to remove it once they decide it is not useful. That's why BMA needs customer-centered brand's own strategy lest BMA should be excluded by customers. As Sherry Turkle characterizes the phenomenon of the smartphone as the "tethered self"[30], a downloaded BMA can be an appropriate medium for intimate brand communication with customers.
In the case of Starbucks's BMA, simple and intuitive UI design works as an utmost important factor to have customers constantly interact with the app. Being able to confirm by just one touch what they want to see the most is possible because of the well-designed home screen comprising of 6 main categories with which every customers are satisfied. In addition to user-centered UI, showing current accumulation of

stars with motion and 'Shake pay' as a feature of multi-touch gesture are also enough to intrigue many customers. Because the smartphone is described as "emotionally intelligence tool"[31], the haptic dimension and perceived ease-of-use of BMA can function as critical elements. In this sense, Starbucks's BMA keenly penetrates emotional sense of customers and their needs in mobile social media society.

5 Conclusion

As the smartphone becomes more intimate and private machine, people instinctively want the smartphone to be "a sort of magical object with which we are physically intimate, and which responds to our interior thoughts and desires with the mere touch of a finger." [32]
Consistent with previous BMA usage and brand engagement studies, this study empirically validated the effects of behavioral intentions in the relation to the antecedents of Starbucks's BMA usage and possibility of establishing brand engagement. The overall research reveals a strong correlation effect between users' involvement toward Starbucks's BMA and their attitudes for building brand engagement. The theoretical modeling comprising of 3 core categories, 13 categories, and 20 sub categories through constant comparison enough to have fully saturated conceptualization also reasserts the study results. Thus, the final result shows the customers' voluntary and active usage of Starbucks's BMA followed by cognitive perception and emotional affection to the institutionalization of BMA is empirically significant in predicting enhancing brand engagement including brand loyalty and trust.
The results applied by grounded theory differ from other previous studies regarding brand engagement in that they reveal the specific characteristics of Starbucks's BMA that lead the success of a brand's owned media. These findings can act as a practical implication to mobile practitioners. Irresistibly, the core factor leading the success of Starbucks' BMA is rooted in very articulated consumer-centered strategy, by which all customers recognize it as "a portable personhood[33]" rather than merely as an application. That's why they enjoy everyday usage of Starbucks's BMA.

As mobile users are becoming technologically interwoven with the smartphone in mobile social media society, the branded mobile app should offer "long-term value" for engaging customers with constant communication rather than merely serving "a short-term objective"[34]. Miller also has noted that, "people use the smartphone for affective and aesthetic purpose."[35] Therefore, the branded mobile app that has to be embedded in the "tethered self"[36], the smartphone, should be a creative mediator of communication between customers and brands in more synergistic ways.

References
[1] Bellman, S., Potter, R. F., Treleaven-Hassard, S., Robinson, J. A., & Varan, D., *The effectiveness of branded mobile phone apps*. Journal of Interactive Marketing, 25, pp. 191-200, 2011.

[2] Zhao, Zhenzhen & Balague, Christine, *Designing branded mobile apps: Fundamentals and recommendations*, Business Horizons, 58, pp. 305-315, 2015.

[3] Ho, H.Y., and Syu, L.Y., *Uses and gratifications of mobile application users.* Paper presented at the International Conference on Electronics and Information Engineering, Kyoto, Japan, 2010.

[4] Miller, J., *The fourth screen: Mediatization and the smartphone*, Mobile Media & Communication, Vol. 2(2), pp. 209-226, 2014.

[5] Aaker, J., Fournier, S., and Brasel, A.S., *When good brands do bad*, Journal of consumer research, 31, June, pp. 1-6, 2004

[6] Brodie, R. J., Holbeek, L.D., Juric, B., & Ilic, A., *Consumer engagement: conceptual domain, fundamental propositions & implications for research in service marketing*, Journal of Service Research, 14.3, pp. 252-71, 2011.

[7] Hayles, N., *How we think: Digital media and contemporary technogenesis*, Chicago, IL: University of Chicago Press, 2012.

[8] Kim, S.C., Yoon, D., and Han, E. K., *Antecedents of mobile app usage among smartphone users.* Journal of marketing communications, pp.1-18, 2014.

[9] Hjarvard, Stig, *The mediatization of culture and society*, Routledge, 2013.

[10] Hepp, Andreas, *Cultures of Meditization*, Trans. by Tribe, J., Polity Press, 2013.

[11] Boudon, R., Review: What Middle-range theories are," Contemporary Sociology 20(4), pp. 519-522, 1991.

[12] Hepp, Andreas, *Cultures of Meditization*, Trans. by Tribe, J., Polity Press, 2013.

[13] Gentry, L., and Calantone, R., *A comparison of three models to explain sop-bot use on the web*, Psychology & Marketing, 19, pp. 945-956, 2002.

[14] Okazaki, S., and Barwise, P., *Has the time finally come for the medium of the future?: Research on mobile advertising*, Journal of Advertising Research, 51, pp. 59-71, 2011.

[15] Nysveen, H., Pedersen, P. E., and Thorbjornsen, H., *Intentions to use mobile services: Antecedents and cross-service comparisons*, Journal of the Academy of Marketing Science, 33, pp. 330-346, 2005.

[16] Davis, F. D., *Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology*, MIS Quarterly, 13, pp. 319-340, 1989.

[17] Moon, J. W., and Kim, Y. G., *Extending the TAM for the world-wide-web context*, Information and Management, 38, pp. 217-230, 2001.

[18] Stafford, T.F., Stafford, M.R., & Schkade, L. L., *Determining uses and gratifications for the internet*, Division Science, 35, pp. 259-288, 2004.

[19] Liu, L.B., Cheung, M. K., & Lee, K. O., *Understanding twitter usage: what drives people to continue to tweet*, PACIS 2012 Proceedings, Paper 92, 2010.

[20] Varey, Richard J. *Relationship marketing: dialogue and networks in the e-commerce era.* Chichester : Wiley, 2002.

[21] Holbeek, L.D., Glynn, M.S., Brodie, R.J., *Consumer brand engagement in social media: conceptualization, scale development and validation*, Journal of interactive marketing, 28, pp. 149-165, 2014.

[22] Strauss, A., & Corbin, J., *Basics of qualitative research: grounded theory procedures and techniques*, Sage Publications, Newbury Park, CA, 1990.

[23] Strauss, A., & Corbin, J., *Grounded theory methodology an overview. In: Handbook of qualitative research,* Denzin, N. K., & Lincoln, Y. S. (Eds), Sage Publications, Thousand Oaks, CA, pp. 273-285, 1994.

[24] Strauss, A., & Corbin, J., *Basics of qualitative research: grounded theory procedures and techniques*, Sage Publications, Newbury Park, CA, 1990

[25] Guba, E. G., & Lincoln, Y. S., *Effective evaluation*, San Francisco: Jossey-Bass, 1981.

[26] Katz, J., *Bodies, machines and communication contexts: What is to become of us?* In J. Katz (Ed.) *Machines that become us: The social context of personal communication technology*, New Brunswick, NJ: Transaction, pp. 311-320, 2003.

[27] Turkle, S. *Always-on/Always-on-you: the tethered self.* In Katz, J. (Ed.), *Handbook of mobile communication studies*, Cambridge, MA: MIT Press, pp. 121-138, 2008.

[28] Urquhart, C., Lehmann, H., & Myers, M. D., *Putting the theory back into grounded theory: guidelines for grounded theory studies in information systems*, Information Systems Journal, 20, pp. 357-381, 2010.

[29] Madianou, M., *Smartphone as polymedia*, journal of computer-mediated communication, 19, PP. 667-680, 2014.

[30] Turkle, S. *Always-on/Always-on-you: the tethered self.* In Katz, J. (Ed.), *Handbook of mobile communication studies*, Cambridge, MA: MIT Press, pp. 121-138, 2008.

[31] Goggin, G., *The iPhone and communication.* In Hjorth, L., Burgess, J. & Richardson, I. (Eds). *Studying Mobile Media: Cultural technologies, mobile communication and the iPhone*, New York, NY: Routledge, pp.11-27, 2012.

[32] Burgess, J., *The iPhone moment, the Apple brand and the creative consumer: From "hackability and usability" to cultural generativity*, In Hjorth, L., Burgess, J., & Richardson, I. (Eds.), *Studying mobile media: Cultural technologies, mobile communication and the iPhone*, New York, NY: Routledge, pp. 28-42, 2012.

[33] Elliot, A., & Urry, J., *Mobile lives*, Abingdon, UK: Routledge, 2010.

[34] Gupta, Sunil. *For mobile device, think apps, not ads.* Harvard Business Review. March Issue, 2013.

[35] Miller, J., *The fourth screen: Mediatization and the smartphone*, Mobile Media & Communication, Vol. 2(2), pp. 209-226, 2014.

[36] Turkle, S. *Always-on/Always-on-you: the tethered self.* In Katz, J. (Ed.), *Handbook of mobile communication studies*, Cambridge, MA: MIT Press, pp. 121-138, 2008.

Phased Expression Technique for Realistic Embodiment of Tiger Fur

Kim, Dong Sik
Dept. of Visual Contents, DSU
tkotw28@gmail.com

Ji, Yun
Dept. of Visual Contents, DSU
jiyunmyself@naver.com

Cho, Seung Woo
Division of Digital Contents, DSU
swcho@gdsu.dongseo.ac.kr

Lee, Hyun Seok
Division of Digital Contents, DSU
hslee@gdsu.dongseo.ac.kr

Abstract

In recent Hollywood movies such as <Dawn of the Planet of the Apes, 2014>, <The Hobbit, 2014> etc, animal-shaped CG creatures are being realistically presented. Materialization of fur serves as an important factor to give each character distinctive features as well as particularly describes CG creatures more realistically. In case of major studios, the fur effect is materialized by using in-house tool or through their own R&D. In most studios, however, the effect incurs technical and financial difficulties. This study, therefore, is to suggest an effective fur making technique using five plugins through experimental research. For this research purpose, this study first draws existing technical limitations and problems through literature review on fur making using CG and case studies of movies. Second, this study establishes optimized work process based on the limitations and problems by utilizing features of general plugins on three steps of ①Fur shape modeling, ②Fur dynamics or animation and ③Fur rendering as a technical method for realistic expression of fur and analyzes its technical utility. Through this procedure, it is to present an effective way of working and it is considered as a useful research that can be applied to projects of studios in general.

Keywords: Realistic Fur,   Fur Effects,   Animal Characters

1 Introduction

1.1 Background and Purpose

In the movie production field, development of computer hardware and software enables materialization of many scenes that cannot be expressed into actual images in CG manner. Fur materialization in recent movies in which CG is given a lot of weight serves as an important factor to give each character distinctive features as well as particularly describes CG creatures more realistically[1]. Movies such as <King Kong, 2005>, <Dawn of the Planet of the Apes, 2014> with animal-shaped digital creatures as its main character and <Mr. Go, 2013> which was made only with domestic technologies cannot be produced without technical support for fur making. Big studios like Weta Digital or Dexter are constantly developing technologies for realistic embodiment of fur and they have come to possess independent software in-house tool. On the other hand, general studios need to utilize general plugins for fur materialization but they have limitations in advanced technical expressions[2]. Thus, this study is to suggest an effective method for realistic fur materialization of animal-shaped digital creatures that can also be utilized in general studios.

1.2 Scope and Method of Study

Realistic embodiment of digital creatures requires numerous steps and processes including production modeling, Fur FX, lighting, rendering, compositing, etc. Among various processes in production, the scope of this study is Fur FX only and it covers object creation and option adjustment of fur; simulation through animation and; a part of shading and rendering. For this research purpose, this study first draws existing technical limitations and problems through literature review on fur making using CG and case studies of movies. Second, this study establishes optimized work process based on the limitations and problems by utilizing features of general plugins on three steps of ①Fur shape modeling, ②Fur dynamic or animation and ③Fur rendering as a technical method for realistic expression of fur and analyzes its technical utility.

Table 1 Research Sequence

Research Questions	Is it possible to materialize realistic fur by utilizing general fur making plugins?
Preceding Research	- Literature review on fur making in CG - Case studies of movies on which fur is materialized
Analysis Criteria derived	①Fur shape modeling ②Fur dynamic or animation ③Fur rendering
Experimental Research	Tiger fur materialization by utilizing plugin based on each step of analysis criteria
Conclusions	Materialization of realistic fur

2 Preceding Research

2.1 Production Process of Fur in CG

Fur lexically means hair, pelt or faux fur and it is used as the same meaning in terms of results of rendering in movie production. Its making process is included in Effects Animation and called Fur FX(Effects) as shown in the pipeline on Figure 1.
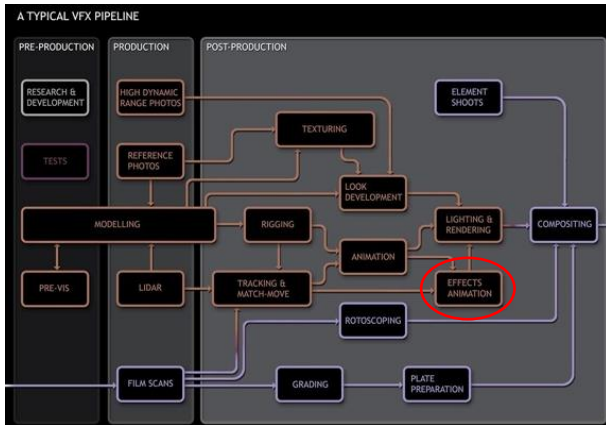

Figure 1 The Visual Effects Pipeline[3].

The process to materialize fur on 3D generally is modeling → fur making by object unit → adjustment of various options such as fur type, direction, density, length, etc → color → rendering[4]. Magnenat-Thalmann et al.(2000) defined this phased fur materialization as the following three main stages. 'One can conceive three main aspects in hair simulation – hair shape modeling, hair dynamics or animation, and hair rendering' [5]. And this can be summarized as in Table 2. With this phased materialization process as analysis criteria, this study checks the current production technology tendency of Fur and examines features of movies in which Fur is realistically materialized.

Table 2 Three steps of realistic fur materialization

1. Fur shape modeling	2. Fur dynamics or animation	3. Fur rendering
Step to adjust shape and options of fur	Fur animation and dynamic depending on movement	Process to realistically visualize fur considering the surroundings

2.2 Technology Tendency of Fur

The initial materialized pattern of Fur that used CG has been produced in the form of texture map as seen in games[6]. This has the merit of fast materialization in the low performance but has the limits when it comes to Fur dynamics or animation and Fur rendering, therefore it is not proper for realistic expression. Various techniques to express Fur shape since have been developed and there are implicit method that expresses Fur as volume model and explicit method that expresses a strand of Fur as curved cylinder, which is widely

used now in CG[7]. In case of Fur dynamics, even though there are many things to calculate and complexity, mass-spring dynamics method is generally used because it is easily combined with other physical systems. And here interpolation method is applied in the minimum Fur to improve for the optimized directions[8]. Fur rendering is divided into the expressions of shading of Fur and shadow of Fur. For shading, tangent method of Kajiya is mainly used but it cannot express exactly the scattering of light inside Fur and has some limitation to realistic expression[9]. To make up for this, Fur model of Marschner that materializes the quality of real hair and has the exact reflection was developed, and a reflection model which applies multiple scattering is recently being studied[10]. For shadow, reflection and refraction can be materialized in shading treatment, so deep shadow through global illumination makes realistic shadow materialized. Such methods were already standardized in large studios and they are now being improved by the optimized direction of pipeline[11]. And it is focused that artists could make more intuitively and effectively through grooming of Fur and simulation and real-time rendering.

2.3 Relevant Case Studies about Making Fur

As Jang Seongran(2013) stated that 'Technology to naturally draw fur using CG is an advanced technology that is exclusively possessed only by a few enterprises among ones on visual effects in the world' [12], realistic embodiment of fur is an advanced technology that requires long-term R&D. <Futureworld> of director Richard T. Heffron which first applied 3D graphics to a real image movie was produced in 1976[13]. But materialization of fur on digital creature through CGI technology was not possible until 1994, eighteen years afterward.

Figure 2 Kitty in <The Flintstones, 1994> (left), Monkeys in <Jumanji, 1995> (right)

The left on Figure 2 is a scene where Kitty appears in <The Flintstones, 1994> in which fur was first applied[14]. Due to the limits to the materialization technique of CG at that time, Fur is little seen in the movies and is only presented in the night scenes and also the size of characters takes small percentage in the screen. Based on <the Flintstones, 1994> and the results deducted from the previous literature research, three steps of the realistic materialization of Fur were analyzed. When analyzing Fur dynamics or animation of the step 2, the movement of Fur according to motions of Kitty is not materialized, hence Fur shape modeling of the step 1 is not made in the form of curve or cylinder but materialized in the form of texture map. For Fur rendering of the step 3, shading of Kitty is materialized as local shading that does not consider surrounding environment and as a result, it has the limit to

realistic expression. Another study on fur argues that <Jumanji, 1995> on the right of Figure 2 is the first movie on which realistic fur is materialized[15]. It can be analyzed that way because the digital creatures of monkey and lion play bigger roles on <Jumanji, 1995> than Kitty on <The Flintstones, 1994> and the dynamic on the second step of fur materialization is partially applied. Figure 3 is a sequence of monkey's riding a bike and it shows dynamics or animation of fur with air friction. This indicates that Fur shape modeling of the step 1 is not produced as a simple texture map but rather is materialized by applying a fundamental pattern of curve in order to express realistic Fur. As to rendering, the third step of fur materialization, however, it has limitations due to unrealistic local shading as in <The Flintstones, 1994>.

Figure 3 Sequence of monkeys' riding a bike in <Jumanji, 1995>

As CG techniques have been generalized further with rapid development of hardware and software since 2000s, there have been great changes in movie production as well. The left and the right on Figure 4 are scenes in <King Kong, 1976> of director John Guillermin and in <King Kong, 2005> remade by Peter Jackson. Since it was impossible to materialize a digital creature in 1976, a 16-inch-tall miniature was made and the movement was expressed through stop motion technique[16] or make-up and filming techniques with special effects were adopted for production.
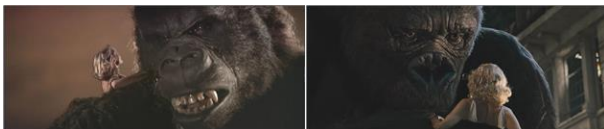
Figure 4 <King Kong, 1976> (left), <King Kong, 2005> (right)

<King Kong, 2005> reborn as digital creature became an issue for fur materialization as realistic as that of a real gorilla. It is the result after the first and second step of realistic fur materialization was performed by utilizing in-house tool named Bonobo by Weta digital studio and then rendering on the third step was done through PRman of Renderman developed by Pixar[17]. Features of each step are analyzed as follows.

Step 1. Fur shape modeling
Fur is produced by utilizing methods of painted maps and guide curve system and Per-vertex & IFF maps for different body parts of the model. Grooming of fur adjusts various attributes <options> of the fur through deformer overlap and wire deformers[18].

Step 2. Fur dynamics or animation
Dynamic of fur is materialized through dynamics and animation. Except for scenes that require materialization of

various dynamics such as when fur is soaked or smoke needs applying, the thick and stiff fur of King Kong is expressed through animation by binding on the creature's surface of body[19].

Step 3. Fur rendering
Reflex model shading is adopted which enables physical based rendering of Marschner method which is based on perception that when real hair is observed with a microscope, the hairs are of a thin single-layered structure and a translucent refractive index[20] and; soft and translucent shadow is created through deep shadow map method.

2.4 Analytical Tools

Table 3 Feature of fur materialization steps through case study of movies

Film Production Case Studies		<The Flintstones, 1994>	<Jumanji, 1995>	<King Kong, 2005>
Fur materialization software		(unknown)	(unknown)	Bonobo, Renderman
Features about Three steps of realistic fur materialization	Step 1. Fur shape modeling	Texture map type simple Fur was produced.	Curve type Fur was produced for realistic materialization.	Curve type Fur enables : - Intuitive grooming - Adjustment of various fur shapes and options
	Step 2. Fur dynamics or animation	It was texture map type but dynamics was not materialized in it.	Fur was partially applied.	Applied to every Fur : - Applying direct animation on fur - Applying dynamic
	Step 3. Fur rendering	Realistic rendering was not materialized because only local shading was applied nor considering its neighbor environment.		Realistic rendering : - Shading of Marschner method - deep shadow map

To summarize features of three steps for fur materialization through the aforementioned three cases of movies, ① shapes and various options of fur that can be intuitively controlled, ② application of fur animation and dynamic for character's movements and ③ materialization of shading and shadow for physical based rendering.

3. Experimental research

3.1 Analytical Tools: General Plugin for Fur Materialization

Three steps for realistic fur materialization are to be applied through general plugins. First, the general plugins are classified as in Table 4 and among them, five of Maya Fur, Shave&Haircut, Zbrush Fibermesh, Peregrine Yeti and FX Hair are selected. The selection criteria is ①whether the plugin is frequently utilized, ②whether 3D Maya can be supported which is used by multiple movie production

enterprises and ③whether various render software is supported. Though FX Hair cannot perform the first step of Fur shape modeling and the third of Fur rendering on phased materialization for its own plugin, it is included in this experiment for its frequent use of dynamic on the second step.

Table 4 General plugin for fur materialization

Plug-in	Software Compatibility	Features	Support Renderer
Maya Fur	3DMaya		Renderman, Mentalray, Vray, Arnold
Shave& Haircut	3DMaya		Renderman, Mentalray, Vray, Arnold
Zbrush Fibermesh	3DMaya, 3DMax	Specialization about fur making and grooming	FiberMesh Render
Peregrine Yeti	3DMaya		Renderman, 3delight, Vray, Arnold, Guerilla Render
FX Hair	3DMaya	Specialization about dynamic	-
Ornatrix	3DMaya, 3DMax		Mentalray,Vray
Hairtrix	3DMax		Mentalray,Vray
Cinema Hair	Cinema4D		Arnold,Vray,ment alray,Renderman
...			

3.2 Subject and Process of Experiment

Tiger creature modeling is conducted by utilizing 3D Maya2015 software as in Figure 5. The reason why a tiger is selected is that an intuitive experiment can be implemented on fur with various patterns, lengths and shapes. The experiment consists of three steps which are: to select the most appropriate plugin for realistic expression on the first step of Fur shape modeling and; to conduct experiment on dynamics or animation as the next step by using the most appropriate plugin.
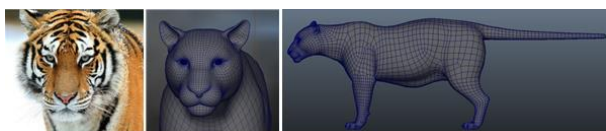
Figure 5 Creature subject to modeling (center), (right) based on the picture of actual tiger (left)
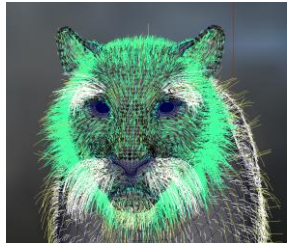
When using a particular plugin, overlapping application of another plugin generally incurs an error. When data cached value of a particular plugin is extracted using guide curve, however, dynamic can be materialized. After selecting an appropriate plugin on the second step through this procedure,

the final Fur rendering on the third step is experimented with render shader that is supported by the initially selected plugin.

3.3 Experimental Research 1: Fur Shape Modeling

Table 5 is the result of applying Fur shape modeling by utilizing plugins. First, materialization through Maya Fur has limitations for realistic expression due to the sole fur creating method (face application), limited fur option adjustment and unintuitive grooming. Second, materialization through Shave&Haircut has two fur creating methods (face application, guide curve), various fur option adjustment and intuitive grooming but it incurs loads on system when the number of fur increases. Third, materialization through Zbrush Fibermesh is of one fur creating method (mask), various option adjustment and relatively free to system specifications with quick grooming but its intuitiveness lacks regarding materialization of various types of fur in a narrow scope like a tiger. Last, materialization through Yeti has various advantages with three fur creating methods (face application, guide curve, density map), various option adjustment through node method and attribute method and intuitive grooming and further, mel script can also be applied upon. FX Hair is a plugin of materializing dynamic only so it is omitted from this process.

Table 5 Fur shape modeling by utilizing different plugins

| A. Maya Fur	B. Shave&Haircut
C. Zbrush Fibermesh	D. Yeti

In terms of materializing tiger's fur as the first step of Fur shape modeling, Yeti plugin is analyzed as proper one with intuitive fur making, grooming and various option adjustment.

3.4 Experimental Research 2: Fur Dynamics or Animation

The next is to apply another plugin to apply dynamic on fur which is produced by using Yeti on the first step. First, acting is applied to creature based on a scene with a running tiger. A camera is set to capture upper body including its head from the side and to move in the same direction as that of creature to

enable analysis on dynamic process of fur. Cached value of fur created by using Yeti plugin is extracted by guide curve and an experiment on dynamic is conducted as in the Table 6. First, dynamic materialization through Maya Fur facilitates quick application through hair system dynamic but it take a long time to process application of Maya fields(air, drag, gravity, newton, turbulence etc). And the result and outcome of dynamic does not match and, consequently it incurs low intuitiveness, which is not appropriate for realistic expression. Second, Shave&Haircut is of quick and precise processing Maya fields and dynamic(collision, self-interaction) of short fur like that of a tiger but it requires long computing time to process long fur, for example, on the jaw. Third, Yeti dynamic is of superb intuitiveness as it is materialized through application of guide curve, which is identical with that of grooming process. However, as movements of numerous fur subject to the guide curve cannot be delicately controlled, it has limitations on realistic expression. Last, FX Hair demonstrates high calculating speed of dynamic even though tiger's numerous fur is materialized and it shows realistic movements of fur depending on the tiger's move through various options (Maya field, collision, self-interaction, goal curves). Zbrush Fibermesh is a plugin specialized in Fur shape modeling and it is omitted from this process.

Table 6 Fur shape modeling by utilizing different plugins

A. Maya Fur Dynamic

B. Shave&Haircut Dynamic

C. Yeti Dynamic
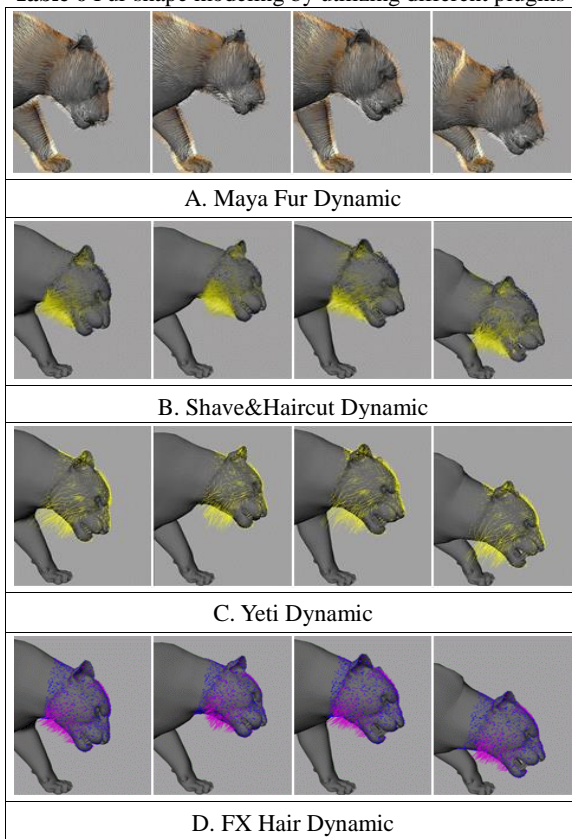
D. FX Hair Dynamic

Through the second experiment, it is concluded that FX Hair plugin is of high appropriateness with high processing speed on dynamic and superb interactive between fur and various options including Maya fields, etc.

3.5 Experimental Research 3: Fur Rendering

The last is to materialize realistic fur through applying shading and rendering on fur. Yeti plugin selected through the first step of Fur shape modeling supports shader and rendering of Vray, Renderman, 3delight, Arnold and Guerilla Render. Among them, Arnold, 3Delight and Guerilla Render are excluded from this experiment for their low utilization. Table 7 is the result from applying 3.92 million pieces of fur by using MtlHair shader of Vray and Renderman RIS shader and performing rendering. Rendering result through V-ray expresses reflection of realistic fur shading of physical based rendering on the basis of Marschner Fiber Model. Materialization method of shadow is a ray reverse tracing of raytrace[21] and it shows high calculating speed by reducing unnecessary calculation other than camera rays but compared to shadow of Renderman, it has a weakness that the materialized shadow is flatter than that of Renderman. Renderman also expresses reflection of realistic fur shading based on Marschner Fiber Model. The shadow materializing method is a bi-directional ray tracing one of path tracing and more realistic fur is materialized as PBR-based shadow expression by calculating not only camera rays but shadow rays[22]. Regarding speed, however, it requires long computing time compared to that of V-ray. Through the Fur rendering experiment as the last step, it is concluded that V-ray which swiftly materializes realistic fur shader on the basis of physical based rendering is of high appropriateness in effective fur making. Regarding the shadow expression, Renderman renderer is capable of more realistic expression but it requires long computing time, which is inappropriate for production of small-scale projects.

3.6 Findings

Among three steps for realistic fur materialization, the first Fur shape modeling is materialized through Yeti plugin that is with superb intuitiveness of fur making and that can adjust various shapes and options in grooming process. On the second Fur dynamic or animation process, movements of realistic fur are materialized based on animation of tiger creature through FX Hair by caching fur produced by Yeti and then importing as guide curve. On the last third step, rendering is conducted on a tiger through materializing translucent realistic shader through VrayMtlHair on the basis of physical based rendering of Vray. The three experimental steps for realistic and effective fur materialization can be summarized as Table 8.

4. Conclusion

Production of animal-shaped digital creature is increasing not only in movies but also in small-scale projects. Materialization of fur serves as an important factor to give each character distinctive features as well as particularly describes CG creatures more realistically. Realistic fur materialization in CG, however, requires long-term R&D and expenses, which incurs technical and financial difficulties to small studios. Thus, this study intends to materialize realistic fur of tiger creature through experimental research. For this research purpose, the study first conducts literature review on fur making using CG

and analyzes phased process for fur materialization and its feature. Second, it applies characteristics of general plugins to the three steps of ①Fur shape modeling, ②Fur dynamics or animation and ③Fur rendering as a technical method for realistic expression of fur and produces effective fur. This study approaches the experimental process of every phase in quantitative ways and analyzes the result numbers as shown in the Table 7. This study, therefore, aims to suggest an optimized method for realistic fur making of digital creature through a phased experiment. The experiment is regarded as significant for presenting possibility of applying fur expression not only in Hollywood-scale movies but also in small-scale projects.

Table 7 Using Vray shader and Renderman shader for Fur rendering

Renderer and Shader	V-ray VrayMtlHair	Renderman RIS(PxrMarschnerHair)
System	CPU: Intel Core i7-5960X 3.00GHz / Memory: 128GB / GPU: Geforce GTX 980 OS: Windows 7	
Software	Maya 2015 / Yeti v1.3.18 / V-ray for Maya 2015	Maya 2015 / Yeti v1.3.18 / Renderman 20.4
Final Output		
Features	Render Time: 1 hour 12 mins Resolution: 720p	Render Time: 15 hours 20 mins Resolution: 720p
	Fur amount: 3.92 million	
	Image Sampler Adaptive Min Subdivs: 1 Max Subdivs: 64 Threshold: 0.005	**Sampling** Max Samples: 256 Pixel Variance: 0.005
	Opaque for Shadows: Off Opaque for GI: Off	-
	GI Primary Engine: Brute Force (default settings) Secondary Engine: Light Cache (default settings)	**Integrator** Path Tracer Max Path Length: 10 Sample Mode: bxdf Light Samples: 8 Bxdf Samples: 8

Table 8 Process of experimental research

104
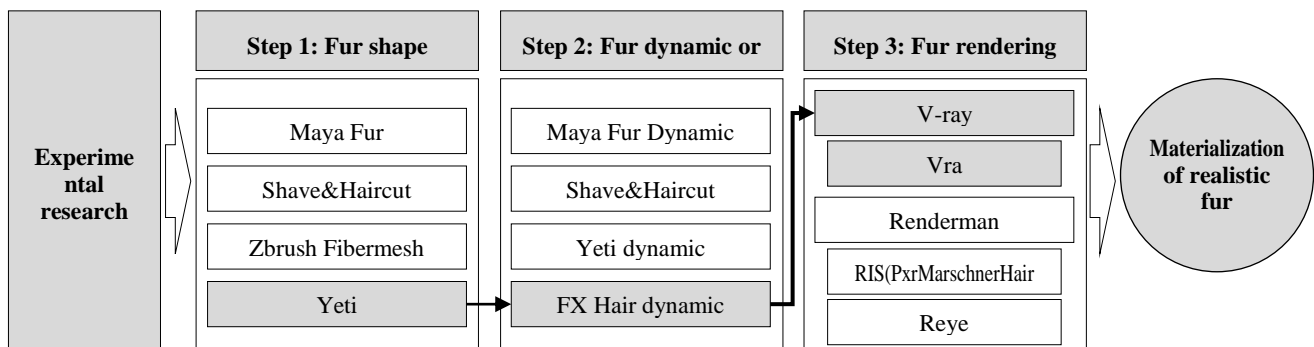
References

[1] Yoo, T., *Noble Incremental Approach for Making Furry Creature in Visual Effect Production,* PhD diss., ChungAng University, p.1, 2002.

[2] Choi, W., Yoo, T., Kim, S., Ko, H., & Kim, T., *Building Efficient Fur Pipeline for a low Cost Production of Creature-based Feature Film*, Digital Production Symposium, p.1, 2013.

[3] The visual effects pipeline.
http://www.andrew-whitehurst.net/pipeline.html

[4] Maya Fur.
https://knowledge.autodesk.com/support/maya/getting-started/caas/mne-help/us/maya/Maya_2014_GettingStarted/files/Fur-htm.html?v=2014

[5] Magnenat-Thalmann, N., Hadap, S., & Kalra, P., *State of the art in hair simulation, In International Workshop on Human Modeling and Animation*, Korea Computer Graphics Society, p.3, 2000.

[6] Park, K., *Shell & Fin based Real-time Simulation Method for Interactive Wet Fur Animation*, master's thesis, KonKuk University, p.5, 2011.

[7] Kim, H., Ban, Y., Lee, C., Nam, S., Choi, J., & Oh, J., *An Adaptive System for Effective Fur rendering*, HCI2009, p.720, 2009.

[8] Yoo, T., *Noble Incremental Approach for Making Furry Creature in Visual Effect Production,* PhD diss., ChungAng University, pp.21-22, 2002.

[9] Kajiya-Kay.
http://blog.naver.com/PostView.nhn?blogId=sorkelf&logNo=40186644136&categoryNo=40&parentCategoryNo=0&viewDate=&currentPage=1&postListTopCurrentPage=1&from=postList

[10] Kim, H., Ban, Y., Lee, C., Nam, S., Choi, J., & Oh, J., *An Adaptive System for Effective Fur rendering*, HCI2009, p.720, 2009.

[11] Yoo, T., *Noble Incremental Approach for Making Furry Creature in Visual Effect Production,* PhD diss., ChungAng University, p.10, 2002.

[12] 3D Digital Character.
http://www.dbpia.co.kr/Journal/ArticleDetail/NODE02233709

[13] Kim, H., *The use and Prospect of 3D Computer Animation,* Korean Society of Design Science, p.236, 1997.

[14] HAGAN, L. L., *Spacial Groom*, master's thesis, Texas A&M University, p.4, 2015.

[15] Normann, A., *Keys to Effectively Create Realistic Fur in Autodesk Maya*, bachelor thesis, University of Gävle, p.4, 2012.

[16] Brinkmann, R., *The art and science of digital compositing: techniques for visual effects*, animation and motion graphics 2nd Edition, Elsevier, p.6, 2008.

[17] Preston, M., Hill, M., Grooming, Animating & Rendering Fur For "King Kong", ACM SIGGRAPH Sketch, 2006.

[18] Preston, M., Hill, M., Grooming, Animating & Rendering Fur For "King Kong", ACM SIGGRAPH Sketch, 2006.

[19] Yoo, T., *Noble Incremental Approach for Making Furry Creature in Visual Effect Production,* PhD diss., ChungAng University, p.9, 2002.

[20] Marschner, S. R., Jensen, H. W., Cammarano, M., Worley, S., Hanrahan, P., *Light Scattering from Human Hair Fibers,* ACM Transactions on Graphics (TOG), Vol.22, No.3, p.780, 2003.

[21] Nikodym, T. *Ray tracing algorithm for interactive applications,* bachelor thesis, Czech Technical University in Prague. p.1, 2010.

[22] Lafortune, E. P., Willems, Y. D., *Bi-directional path tracing*, Proceedings of CompuGraphics, Vol.93, p.146, 1993.

Art Paper

International
Journal of
Asia Digital
Art & Design
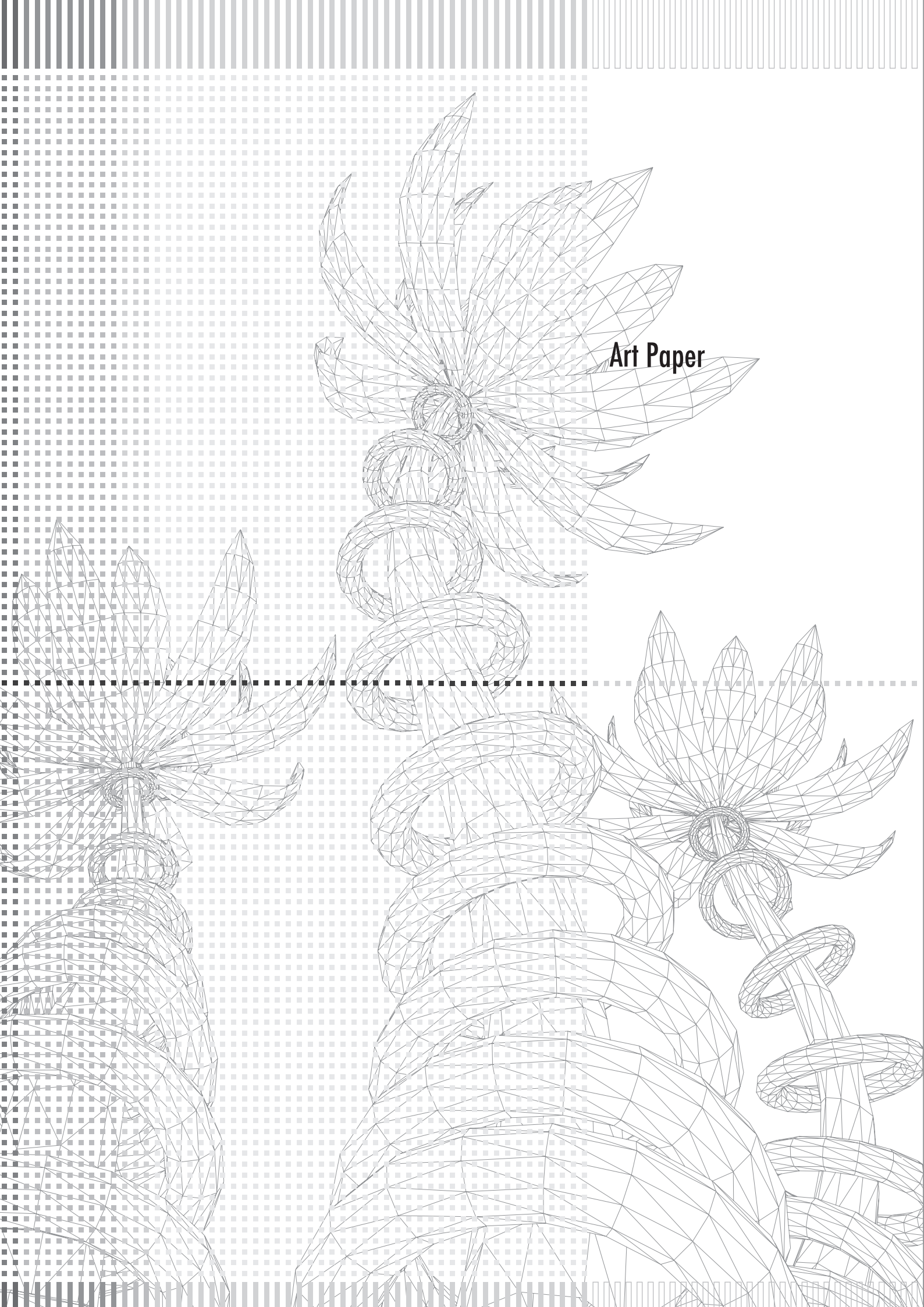
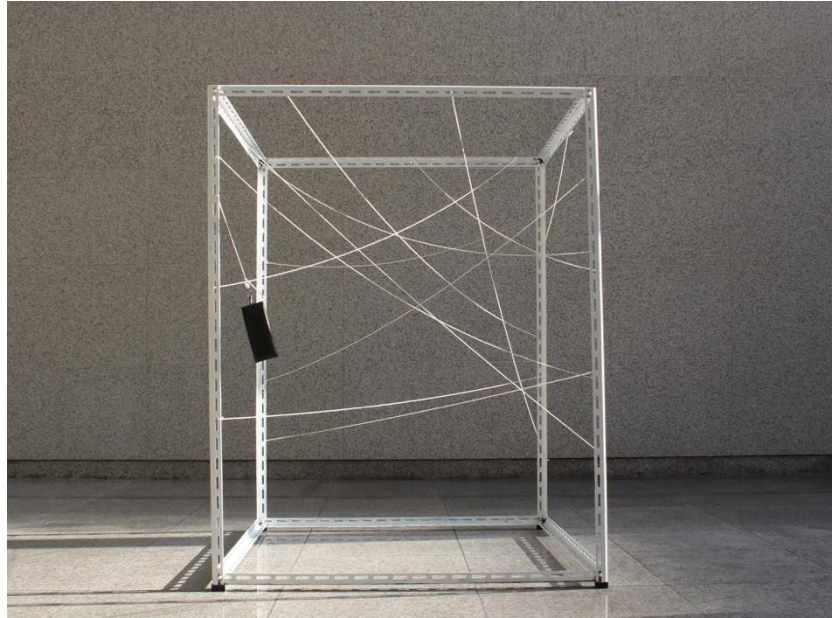Kim, Hee-Eun
Ewha Womans University
heeeun1005@gmail.com

Yang, Yoona
Ewha Womans University
yoy317@gmail.com

Lee, Yoojin
Ewha Womans University
ideeper@gmail.com

Park, Seungho
Ewha Womans University
pluxus@gmail.com

Designing Playful Metaphors in the Interactive Sound Installation

Focusing on 'Net Disruption'

Abstract
In the field of interactive media art, artists design how to make visitors voluntarily participate in their artwork. This paper discusses an idea of utilizing playful metaphors in an artwork in order for visitors to easily recognize the play and act according to the artist's intention. This paper presents an interactive sound installation 'Net Disruption' that adopted the metaphors of play including cat's cradle and musical instrument. The paper point outs the drawbacks discovered during the exhibition. It is related to the duality of the metaphors and technical issues. In the end, the study suggests a future plan that focuses on the main metaphor as cat's cradle reflecting the solution for the shortcomings.

1 Introduction

Interactive media art requires visitor's participation. It is not yet complete until visitors participate and interact with the artwork. In order to attract visitors and lead them to participate, artists often design 'affordance' as the basic concept of interaction design. According to D. Norman, designers should care about whether users perceive that some action is possible when they encounter designed objects in everyday life [1]. Furthermore, affordance can be explained by the cultural and experiential viewpoint as well. William W. Gaver insisted that affordances are intrinsically about crucial properties that they need to be perceived as any form regarding human senses. He, then,

illustrated the notion of affordances from the aspect of "culture, experience and learning". To be specific, the observer's culture, social setting, experience and intentions can influence the perception of affordances to be partially determined [2].

Therefore, affordance can primarily stimulate human senses visually, aurally, or physically. It gives a hint to a visitor what gestures to take based on human's common senses and knowledge. But most importantly, affordance can be also perceived by the person's cultural background and experience in the past. This study attempts to explain how the interactive art installation, *Net Disruption* expressed the notion of 'play' in

its form and interactions and how visitors can react to the new form of art through interactions recognizing the similar playful metaphor that the person had played in the past as young.

This study, first, explains how the installation *Net Disruption* reflects the metaphors of play as affordances such as a traditional game and musical instrument. Next, it explains how metaphors enable visitors to easily recognize what they are expected to do in order to participate in an interactive media art, in general. Then, it illustrates the technical aspects of realizing the metaphor of play in this installation. Finally, it discusses the shortcomings discovered during the exhibition and suggests improvements. In the end, the study presents the future development of this artwork, reflecting the overall improvements that can be made through the entire study.

2 The Concept of Play in 'Net Disruption'

Net Disruption is an interactive sound installation in which the form takes after the string figures of cat's cradle and presents the geometric figure made from the division of space inside. When it's played, interactions take after the gestures of playing a stringed musical instrument. This artwork can be specifically categorized as ludic interface, which is inherently "playful" interface according to HCI. It is related to the concept of humans as playful creatures, introduced in 'Homo Ludens' by Huizinga [3].

This artwork has a dual aspect of playfulness including the form and the gestures of interactions. The table below briefly explains how the metaphors of play are constructed in the form, contents, and experience of the installation (Figure 1). *Net Disruption* has two aspects of play, implying cat's cradle and a musical instrument. First, this artwork was inspired by the division of space and geometric patterns occurring during cat's cradle play. Therefore, the installation anchored the strings randomly inside the cube representing the geometric figures. Through the geometric string figures, the fundamental visual form of the artwork is constructed. The space inside is divided into different scales and disrupted when a smartphone on a string triggers sound through vibrations when it moves along with the string.
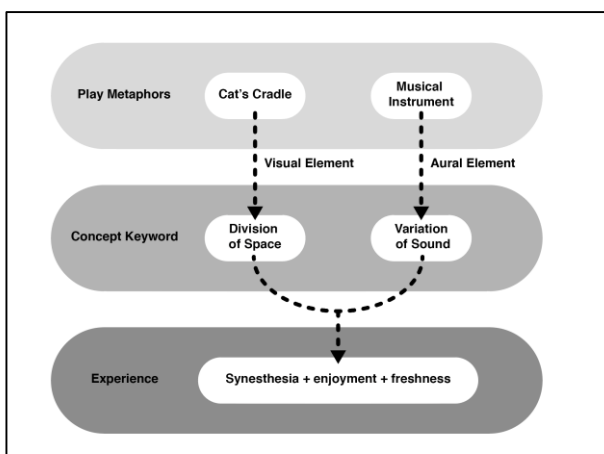
Secondly, the installation leads to the playful interactions through gestures and sound, which play the most important role to compose substantive contents of this artwork. 12 strings are anchored in *Net Disruption*. This number implies the number of major scale of music. A visitor should take certain gestures in order to make sound as an outcome. This action occurs naturally as if "all play is a voluntary activity", mentioned by Huizinga [4]. These gestures have a metaphor of plunking the strings on a stringed instrument such as Korean traditional musical instrument, Gayageum.

The visual elements of the artwork extend to the auditory elements, so that audience can experience synesthesia while the two 'play' metaphors above converge. The experience for the synesthesia refers to the new experience, a slightly different from the experience of ordinary life with enjoyment and freshness.

3 The Roles of Play Metaphors in the Interactive Media Art

In *Net Disruption*, the roles of a play metaphor are demonstrated through interactions with visitors. Play metaphors have a significant role when it comes to interacting with *Net Disruption*. The diagram below shows the influences of playful metaphor on the interactive media art (Figure 2). A metaphor can influence the form, content, and experience of an interactive art, creating new experiences through digital media technology at the same time.

When the metaphor is reflected on the form, visitors can percept more intuitively what action they need to take according to the artist's intentions. When the metaphor is reflected on the contents, visitors can catch the message of the artwork more easily. Moreover, if a visitor has an experience of playing the metaphor that is reflected on the artwork, it will be much easier and more natural for the visitor to participate and play with it. However, the experience will be different from the visitor's expectations and experience in the past, because digital technology transforms a common experience into a whole new experience. In short, these three aspects mentioned above including the form, content and experience can be all referred
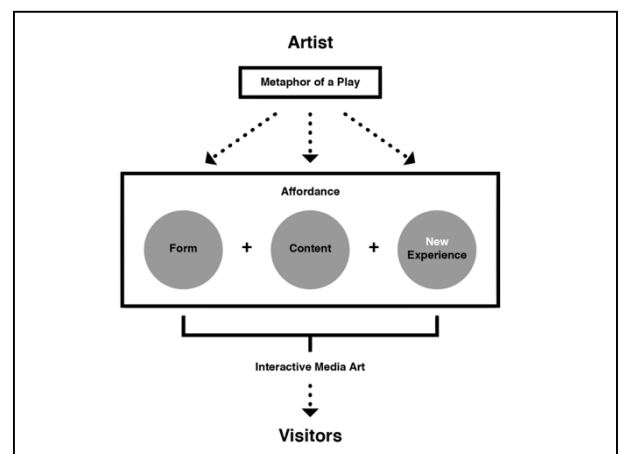

Figure 1 Conceptual Construction of 'Net Disruption'

Figure 2 Illustration of the Influences of a Metaphor

to as affordance, which lead a visitor to take a certain action. Good affordance has a form of a 'metaphor' and there appears 'logic' between the interface and a desired event as well as 'clarity' during the process of interactions [5].

As seen from the artworks below (Figure 3), a physical object such as a bicycle or a spade gives a hint to a visitor what actions to take, working as a symbolic medium for the artwork. Visitors act based on their previous experiences and knowledge of a play. Utilizing a visitor's child memory and previous experience works as a starting point of interacting with the artwork.

Figure 3 Left: Jeffrey Shaw <The Legible City>,
Right: Everyware <Oasis>

Two examples below are interactive media art installed in the public space (Figure 4). The form itself is not in any degree different from the original shape of the rides we easily find in the playground. A visitor comes and plays with it thinking of the childhood memory and experience of playing the ride. Sound and light respectively work as a creative factor that makes difference to the common experience. Convergence of the visual element of light and the aural element of sound adds amusement and freshness to a usual experience.

Figure 4 Left: Eness <A Tilt of Light>,
Right: Daily tous les jours <Balancoires>

Next, two more examples (Figure 5) are interactive media art that encourage multiple visitors to interact and participate together with the installation. These artworks work as a musical instrument or a playful ride that generate either harmonious sound or ambient sound according to the movement of the participants. Specifically, in the picture on the left, visitors move around the chairs and sit on a random chair as if they play the game 'musical chairs' and listen to the different timbre of

Figure 5 Left: Bobby Petersen <Musical Chairs>,
Right: Meret Vollenweider <Sonic Motion>

the sound each chair makes. In the picture on the right, visitors jump and climb around the bamboo structure, which is similar to the form of a jungle gym. These playful metaphors that are reflected through the form and content such as the game 'musical chairs' and a 'jungle gym' play an important role in an artwork, not only working as a cue for visitors to play their own music, but also to create melodies together with other participants [6].

In *Net Disruption*, playing cat's cradle is presented as a musical performance. The concept of cat's cradle is combined with the act of playing a stringed musical instrument. The installation works as a musical interface. When a visitor hangs a smartphone on a string and manipulates the string, the installation begins to work as a musical instrument. Through interactions, a visitor becomes a performer himself or herself creating sound. One or multiple visitors can participate at the same time and do the performance together.

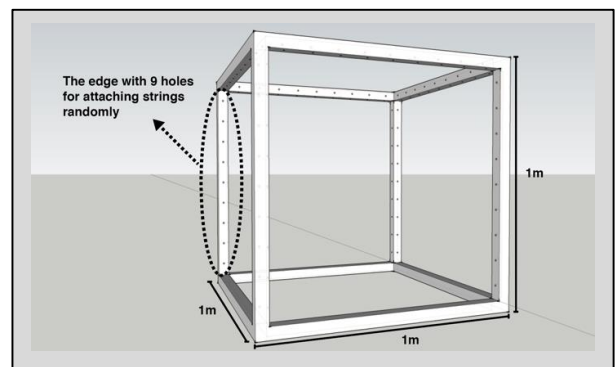## 4 The Technical Aspects of Realizing Playful Metaphors in 'Net Disruption'

Figure 6 3D Sketch of the Structure of 'Net Disruption'

Net Disruption is a cube-shaped interactive sound installation with the dimension of 1m in width, 1m in length, and 1m in height as shown in the sketch above (Figure 6). Strings are randomly attached to the edges of the cube that create different scale of spaces inside. The string patterns are the metaphor of a net and the division of the space represents disruption of a net as audience interacts and transforms the shape of the spaces inside. This division of space can be experienced from the multi-sensory perspective, including the visual elements and the aural elements as well.

The string patterns that divide space inside the cube are consistently transformed while strings are sunk down with smartphones hung on the string. As an input device, smartphones were utilized in order to send the data from the movements on the string. The computer receives data from the smartphones and transforms the data into sound according to the mapping strategy. Therefore, a special case for smartphones was necessary to make a smartphone freely move along with the string. The case was created through the 3D printer. It protects a smartphone and enables a smartphone to move
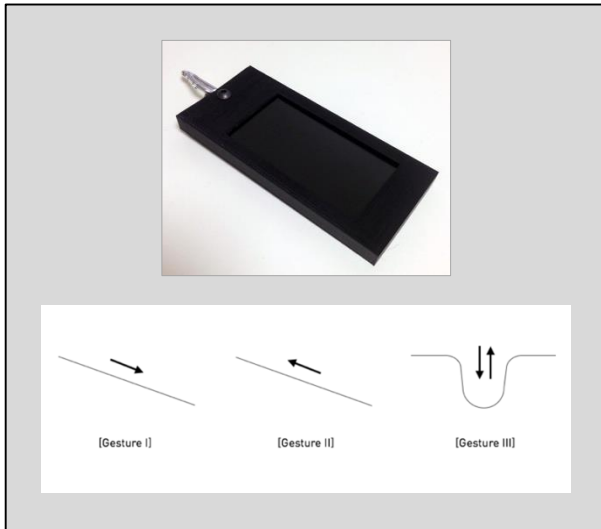
Figure 7 Top: Case for Smartphones,
Bottom: Three Gestures to Play with the Installation

smoothly on the string (Figure 7). There are mainly three gestures that the visitors can take in order to make sounds as the illustration on the bottom of the figure (Figure 7). Visitors can simply slide a smartphone along with the string, lift it or shake the string. When a smartphone is stuck at the middle of the string, the variations of sounds are made which lead to the variations of spaces as it visually and aurally disrupts the different scale of spaces inside. The pieces of the space divided by the strings are expanded or reduced by the gestures of audience.

Sound mapping was done through programs including OpenFrameworks, Xcode, Max/MSP and Logic Pro X. OpenFrameworks and Xcode were used to receive data from the sensors of a smartphone including the compass and the accelerometer. Xcode sends raw data from the sensors to the mapping in Max/MSP to transform the data into sound. Specifically, the data from the compass sensor is transformed into the pitch of sound. The range of the raw data from compass sensor is from 0 to 360 degree. The degree of data constantly goes up and down. Therefore, a compass sensor was considered to be appropriate for controlling the pitch of sound, which can make sound variations from low to high constantly. X, Y, Z values from the accelerometer sensor control loudness of sound. Logic Pro X software was used in order to transform pure sound
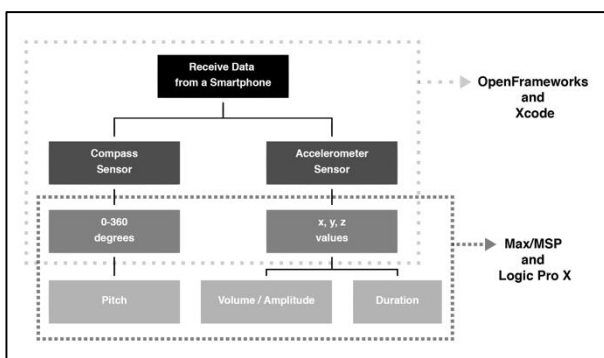

Figure 8 Structure of Sound Mapping Algorithm

wave into MIDI bell sound. The diagram above illustrates how the sound mapping algorithm works (Figure 8).

In addition, the accelerometer sensor was used to create an event to make variations of sound. Data coming from Z-axis value have much greater variations than that from X or Y-axis values when a visitor shakes or lift up the string. Therefore, Z value was used to create an event that generates sound with higher amplitude and duration instantaneously when visitors vigorously lift or shake the string. In this way, when there are big changes in data, it creates random sound and adds to the coincidences of the play. On the other hand, X and Y values were used to generate certain range of sound continuously. The sound mapping strategy for *Net Disruption* is shown as the source code from Max/MSP (Figure 9).
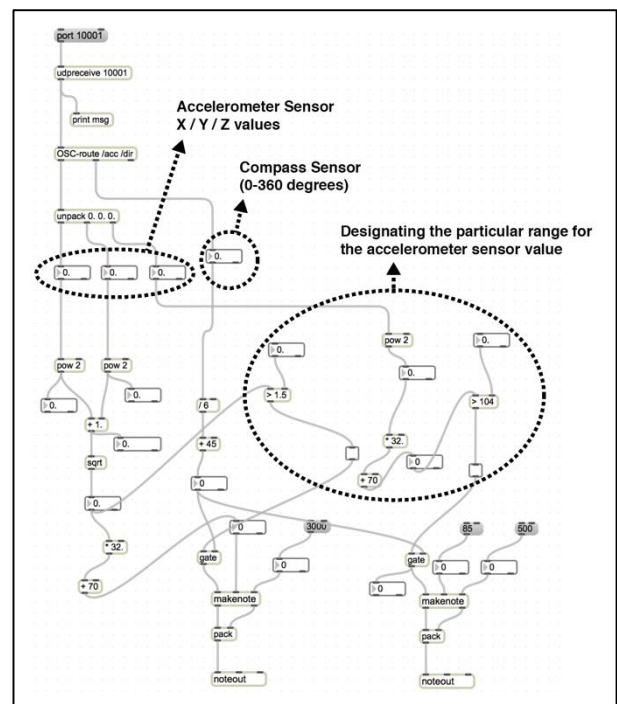

Figure 9 Source Code of Sound Mapping

5 Exhibition and Evaluation

Net Disruption was selected to have a showcase during the FutureEverything Festival held in Manchester City Hall, UK in February 2015. During the conference, *Net Disruption* was introduced as 'Interactive Art Performance' for the installation shows its interface as a musical instrument. Through performance, visitors learned how to interact with the installation and played with it after the presentation. Pictures above describe how visitors interacted with the installation and participated in the performance (Figure 10).

Visitors shook a string with one hand, while pressing it with the other hand as if playing an instrument. Usually, two people participated at the same time and played together. The way of playing with the installation varied depending on each person. In the meanwhile, there were some feedbacks from the visitors related to the sound of the artwork. Some visitors recommended

Figure 10 'Net Disruption', Showcase in City Hall, Manchester

for the artwork to be a more delicate musical instrument that can control volume and pitch more freely as if a traditional musical instrument produces sound with controllers.

There were some shortcomings discovered during the exhibition as in the following. One of the prominent weaknesses was that there was a collision between the two different metaphors of 'play', which were cat's cradle and playing a musical instrument. Due to the duality of 'play' metaphors that are reflected on the installation, metaphors of the play overlapped and didn't work properly as clear affordances. The form of the installation reflected the concept of space division from cat's cradle play. The interaction reflected the metaphor of playing an instrument. There should have been one single integrated metaphor that has a main metaphor and sub metaphors that support the main metaphor. Thus, there could have been a clearer distinction between the main and sub metaphors, which indicate certain actions visitors mainly have to do in order to participate.

Another shortcoming related to the technological issues was that the installation didn't work properly as a musical instrument. Since the installation was presented as a musical performance before audience, visitors might have expected an elaborate musical instrument that enables them to control pitch and volume of sound more freely and easily. For instance, 12 strings that are attached to the artwork could have been analyzed by the different degrees and applied more delicate sound mapping that allow visitors to play the installation as a traditional musical instrument.

6 Moving Forward

In order for this artwork to properly provide affordances to visitors, it needs to have more delicate work as a musical instrument or as a cat's cradle play. It has to have a clear identification of which play to reflect as interactions. Therefore, the future plan of this work will be reflecting the motions of cat's cradle for the interactions as well. Furthermore, detailed sound mapping should be applied to the installation in order for visitors to freely and easily control the elements of sound.

The future plan of *Net Disruption* is illustrated in the sketch (Figure 11). *Net Disruption* anchored strings in the cube, which clearly worked as the visual element. Besides, the smartphone swinging through the movement of the strings stood out as the visual object. However, hands and thread are the visual objects

while generating geometric patterns and interaction between players in the real cat's cradle play. Thus, the cube frame and the smartphone can be the serious impediments to form refined interface which leads visitors' interaction of the play metaphor concerning on the cat's cradle in this artwork. Therefore, in this future plan, small-sized accelerometer sensors, compass sensors, and speakers will be directly utilized, hanging on strings, not as the components of a smartphone. In addition, visitors will control strings more freely with their hands out of a solid frame. Instead of a fixed cube-frame, a pivot will exist in the middle linking 12 strings. Each string has a hole on the edge in order for visitors to put their fingers inside and then move the string. It will give a few options for visitors. A visitor will be able to play alone with the new instrument because holding different strings by using one finger. Also, multiple visitors can play together with the instrument since they can hold each string. It will allow visitors to act as playing cat's cradle not only by oneself, but also with others. This way of playing with the artwork by visitors will make more diverse visual patterns as well as various sounds in the artwork.

Furthermore, in order to make this artwork more elaborate musical instrument, sound with a continuous scale has to occur
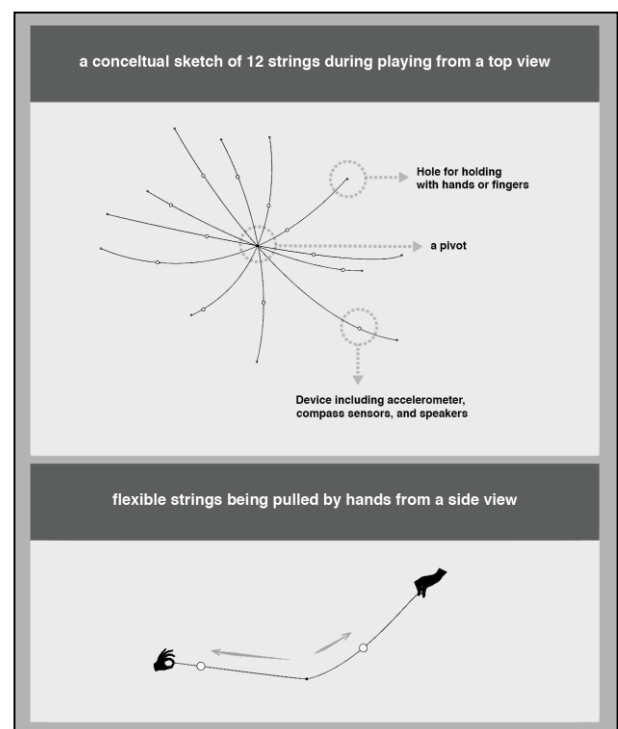

Figure 11 Future plan of 'Net Disruption'

while pitch and volume change if there is movement at any time. Therefore, in the developed version of *Net Disruption*, 12 strings will be mapped to each musical note in major scale. Also, the strings will be replaced by the more flexible material, for example an elastic band so that the movement of strings with each particular scale will have much more unconstrained changes. According as moving the flexible string up and down, left and right or transforming the string to be shorter or longer, the accelerometer and compass sensor will detect the large or small variation of the string. The change of the value from the accelerometer data will be mapped on the variation of the volume. Moreover, the change of the degree from the compass sensor will be mapped on the alteration of the octave for each note. Consequently, the more various sounds will be created.

7 Conclusion

This study investigated 'Play metaphor' which gives an opportunity to visitors to experience newness and familiarity simultaneously, evoking the previous memory from childhood or past experience with amusement. Interactive sound installation *Net Disruption,* proposed in the paper, tried to imply the metaphor of playing an instrument with the concept of division of space, disrupting the net visually and aurally. It first started as cat's cradle, which almost everyone played as a child, especially girls. The concept influenced on the formation of the installation. For interacting with the artwork, another playful metaphor, which is playing a stringed musical instrument, was adopted. Therefore, there were some collisions between the form of the installation and the approach to play with the installation.

In order to solve the problem, a single integrated metaphor and the structure of the main and sub metaphors were adopted in the future plan. Cat's cradle works as a main metaphor and sub metaphor is a stringed musical instrument. It can control pitch and volume of sound freely like playing a traditional musical instrument.

Therefore, the future plan for this artwork emphasizes the motions of playing cat's cradle with multiple people for interactions. Furthermore, sound mapping will be developed in order to allow visitors to freely and easily control the elements of sound including pitch and volume by just playing with the strings. Eventually, the installation will more strongly and intuitively give hints to visitors what they are expected to do through the form and interactions of the artwork that reflect cat's cradle as one single integrated metaphor.

References

[1] Norman, D., *Affordances and Design,* http://www.jnd.org/dn.mss/affordances_and.html

[2] Gaver, W. W., *Technology affordances*, Proceedings of the SIGCHI conference on Human factors in computing systems. ACM, pp. 79-84, 1991.

[3] Huizinga, J., *Homo Ludens: A study of the play-element in culture*. Boston: The Beacon Press, 1950.

[4] Huizinga, J., *Homo Ludens: A study of the play-element in culture,* Routledge and Kegan Paul, 1949.

[5] Kim, D. H., Yi, M. J., Park, S. H., *Affordance for Interactive Media Art*, Digital Design Studies, Vol. 8, No. 2, pp. 341-348, 2008.

[6] Peter, B. http://www.bobbypetersen.com/