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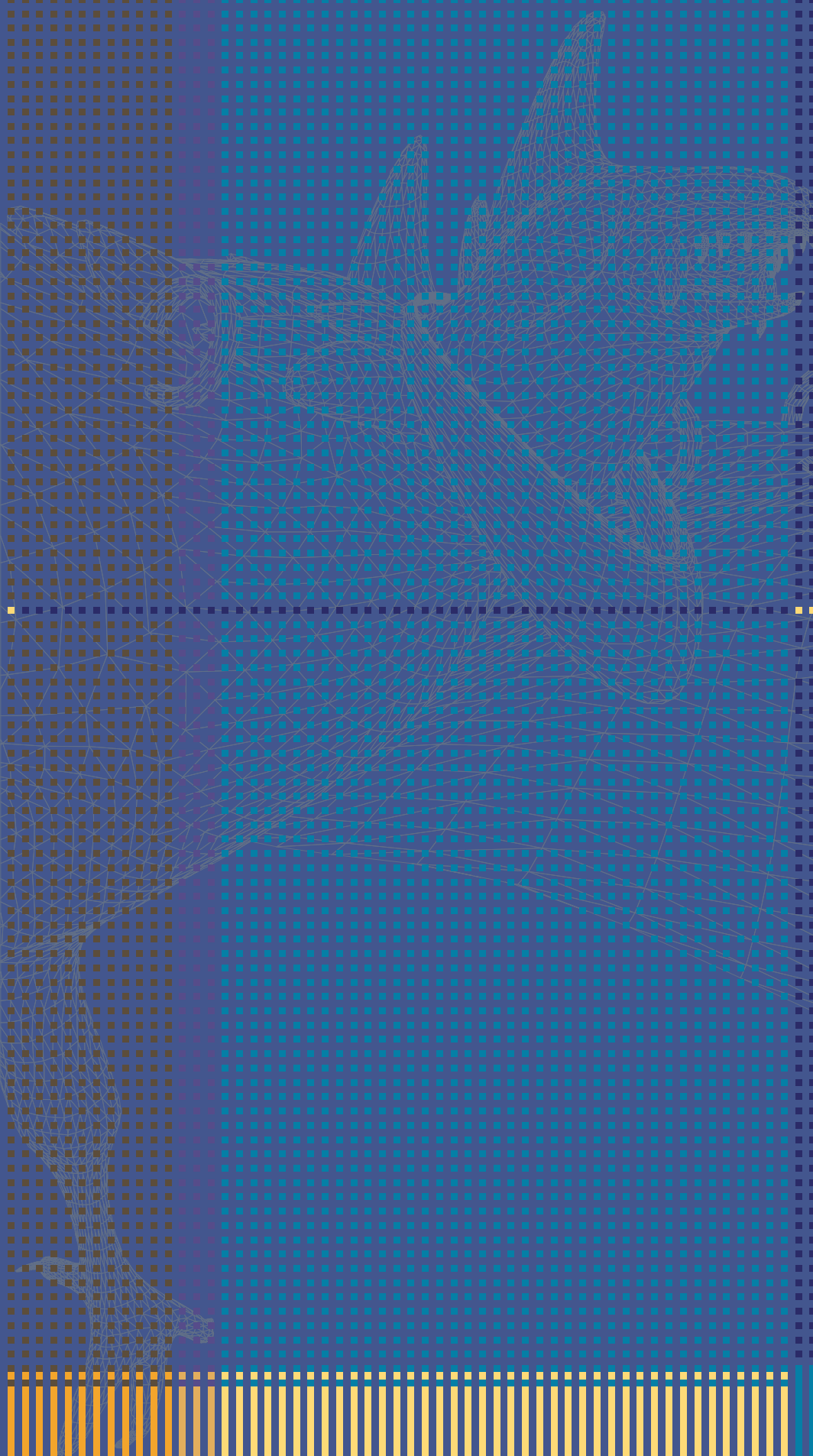

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Contents

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

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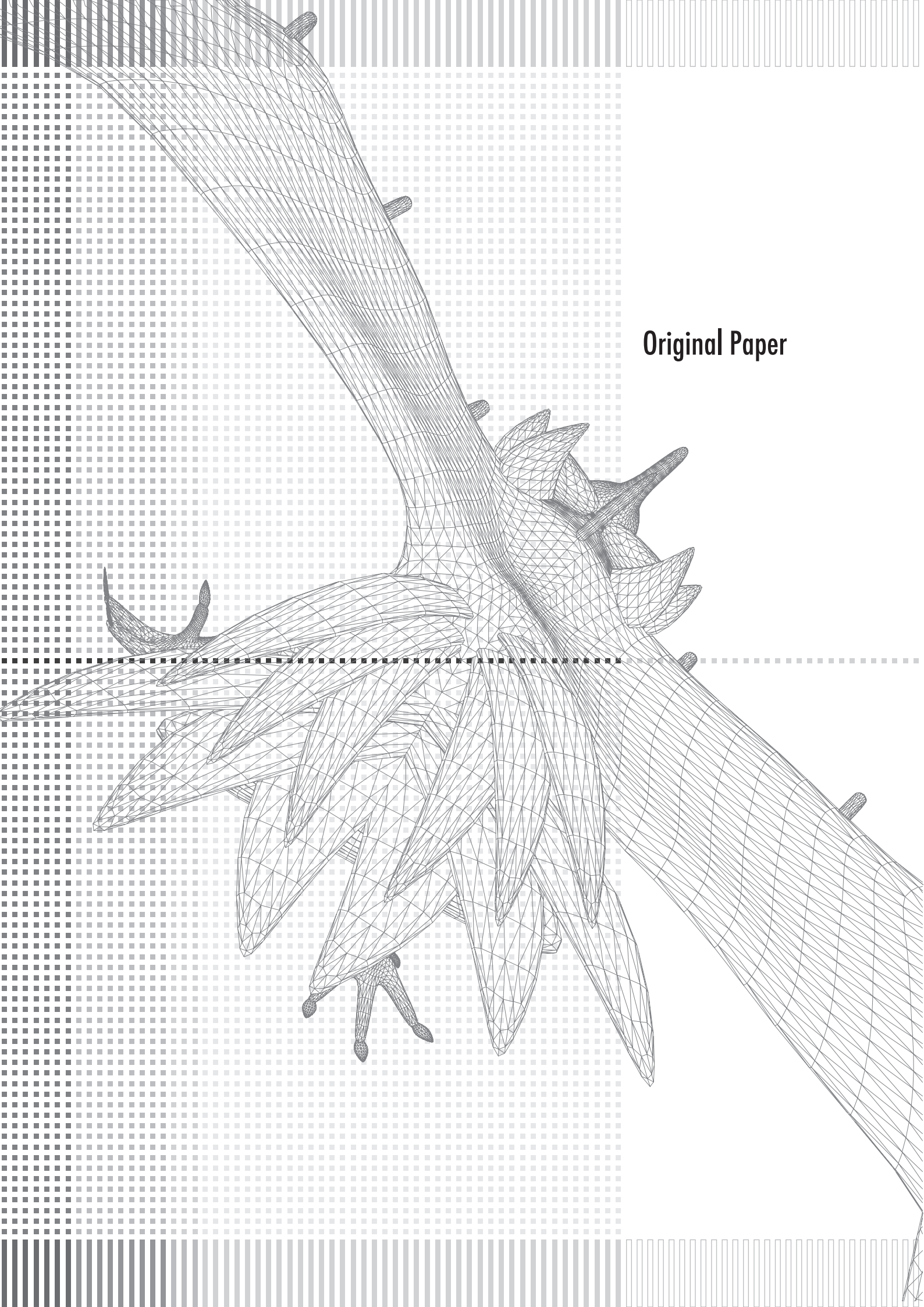

Original Paper

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Affective Agent Interface Design

Development of a Multi-agent Website with Affective Interfaces for Language Practice

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Abstract
This research intends to design better agent interfaces for users to enable superior interaction during language practice. Subsequent to previous two surveys [1][2] that investigated the affective feelings of users towards different agent interfaces, the outcomes that resulted from the two surveys have been adopted in conjunction with some existing guidelines in order to develop this multi-agent website. The development of this multi-agent website for inexperienced English learners has been developed with respect to the research results of the previous two surveys [1][2]. These results include the preferred agent interface design for language learners and the facial expressions of agents that attract users to engage in the learning tasks. Therefore, this is a website designed with preferred agent interfaces that is likely to attract users to further their engagement in the language practice tasks. The website also incorporates ten characters equipped with six basic expressions as well as one neutral face, and these were created as CompanionBots.
Moreover, this website provides some significant design, computer science and psychological challenges in terms of agent character design (user impression in a learning task), agent emotional expression design (evoking users' affective responses), the Emotional Keyword Filter (emotional keywords lead to agent expression exchanges), device compatibility (suitable use on computers and smart mobile devices) and the IELTS (International English Language Testing System)-Bot (designed for IELTS rehearsal use). In truth, this website has been devices via certain computer science techniques and psychological theories. Also, this website intends to implement these design guidelines into practical use in order to develop better agent interfaces.

Keywords: Affective Agent Interface, Embodied Conversational Agents (ECAs), Facial Expressions of Agent

1 Introduction

This research investigates the affective interfaces of embodied conversational agents (ECAs), and this website aims to provide a platform for improved design-agent interfaces and enable improved interactions between users and the ECAs. The previous two surveys [1][2] established that ECAs interfaces could alter users' affective states through hardware interfaces and character classifications. This website adopted existing guidelines and outcomes from these two surveys [1][2] to design better interfaces for users to enhance engagement during human-computer interactions (HCIs), such as more preferred characters for CompanionBots, vivid and exaggerated facial expressions of CompanionBots, themed backgrounds for language practice, tips for trigger specific functions and rearranged positions for more obvious display of character faces. In addition to applying these aspects to designing improved interfaces, this website also adjusted some functions from the previous two surveys [1][2] in order to ameliorate assistance to inexperienced English learners during language practice.

2 Background

This study concerns human feelings when they interact with computational agents that are represented by visual characters, and these are regarded as affective factors. Computational agents that interact with humans through natural language with embodied characters are referred to as ECAs, and these are one type of anthropomorphic agents. ECAs consist of a combination of embodied agents and natural language processing (NLP). As a consequence, humans interact with computational devices that are represented by ECAs by means of a natural and intuitive manner, and this enables easy communication via natural language and gestures. With developments in computer technology and advancements in computer graphics, ECAs are expected to be increasingly employed in HCIs, in which affective interfaces of ECAs play a critical role, and these are regarded as affective agent interfaces.

Researchers have advanced these developments, most noticeably in the past two decades, in terms of their functional and operational speed. One of the most common areas of contemporary research has been the visual representation of agents. This interest may derive from humans' first impressions of intelligent agents typically being by way of their visual representations. However, the question remains as to what extent the appearance of these agent characters is

likely to determine the quality of the computer user's interactions.

An agent interface is an intelligent agent that is represented by one type of visible interface, and users are able to communicate with the agent through the interface [3]. In a situation where visible interfaces are symbolised in graphic user interface (GUI) forms, these visual representations are mostly anthropomorphic characters [4].

In order to improve HCI performance towards human-human interactions, computers are required to possess more human-like capabilities [5]. For example, computers are represented by visual characters as well as being designed with emotional facial expressions in order to express thoughts and communicate with humans naturally. Anthropomorphic agents generally are the computer systems displayed in human forms, and are also a type of affective computing.

According to Russell [6], affect as classified by psychologists generally covers feelings and emotions. As a result, it is patently clear that affect is intimately involved with human emotions. Humans are not entirely rational or logical beings, given that feelings, moods, emotions, and other types of affective factors have a significant influence on people's thoughts and behaviours.

Affective factors not only affect humans in terms of their behaviour and thoughts, as they are also affected by external objects, events and other individuals. Norman [7] suggested that "pleasing things work better", given users are attracted by beautiful products and express greater willingness to use those products. In fact, even a single external objective event can clearly alter humans' affective states [6]. These represent some of the reasons why Zhang and Li [8] pointed out that utility and accessibility were not the only factors that IT designers should pay attention to, as affective factors should be given due consideration.

In summary, according to the above studies, it is not particularly problematic to establish that the appearance and expressive manner of agents affect humans. However, limited research has focused on the visual form of agents. Gulz and Haake [9] addressed two possible explanations as to why visual appearance is commonly neglected in research on embodied agents, given "it cannot be readily approached with existing research methodology" and "the influence of look on emotional and intellectual processes is not readily accepted, although empirically well established". In addition, a paucity of investigations have been conducted on affective interfaces with agents. However, agent interfaces continue to play a significant role in user engagement and overall feelings. As a result, designers and researchers should grant additional attention to improving design of the interfaces with ECAs.

3 Emotional Expressions of CompanionBots

During HCIs, emotions play an essential role in the design of the agent interface [13] as humans interact with computers as though they were social actors [14]. Furthermore, emotion is an important element to develop the credibility of intelligent agents interacting with humans [15][16]. According to [13], agents need an emotional model to express their emotions. In truth, agents are also likely to need to able to detect the emotional mode of users, although this aspect does not form the focus of this study.

It is widely known that body language, including gestures, facial expressions and body movements, is an essential component of emotional human-computer interactions. This study only addresses emotional facial expressions for ECAs because facial expressions provide natural and constant feedback regarding the status of the communication to users and therefore plays a critical role in the design of agent interfaces [13][15]. Additionally, it has been demonstrated that agents with social facial expressions, such as smiling, are able to trigger some human brain regions to improve HCIs into human-human interactions [17].

In terms of the emotional categories of facial expressions, Ortony, Clore and Collins [11] have established the OCC model as the standard model for emotion synthesis. The OCC model categorises various emotional categories based on positive or negative reactions to events, actions and objects. In fact, 22 emotional categories have been classified in the model and therefore the model offers a sufficient level of complexity and detail to cover most situations an emotional intelligent agent might have to tackle.

As a result of these capabilities, numerous pieces of research have adopted the OCC model to generate emotions for their intelligent agents. Nevertheless, it is problematic for intelligent agents to present 22 different emotions when they interact with humans because agents do not possess the ability to express 22 different emotions clearly and identifiably on their faces. Hence, Ortony [18] acknowledges that the OCC model might be too complex for an emotional agent. These limitations led to the creation of ten emotional categories that consist of five positive categories (joy, hope, relief, pride, gratitude and love) and five negative categories (distress, fear, disappointment remorse, anger and hate) for developing emotional agents.

Although this shortened categorisation may facilitate emotional expression, ten emotional categories may remain an excessive amount for an agent to convey individual emotion clearly. As a consequence, a significant amount of studies have applied the Ekman, Friesen and Ellsworth's [12] six basic emotions to develop their emotional agents. Fridlund, Ekman and Oster [19] reaffirmed these six basic emotions. The six basic emotions (anger, happiness, fear, surprise, disgust and sadness) can be communicated efficiently and recognised across a number of cultures [20]. These six emotions can be distinguished from other emotions, although fear and surprise are not always capable of being distinguished from each other [21]. Accordingly, CompanionBots in this website adopted these six basic emotions to design their facial expressions.

In fact, exaggerated expressions of characters are necessary to elicit powerful emotional responses from audiences [22]. In addition to the exaggerated facial expressions of agents, Baylor and Ryu [23] discovered that animation is beneficial for pedagogical agents. Lee and Nass [24] demonstrated that animated agents are more attractive and trustworthy than stick images and text boxes. Each CompanionBots possesses seven different facial expressions, including one neutral face and six basic emotional faces exhibiting anger, happiness, fear, surprise, disgust and sadness. The facial expression design also adopts exaggeration and animation as the design guidelines.

Similar to the previous two surveys [1][2], the Emotional Keyword Filter has also been applied in this website to generate the exchange of the CompanionBot expressions. These ten CompanionBots alter their emotional expressions based on emotional keywords. The emotional keyword filter program has been developed for this multi-agent website in order to alter facial expressions of the CompanionBots during the keyboard conversations. In truth, the emotional keyword filter program detects the textual responses of CompanionBots and then modifies the emotional expressions of the CompanionBots.

4 Requirements and Specifications

The requirements and specifications in this section have been categorised into the user and the client-server architecture. The client-server architecture is classified as the client (the front-end of the website), designed to be as simple, reliable and light-weight as possible (regarding to user system resources), and the server (the back-end of the website), which is used to store the source code and perform dialogue handlings. Additionally, the observable content (e.g. page layouts and agent interfaces) is referred to as the front-end, which works on the Windows Server 2003 operating system with Microsoft MSSQL Server 2005 Express Edition and .Net Framework 2.0. In fact, the back-end comprises three AIML-Bot format files that process the textual output to the front-end operations under the Windows Server 2003 operating system.

The website facilitates user to browse via their choice of web browsers, including Internet Explorer, Firefox, Safari and Chrome by means of computers or smart mobile devices. The optimal screen resolution available for the website is 1280x800, albeit it remains compatible for other screen resolutions. For higher screen resolution (such as computers equipped with larger screens), extendable backgrounds ensure that the observable content remains in the centre of the screens. In the case of poor screen resolution (for example portable devices equipped with smaller screens), devices are able to adjust the best browser resolution through a zoom-in or zoom-out function. Thus, users have the capacity to adjust their browser resolutions to fit better recognisable presence when they utilise portable devices to browse this website.

5 System Architecture and Interface Design

In the back-end, the conversational database contains three AIML-Bots, namely the IELTS-Bot, the PI-Bot and the AAA-Bots. In fact, the IELTS-Bot was developed for [2] to allow subjects to prepare for the IELTS speaking test online. This website also adopted the IELTS-Bots as the conversational database for users to practice sample IELTS speaking tests. Additionally, the PI-Bot was designed for the CompanionBots in the character interface experiment to respond to some questions in relation to the personal information of the CompanionBots. The Annotated ALICE AIML Files (AAA Files, named AAA-Bots in this research) is a revised version of the free ALICE source. In reality, the AAA Files contain 59 AIML that are mostly compatible with all AIML 1.01 compliant software. The AAA is specifically reorganised to facilitate BotMasters to clone ALICE's brain and create customised bot personalities, without having to expend much effort in editing the original ALICE content [10].

The chat flow of CompanionBots is depicted in Figure 1. In the textual response phase, users input sentences in the conversational user interface. In fact, the IELTS-Bot will generate a response according to the sentence that subjects input if the sentence is related to the knowledge of IELTS speaking test. Alternatively, PI-Bot will answer the question if the sentence concerns personal information about the CompanionBots. In all other circumstances, the AAA-Bots will answer other general questions or generate a random response. In addition, the AAA-Bots adopted in this website is a revised version of the free ALICE source that has been adopted to generate a textual response excluding personal information and IELTS specific knowledge. Subsequent to generating a textual response, the 'Emotional Keyword Filter' selects one facial expression according to the textual response. Finally, both the textual response and facial expression are displayed in the conversational user interface in order to elicit further responses from users.

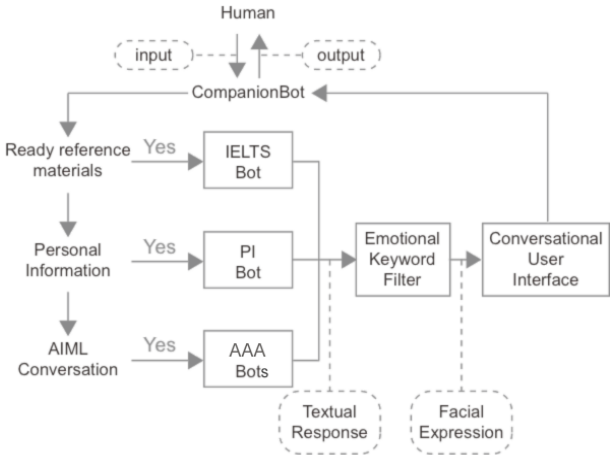

Figure 1 The chat flow of the CompanionBots.

The content of the website has been segmented into three

distinct categories, namely chatting with CompanionBots, Emotional agents and Experiments. In the Chatting with CompanionBots category, three character classification pages exist, namely the human classification page, the animal classification page and the creative creature classification page. In reality, each character classification page contains two to four CompanionBots for users to select for augmented language practice. Additionally, when users click any CompanionBot in the character classification page, the webpage links to one chatting page and users may have more keyboard conversations with the CompanionBots on the chatting page. Furthermore, in the Emotional agents category, all the animated facial expressions of the CompanionBots are listed in the Emotions of CompanionBots page while evaluation of agent facial expressions from the OCC mode's 22 emotions [11] to the six basic emotions [12] are provided in the Evaluation of agent emotions page. Similarly, all the emotional keywords that initiate a change of expression for the CompanionBots are shown on the Emotional keywords page. In the Experiments category, the aims, variables, procedures and results of both the previous surveys [1][2] are addressed in the Hardware interface experiment and Character interface experiment pages.

This website was designed for inexperienced English learners to practice language online, and the interactions between users and agents formed a vital component tested through the learning tasks. Therefore, the website interface was designed to stimulate a study environment, such as the inclusion of a book to present learning content, vocabulary cards by the side, and a cup of coffee on the table. In terms of the interface structure of this website (see Figure 2), every webpage featured the website title, which allows users to navigate to the homepage of the site. This feature is situated at the top of the page, while a copyright announcement is located at the bottom of each webpage. Furthermore, three tags are positioned on the right fringe of the book. In fact, users have the ability to rapidly link to the three character classification pages via these three tags. Similarly, the Home tag, on the left fringe of the book, provides users with a link to the homepage by clicking the Home tag.

Figure 2 Interface structure of the multi-agent website.

Figure 3 indicates the conversational user interface page of this website. In truth, this interface is an enhanced version of the conversational user interface of the previous survey [2]. Moving the input frame next to the characters' facial expressions, and users are likely to pay more attention to the exchange of emotional expressions. Additionally, adding textual input tips, including the IELTS-Bot sample question in the input frame and the emotional exchange tips in the left-bottom corner, in the interface to remind users to operate these utilities effectively.

Figure 3 The conversational user interface page.

6 Implications

This multi-agent website applied numerous design guidelines from the existing interface design and some results from previous experiments [1][2]. This website combined AI techniques, affective factor design for language learning and affective interface design to develop learning companion agents for novice English learners in order to practice their language skills online.

In fact, several lessons can be learned from this research that are applicable to the practical, sociological and research dimensions of building affective interfaces of ECAs.

Practical implications include implications for human-computer interface design and experimental design. One of the most intriguing findings from these experiments concerns the implications for interface design, which discovered that following just a brief introduction all subjects managed to utilise the agent interfaces without any problems, possibly due to the popularity of instant messaging (IM) and intuitive usage of natural language. Another important lesson is that, while realism and aesthetics are highly prized in the interface design of ECAs, character classification representations and emotional expressions of ECAs are similarly important for keeping users engaged with their tasks. Additionally, this study has shown that ECAs with affective interfaces may provide a positive role in terms of socialisation. In fact, ECAs with affective interfaces have the potential to provide virtual social support when users lack real social support, such as experienced when in a foreign country. Some positive impacts of ECAs exist in socialisation just like real humans attempting to capture someone's attention [25], and according to the old maxim: 'better a little fire to warm us than a great one to burn us'. ECAs with affective interfaces might be able to satisfy users with psychological support. However, other sociological concerns are that if users rely excessively on these agents for the virtual social support and learning company, this may decrease individuals' social skills. This underscores the need to ensure that ECAs with affective

interfaces are as rich as possible, and used carefully [26].

In the psychological area, ECA affective interfaces have shown that applying psychology to technology in order to create computers that appear more human. In terms of the design aspect, this research demonstrates the original intention of most designers, designing better products for users, also known as user-centred design, remains critical.

7 Discussion

A reasonable amount of work has been conducted over the past few years on models of agent interfaces and affective factors. However, minimal studies have been applied to the understanding and modelling of the affective interfaces of ECAs during learning tasks. As a consequence, this study represents an underrepresented field of study addressing the affective influences of ECAs when ECAs are represented by various character classifications in language practice tasks.

In terms of AI, complex real-time dialogue is not necessary for small talk between HCIs, although it is crucial for conversation practice in language practice tasks. More than 50 dialogue-planning files seemed insufficient for English experts to process English conversations. In truth, the complexity of dialogue planning should be designed based on the content and purpose that the ECAs intend to perform.

In relation to learning, one feature of ECAs requiring consideration is the application of correct information for successfully completing the learning tasks. Another dilemma involves the provision of sufficient information based on the content and purpose of the learning tasks. In this field, users typically interact with agents in the learning tasks in order to absorb specific knowledge, thus, the information that agents provide should be beneficial for the users as well as being correct and current. Furthermore, sufficient information related to learning topics is essential for agents to effectively interact with users during the learning processes and attract users to engage in the tasks.

In terms of ethical concerns, the affective interfaces of ECAs, as with any technology, have the potential to be abused. ECAs that are represented by affective interfaces may earn users' trust during the interactions, which may lead to some prospective ethical problems. One major worry is that personal confidential information may be released to these ECAs. This is a vital issue, given that after a period of interactions, users generally believe agents because agents are computers that, unlike humans, resist gossip with others. However, if agents release any of the users' personal data for improper or commercial purposes, this is likely to cause a series of ethical conundrums. In addition, the trust towards agents might be misused by scammers or marketers. For example, when users ask for product suggestions, agents might be programmed to provide biased information, resulting in reduced user trust towards agents. It is exceptionally important for agents to earn users' trust and any type of abuse, such as user trust, is unethical.

A final issue emanating from this study is the judicious employment of the affective influences of agent interfaces. The affective interfaces of ECAs are designed to gain positive affective influences on users, and it is against the purpose of affective interfaces of agents if the agents intentionally alter the affective states of users and further damage their learning outcomes. In fact, the aim of agents in the learning tasks is to assist users. That said, the appropriate use of affective influences of agents on users should be carefully considered.

In this research, ECAs were designed as learning companions, albeit ECAs in learning tasks may also be suited as all-purpose learning assistants and intelligent personal tutors. Furthermore, researchers and designers might be interested in some issues in relation to learning interactions and outcomes, which were affected by different mission-carried agents as well as some subjects of further affective alterations of humans during HCIs in the course of undertaking learning tasks.

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References

[1] Hsu, Y.-C., *Affective Influences of Chatbots: Comparing a Computer Chatbot to a Portable Device Chatbot.* Proceedings of the Asia-Pacific Conference on Technology Enhanced Learning 2010 (TFTA-01). Osaka. Japan, 2010, September 24-26.

[2] Hsu, Y.-C., *Affective Interfaces of Embodied Conversational Agents: A Study of Character Interfaces.* Proceedings of the International Conference on Kansei Engineering and Emotion Research 2012 (KEER 2012). Penghu. Taiwan, 2012, May 22-25.

[3] Shneiderman, B., & Maes, P., *Direct manipulation vs. interface agents*. Interactions, 42-61, 1997.

[4] Laurel, B., *Interface Agent: Metaphors with Character*. In B. Laurel, The Art of Human-Computer Interface Design (pp. 355-365). The United States of America: Apple Computer, 1990.

[5] Geven, A., Schrammel, J., & Tschelig, M., *Interacting with Embodied Agents that can see: How Vision-Enabled Agents can assist in Spatial Tasks.* NordiCHI , pp. 135-144, 2006, October 14-18.

[6] Russell, J., *Core affect and the psychological construction of emotion.* Psychological Review, 110, 145-172, 2003.

[7] Norman, D., *Emotion & design: attractive things work better.* Interactions, 9 (4), 36-42, 2002.

[8] Zhang, P., & Li, N., *The importance of affective quality.* Communications of the ACM, 48 (9), 105-108, 2005.

[9] Gulz, A., & Haake, M., *Design of animated pedagogical agents - A look at their look.* International Journal of Human-Computer Studies, 64 (4), 322-339,

2006.
[10] Wallace, R., *The Annotated A.L.I.C.E. AIML* [Fact Sheet]. Retrieved March 17, 2010, from A.L.I.C.E. Artificial Intelligence Foundation: http://www.alicebot.org/aiml/aaa/, 2007, January 02.
[11] Ortony, A., Clore, G., & Collins, A., *The cognitive structure of emotions* (Paperback Ed.). Cambridge, UK: Cambridge University Press, 1990.
[12] Ekman, P., Friesen, W., & Ellsworth, P., *Emotion and the Human Face: Guidelines for Research and an Integration of Findings.* New York, NY: Pergamon Press, 1972.
[13] Picard, R. W., *Affective Computing*. Cambridge, MA: MIT Press, 1997.
[14] Nass, C., Steuer, J., & Tauber, E. R., *Computers are social actors.* Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Celebrating Interdependence (pp. 72-78). Boston, MA, 1994.
[15] Koda, T., & Maes, P., *Agents with Faces: the Effect of Personification of Agents.* Proceedings of the Fifth IEEE International Workshop: Robot and Human Communication (pp. 189-194). Tsukuba, Japan, 1996, November 11-14.
[16] Reilly, W., *Believable Social and Emotional Agents* (Doctoral dissertation, Carnegie Mellon University, Pittsburgh, PA). Retrieved March 17, 2010, from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.52.4599&rep=rep1&type=pdf, 1996
[17] Schilbach, L., Wohlschlaeger, A., Kraemer, N., Newen, A., Shah, J., Fink R., & Vogeley, K., *Being with virtual others: Neural correlates of social interaction.* Neuropsychologia, 44(5), 718-730, 2006, September 19.
[18] Ortony, A., *On making believable emotional agents believable*. In R. Trappl, P. Petta, & S. Payr (Eds.), Emotions in Humans and Artifacts (pp.189-212). Cambridge, MA: MIT Press, 2002.
[19] Fridlund, A., Ekman, P., & Oster, H., *Facial expression of emotion.* In A. W. Siegman, & S. Feldstein (Eds.), Nonverbal behavior and communication (pp. 143-224). Hillsdale, NJ: Lawrence Erlbaum Associates, 1987.
[20] Ekman, P., *Are There Basic Emotions?* Psychological Review, 99(3), 550-553, 1992, July.
[21] Ekman, P., *Facial Expressions*. In T. Dalgleish, & M. Power (Eds.), Handbook of Cognition and Emotion (pp. 301-320). Hoboken, NJ: John Wiley & Sons, 1999.
[22] Gard, T., *Building Character*. Retrieved from Gamasutra: http://www.gamecareerguide.com/features/20000720/gard_02.htm, 2000, June 20.
[23] Baylor, A. L., & Ryu, J., *Does the presence of image and animation enhance pedagogical agent persona?* Journal of Educational Computing Research, 28(4), 373-395, 2003.
[24] Lee, E-J., & Nass, C., *Experimental tests of normative group influence and representation effects in computer-mediated communication: When interacting via computers differs from interacting with computers.* Human Communication Research, 28(3), 349-381, 2002.
[25] Dehn, D. M., & van Mulken, S., *The Impact of Animated Interface Agents: A Review of Empirical Research.* International Journal of Human-Computer Studies, 52(1), 1-22, 2000.
[26] Baylor, A., *Promoting motivation with virtual agents and avatars: role of visual presence and appearance*. Philosophical Transactions of the Royal Society B, 364(1535), 3559-3565, 2009.

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Marilyn Monroe –The Digital Pop Art Creation and Practice

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Abstract
Using on the arduino microcomputer chip, the iconic image of Marilyn Monroe in the film, "The Seven Year Itch" is used with movements made by wind as interactive media. The artwork uses a large fan to bring Monroe to life. The creation takes one of Andy Warhol's classic Pop Art works – "Marilyn Monroe" as the original concept which is combined with interactive media to let audiences interact with the Pop Art style of Marilyn Monroe with the essence of Pop Art in spirit. Modern Pop Art demonstrates a series of visual images. In digital technology and the art aesthetics trend, this creation combined digital pop art with interactive devices allows users to participate and become the part of the art work, then create an experience for the visual pleasure of a continuous, dynamic image.

Keywords: Marilyn Monroe, Pop Art, Interactive

1 Background

In recent years, interactive device have been combined with technology, by which it has become the so-called new media art. In many places, such as museums, art galleries or exhibitions from different regions, new media art has become the performances milestone since it combined with interactive elements. Digital technology has driven a change on production methods for audio and video editing, clips and synthesis. Meanwhile, the realistic or mix method provides the creator a tremendous challenge to the traditional concept of the creative fields [1].

From computer art to media art, and then developing to the digital art or new media art, its application value had progressed into the field of science, and even life design application for pure art exhibition and appreciation. Interactive devices are a part of new media art, since it has the characteristics interaction, the participation of the audience becomes a part of the work beyond the function of just looking. The work value lies in the situational experiences through the interaction.

One notable example of these interactive experiences was used at the Digital & Interactive Gaming Conference, held in London in January 2008 [2], it took a game as the theme to explore interactive experience to go further in exploring how gaming and interaction be become very integrated in digital media. For instance, an application for teaching media design with game concepts can improve the entertainment of the application and make a change on human communication in the way modern society uses by digital media. The conference participants included digital art creators, experts, scholars, digital technology researchers and students. The Seminar sites also presented many of the latest technologies and its experiential creation works. By taking a game as an idea to catch human curiosity, and the attractive feature of art, it had indeed captured the eyes of audiences.

In creation of digital art, there are many cases of taking the concept of wind as interactive medium. When the fan starts, the wind will flow. Thus, the users in the performances space not only could have the visible phenomenon for wind, which was originally invisible to the eyes ,but also the physical senses in which could feel the flow of air. For instance, the work, "Blow Up", by American artist, Scott Sona Snibbe, constructed a wall of 12 small fans, and then using it in the same way in the opposite position, formed a wall of 12 large fans, then, the users could control the large fans by blowing the small fans one by one, so, the fan walls were driven by the interface with each other, creating a form of an endless air flow effect [3].

In "Flow 5.0", Daan Roosegaarde constructed two walls and walkway made of hundreds of small digital fans, and then letting the users walk in to this fan walkway to lead them to feel it is a virtual environment by its interactive technology. It is clear that the wind is an obvious media related to sense our existing space in our daily lives. The creation takes human breathing to explore human presence and perception. On his website, Scott Snibbe argues for this creation that: in the physical world, our bodies get perceived through some of phenomenon; we hear our voices through the vibration of air sound; we see our faces through bending light, breathing also as one attribute of the human fundamental nature. By breathing, we present that we are autonomous individuals [4].

Based on the above viewpoint, this creation work takes the movement of wind as interactive media to connect with Pop Art. An animated performance with the iconic image of Marilyn Monroe in the film, "The Seven Year Itch", takes an arduino microcomputer chip as a basic controller to create the feeling of wind. The switch of the fan is given to the users for the interactive experience. The related artistic motivation, design process, and its experimental tests are presented in following sections.

2 Artistic Motivation

During the early 20th century, Marilyn Monroe is a famous movie star in the United States, whose attractive performance style led her to become a sexy symbol. Because of this, she later became one of the most memorable figures in popular culture [5]. After, Marilyn Monroe committed suicide, the American Pop artist, Andy Warhol, quite shocked by her death, was inspired to create the artwork “Marilyn Monroe”. This work became one of the famous masterpieces of Pop Art, seen in figure 1 [6]. In “The Seven Year Itch”, Marilyn wearing the flowing white dress thus became a memory impressed deep into our minds, it also became an inspiration for many artists as an object for imitating or acting (as figure 2).

Fig. 1 The iconic of Andy Warhol's Pop Art
Resource: [6]

Fig.2 “The Seven Year Itch” Photo of Marilyn Monroe
Resource: IMDb [7]

How to provide interesting interaction to the users is an emphasis on how the concept of interactive technology and art is integrated in performance. Interaction is a process of communication between the work and the viewers, which the interactive should be focused on the viewer's cognitive and mental level, the art will be based on one-on-one to interactions to its message, by which progress of the interaction changes with the user. Its interactive behavior will change the result of each performance. The value of digital art is the interactive interesting; Megatrends's author, John Naisbitt, said that "First of all you have to do something interesting, if you want to sell products, inspire employees, and attract customers". In the post-modern society, entertainment is seen as an essential element in our life.

Based on the above statement, this creation takes one of Andy Warhol's classic works, Marilyn Monroe, as the model to connect interactive art to let the audience interact with Marilyn Monroe in the spirit of Pop Art. In contemporary art, its pop performs a series of visual image. In digital technology and the art aesthetics trend, this creation aims to combine multimedia and digital pop art with interactive devices so as to allow the users to participate in part of the digital media, allowing them to experience the visual pleasure of a continuous, dynamic image. By using the flow of wind as part of medium, this creation attempts to create an animated performance of Marilyn Monroe through the interaction with users.

3 The design process and practice

3.1 The original concepts

Interaction Design (its abbreviations as “IxD” or “IaD”) is a new subject field which integrates human science, technology, culture, and aesthetics. According to the definition from Wikipedia [8], interactive design is a field of artificial systems and behavior. Interactive design can create the experience of communication and its interaction with the users. And is thus, interactive design is an essential element for the processes of production, for example, software, mobile devices, artificial environment, services, portable devices, and the structure of system organization.

Through the system of interactive design, we could create a positive reaction, as well as the experience of ease, comfort and its emotional feedback. Among them, how to create an emotional reaction to the users is to allow them to have its positive memory as the mainstream design of concept [9]. In the creation of interactive devices, the designers usually take the direct, natural, and instant design considerations. However, most natural interactive methods should be based on the intuition to operate, by using the input image and its interactive interface to communicate with computer. This leads the computer to perform its action so as to get the visual and audio feedback to achieve the effect of interaction [10].

The creation uses arduino microcomputer clip as the main controller, by mean of the switch of the fan, its positive and negative magnetic conversion gives a signal to the computer to control the speed of the wind to play different sections of Marilyn Monroe's flowing white dress. Its visual art elements represent Pop Art. The image of Marilyn Monroe is collected from Andy Warhol's “Marilyn Monroe” and not from human acting. When the users switch on the control of movements of the fan, by the Pop Art, and the visual image of Marilyn Monroe's flowing white dress can be seen, the interactive viewing experience is created as well. This artwork’s hardware device included a the fan integrated with arduino clip, multimedia PC, LCD screen, and a projector. The creation's design and its devices are shown in figure 3, the output

projection of visual animation in figure 4.

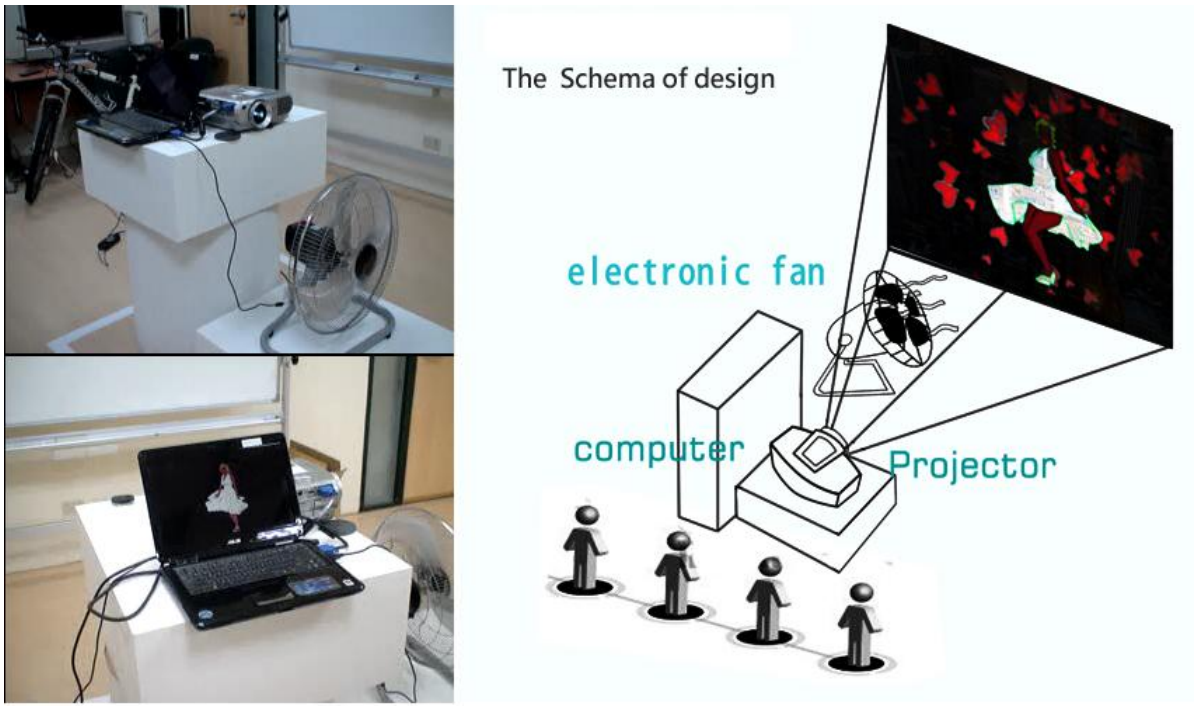

Fig3. The schema design of Marilyn Monroe (Digital Pop Art)

Fig 4. The screen output of Marilyn Monroe (Digital Pop Art)

3.2 The system architecture

The composition of this creation includes input an electronic fan as well as an arduino microcomputer chip. It uses this computer chip to make sure whether if the fan is activated. Through the speed of fan blades, the different signals are created. The fan's power is divided into 7 levels; 0 to 6. These different levels are then sent to a computer. The artwork is created with Adobe Flash, and the massages received from the fan will affect the overall animated presentation. The stronger fan signal, the larger the movement and angle of Marilyn Monroe's white dress will be flowing in. The output for this animation is projected onto a wall screen. The end-result is an interactive piece of Marilyn Monroe, where the audience can control the movement of the fan creating different animations, as in figure 5.

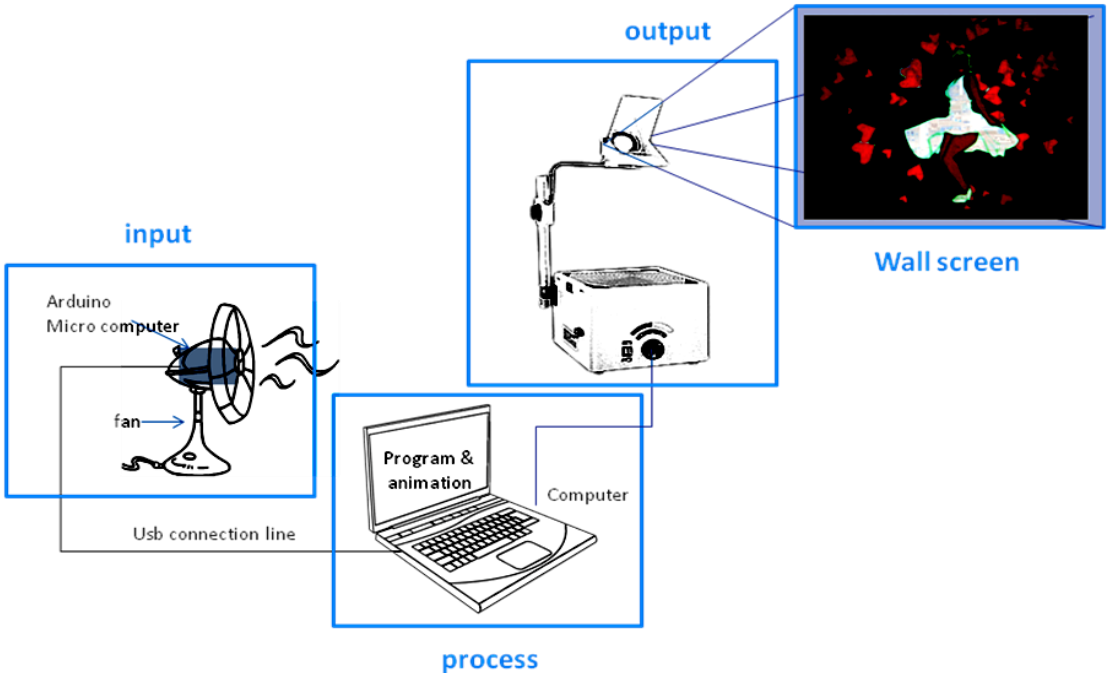

Fig. 5 The system architecture of Marilyn Monroe (Digital Pop Art)

"Pop Art" is derived from an English Independent Group, and originally defined as a discarded, temporal, free consuming culture. That made it a reaction for political satire, including comic style, cartoon characters, popular idols, and mixing colored small objects in daily life, this presented the popular culture during the 1950's. In the 1960s, Andy Warhol, held an exhibition which he presented by Campbell Soup cans, Coke bottles, money, and celebrities' portraits as artwork. Its Pop creative elements charmed its way into mainstream media, causing a sensation.

How do we identify the feature of Pop Art? On July 1st, 1957, Hamilton wrote the definition of pop art: "Pop art is popular, can be expanded (easy to forgot), mass-produced (as cheap), young, smart, spelling, and commercialization". From the above definition, we may easily think of it as what was popular with young adults at the time; such as idols, love, or sex, brilliant colors (such as magenta, bright yellow, bright orange, apple, and green), as well as generous geometric patterns or lines (for example, heart-shaped, round, square, colored lines, and spots) into patterns[11].

In order to further add to the style of Pop Art, the work uses magenta heart shapes and other colorful animations onto background of Monroe for the performance. Thus, this Marilyn Monroe creation has a Pop Art as well as pleasing, visual effect. (as figure 6, 7)

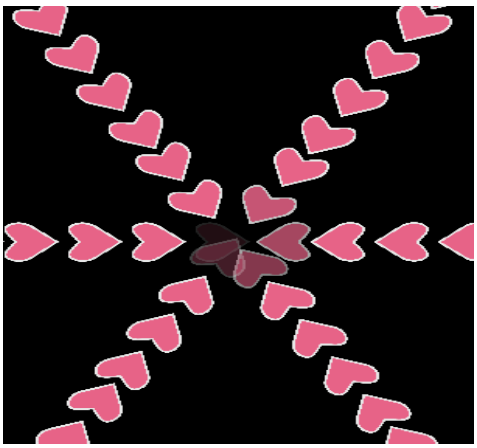

Fig. 6 The Pop Art style of the pattern in the work

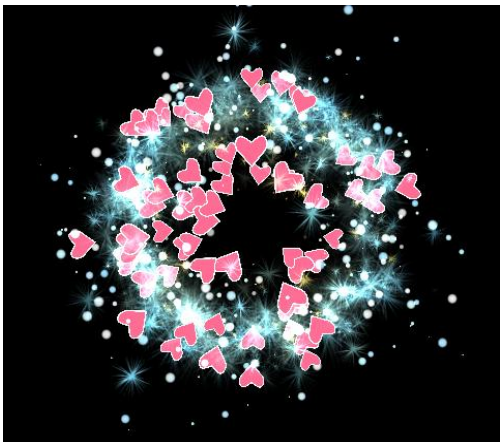

Fig. 6 The Pop Art style of the pattern in the work

3.3 The programs coding

Just like the about Roosegaarde's approach is that his famous work - FLOW 5.0 [4] are not simply built and let everyone feel inside his work with wind. So, this work must install adapting the software and wind materials to create new contexts, and strategies of interaction for the audience.

When the audience switch on the fan in the space of exhibition, the arduino clip can detect the rotation speed of the fan and transfer a message code to computer, which the clip is installed in the fan. In the meanwhile, the flash program had received the message, and then derived the Monroe's show according the value of message code, which was divided into four levels. More strength the wind, the action level would be dramatic more, and greater of Monroe's skirt fluttering magnitude. In order to create the visual effect, the pop art patterns also match Monroe's show, more the strength of wind; the effects will be more gorgeous. The audience on the switch of fan, the show action will play it once. After the Monroe's show was end, the work will return to the ready situation to wait for the next audience interaction. The flowchart for the audience interacting with *Monroe* is listed below (Fig. 7):

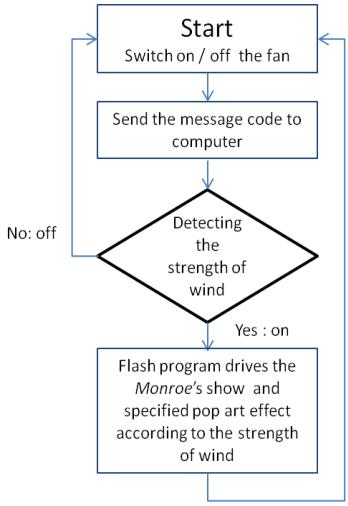

Fig. 7 A flowchart for detecting the fan wind of the work

In the program about how to drive the Monroe's show and specified pop art effect according the strength of wind, which is coding as below tow parts. The first part of program is the function which is received the message from fan and detecting the strength of wind from Arduino clip.

```
var randomValue = 0;
Mouse.hide();
aListener = new Object();
aListener.onConnect = function()
{trace("** Arduino connected! **");};

aListener.onConnectError = function()
{trace("** Arduino connection Failed!
check the port number and serialProxy **");};
//this gets triggered when Flash disconnects from Arduino
aListener.onDisconnect = function()
{
trace("** Arduino disconnected! **");
};
//this gets triggered when Flash receives data from Arduino
aListener.onReceiveData = function(evtObj:Object)
{
//trace(evtObj.data);
var inData = evtObj.data;

if (inData == 0){
randomValue = 0;
//trace("none");
trace(randomValue);}

if (inData == 1){
randomValue = 11;
//trace("weak");
trace(randomValue);}

if (inData == 2){
randomValue = 12;
//trace("middle");
trace(randomValue);
}

if (inData == 3){
randomValue = 13;
//trace("strength");
trace(randomValue);}
};

var a:Arduino = new Arduino(5332);
a.addEventListener("onConnect",aListener);
a.addEventListener("onConnectError",aListener);
a.addEventListener("onDisconnect",aListener);
a.addEventListener("onReceiveData",aListener);
```

The second part of program is to drive *Monroe's* show according the strength of the wind, which is transformed to the code of 'randomValue' in the first part of program.

```
showAnimation();

function showAnimation() {
if (randomValue == 0) {
```

```
                    tellTarget ("mary")
                {gotoAndStop(1);}
                                }


                if (mary._currentFrame == 1 ||
mary._currentFrame == 76 || mary._currentFrame == 165 ||
 mary._currentFrame == 245 || mary._currentFrame == 1)
                                {

                  if (randomValue == 0){
                        tellTarget ("mary")
                       {gotoAndStop(1);}}

                  if (randomValue == 11){
                        tellTarget ("mary")
                      {gotoAndPlay("level1");}}

                  if (randomValue == 12){
                        tellTarget ("mary")
                     {gotoAndPlay("level2");}}

                 if (randomValue == 13){
                        tellTarget ("mary")
                   {gotoAndPlay("level3");}}
                                }
}
```

4 Conclusions

The significance of new media to the users, is not only a efficient and high productivity for work, but emphasizes on entertainment, enjoyment, and interest. It can inspire an experience of perception in the aspect of aesthetic and creativity, in which it is the key point of the modern interactive design. This creation takes interactive art as a thought and takes a technical aspect as a new way for thinking. Using the means of the interaction between the users and the artwork, the diversity of art thus presented. Pop Art can create a series of visual images; this creation thus can bring a fun form of continuous dynamic visual movement. That is, through the combination of digital technology and art to embody a form of visual art and digital design. The creation attempts to combine the interactive art with technology, and then with the users' interaction in order to represent the spirit of Pop Art, the art style is easy to understand since it is common amongst our daily lives.

References

[1]Christiane Paul, *Digital Art*, Thames & Hudson Ltd, London, 2003.

[2]Wikipedia, *Digital & Interactive Gaming Conference*, Retrieve from http://en.wikipedia.org/wiki/Digital_%26_Interactive_Gaming_Conference, 2012.

[3]Snibbe, S.S: *Blow Up*, Retrieve from http://www.snibbe.com/projects/interactive/blowup/, 2012.

[4]Roosegaarde, D.: *FLOW 5.0*, Retrieve from http://www.dezeen.com/2007/12/13/flow-50-by-studio-roosegaarde/, 2012.

[5] Churchwell, Sarah., *The Many Lives of Marilyn Monroe*, Metropolitan Books. 2005.

[6] Xu Lwen (許麗雯), *You must know 300 paintings and their painters and painting genre (你不可不知道的300 幅名畫及其畫家與畫派)*, Chinese edition, Taipei, Gao-Tan Museums and art galleries(高談文化藝術館), 2006.

[7]IMDb, *The Seven Year Itch Photos with Marilyn Monroe*, Mptvimages.com, Retrieved from http://www.imdb.com/media/rm2879166464/tt0048605, 2012.

[8]Wikipedia, *Interactive Design*, Retrieve from http://en.wikipedia.org/wiki/Interaction_design, 2012.

[9]Preece,J., Roger, Y., & Sharp, H.: *Interaction Design: Beyond Human-Computer Interaction*, John Wiley & Sons., NY, 2003.

[10]Sung Heng, Wang Chao Ming, and Lee Chi Wei, *New Approach to Digital Art –Using Projection of Materiality to Design the Virtual and Physical Interactive Scenario*, 2007 Hawaii International Conference on Arts and Humanities, Hawaii, pp. 5151-5159, 2007.

[11]Julier,G., *20thcentury design and designers*, Second Edition, The Thames & Hudson Publishers, 1993 .

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Mixed-Style Print Advertising Combining Fashion Photography and Digital Illustrations: Examining the Print Advertising of Consumer Products in Taiwan

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Abstract

This study reveals the new shape of print advertising design in the digital era, investigating the new construction of graphical design images produced by the combination of illustrated media and photographs, to gain a deeper understanding of the reasons for which modern consumers enjoy this mixed type of visual structure and style. The research methods rely on sample print advertisement images to analyze the factors that make up their visual designs. The psychological attention-interest-desire-action (AIDA) model was used as a measurement tool to construct quantitative questionnaires to inquire into consumer preferences. A total of 516 valid questionnaires were collected. Men comprised 41 % of the respondents, whereas women were 59 %. Those between the ages of 14 and 25 were the majority, comprising 63 % of the sample. The results of this study indicate that the Art Nouveau style of print advertisements, which combine fashion photography with digital illustrations, is extremely effective in drawing the attention of consumers, inciting their interest, and stimulating their desires. The research methods rely on sample print advertisement images to analyze the factors that make up their visual designs. The AIDA model was used as a measurement tool to construct quantitative questionnaires to inquire into consumer preferences. These results can provide the advertising industry with a clear theoretical design analysis capable of serving as a reference standard in future print advertising design.

Keywords: Print advertisements; Digital communication; Digital illustration; Fashion photography; Mixed style; Art Nouveau.

INTRODUCTION

A. Research background and motivations

In free societies, various economic markets have rapidly replaced governments and religious groups, becoming the highest authorities of law; these markets have no values and cannot communicate in a human language [1]. Nevertheless, advertisements can open a new field in this domain, integrating human consciousness into these products and the circulation of capital, and stimulating the connection between enterprises and consumers to create brand impressions and put them into practice. In digital marketing, where businesses want to corner the market and gain profits, the key lies in touching people's hearts. Philip Kotler, "the father of modern marketing," believed that touching the emotions of customers and making consumers feel good when purchasing products makes the relationship between businesses and consumers more intimate [2].

Following the financial crisis, the majority of industries in free markets face the challenges of excess supply, with competitors selling highly similar products. Thus, enterprises must display more innovative, intimate, or reliable images to differentiate their marketing. With differentiated marketing strategies, there have been varied changes in strategies for different types of products. Strategies such as online marketing, product placement, brand marketing, narrative marketing, and even experiential marketing are aimed at drawing the attention of consumers and inducing consumer behavior. Kotler further indicated that "moving people's hearts" is an issue that enterprises must focus on in creating industrial vitality. The "power of the five senses" is best able to directly move the hearts of consumers. Among these, the power of vision has the greatest influence on consumers. The first impression that consumers receive from a product is how visually compelling the product is. This becomes a key factor

influencing purchasing decisions [3]. In other words, the development of technology has promoted digitalized lifestyles.

Combined with the flourishing of visual communication environments, this has driven a new era of visual culture. Visual communication through products can be seen as the first point of contact between enterprises and consumers. If enterprises are able to make good use of this "visual narrative" to visualize advertising presentations, allowing advertisements that rely on the maxim "a picture is worth a thousand words" to fully display their persuasiveness, true brand value and customer loyalty can be established between businesses and their consumers [4].

The trend guru Naisbitt indicated that the history of civilization is the history of communication. If forms of communication have already been transformed from textual to visual images, then we must study new symbols of interaction [5]. Observation of marketing and communications indicates that visual design has already become the most powerful form of communication in the world, with many different levels. Among these, the visual symbols of print advertising, combined with a human atmosphere, have become as important as the actual products themselves. Advertising design style adds soul to products, and can be described as one of the keys for enterprises in succeeding in a competitive market.

Following the rapid development of global imaging art and computer technology, large quantities of visual images have been flooding into daily life. Visual experiences have become an indispensable part of modern living, entertainment, and work. Humans rely more on vision to recognize the outside world and interpret various forms of visual images than during any other era of history [6]. The twenty-first century is a market-oriented digital era. Numerous financial, technological, informational, and traditional industries desire to establish intimate interactive relationships with consumers, gradually using "Vision" to transmit their enterprise culture and product spirit en masse. They believe that visual images are more effective than traditional text, because images can provide a consciousness of popular mass culture [4].

For example, today one can see an array of advertisement display boards for fashion brands next to department stores, in shopping malls, on busy streets, and when riding on metro systems. By observing these fashion advertisements, they can be largely divided into photographs or a digital synthesis of images and digital illustration. These fashion advertisements decorated with digitalized images not only display design creativity, they also compliment the characteristics of their products, drawing the attention of potential consumers.

Print advertising has a long history of development. Consumers obtain product information through the content of these advertisements. With advances in computer technology, methods of visual expression within advertising design have been changing rapidly. Fireworks are produced when digital technology and design collide. Design vocabulary and symbols also produce ingenious shifts. The concepts of single medium design are no longer able to satisfy the "Visual" demands of consumers. A combination of art and technical knowledge is necessary for designers as a medium for developing their unique creative concepts [6].

The goal of advertising design lies in drawing the visual attention of consumers, and inducing them to form short-term memories of products. These short-term memories are further transformed into long-term memories via intensive marketing campaigns, producing positive and negative feelings among consumers toward products, and influencing their consumption [7]. Overall, designers must use different themes and content, and mix new styles created with different media to give their audience more visual images that interweave the real with the fictitious. Though print advertising for all types of products can be seen everywhere, research on print advertising styles remains in the developmental stage.

In the past, the majority of researchers have focused on examining visual culture and art education or visual culture and art appreciation when discussing the topic of visual communication [8-20]. Few have measured the effectiveness of print advertising using consumer preferences. Therefore, this study reveals the new forms of print advertising design in the digital era, examining new constructions in graphic design images produced by the mixture of illustrated media and fashion photography in the Art Nouveau style, and testing whether consumer preferences toward this mixed visual form and style influence their consumption and purchasing decisions.

Quantitative research methods were used for testing, with print advertising images that mix illustrated media with fashion photography as the sampling subject. Product types were divided into four categories: fashion, music, athletics, and technology. First, the existing literature was examined to analyze the elements of Art Nouveau visual design. Next, the psychological attention-interest-desire-action (AIDA) model was used for the main items on a questionnaire. After data collection, SPSS statistical software was used as a measurement tool.

In view of human, material, and financial restrictions, this study adopted an Internet questionnaire method. The subjects could go online to complete the questionnaire at any time. In addition, this study primarily investigated the elements of Art Nouveau style in the fusion of fashion photography with digital illustration. Thus, the lighting techniques and compositional forms of fashion photography were not included within this discussion. We hope that this study can provide product vendors, advertising agencies, and advertising designers with references for future graphic design by analyzing the design theory of new mixed styles using the visual preferences of consumers.

LITERATURE REVIEW

This section covers the following issues: New Artistic Styles, Fashion Photography in the Digital Era, The Relationship between Digital Illustration and Visual Culture, and Mixed-Style Print Advertisement.

A. New artistic styles

The Art Nouveau movement began in the 1890s. At that time, the style swept through Europe and North America, with extremely long-lasting influence that reached its peak during the 1900 Exposition Universelle in Paris. Art Nouveau took over the wave of artistic innovation from the Arts and Crafts movement, with which it shared many similarities. Both movements strongly opposed industrial art styles and mechanization. At the same time, they also both opposed the flashy Victorian style [21]. In contrast, the "Art Nouveau movement" strengthened the enthusiasm and importance placed on traditional craftsmanship. Its decorative style also advocated the complete abandonment of any conventional baroque or rococo decoration types, turning instead to the development of decorative styles and patterns that center on displaying the graceful curves of animals and plants [22].

The "Arts and Crafts movement" promoted vintage and gothic styles, stressing the demands of handicrafts. This is where these two movements differed. Art Nouveau persisted up to around the year 1910 before being gradually replaced by the Modernist movement and the mechanized aesthetics of Art Deco, and evolving into the Postmodernist movement. Historical research into the Art Nouveau style reveals that it originated in the art of the European Middle Ages, with traces of eighteenth century rococo art and the decorative elements of handicraft culture. In addition, it also carried with it the aesthetic characteristics of Eastern art. The use of new industrial materials and techniques in Art Nouveau included the nostalgia of people for the past, and their yearning for the new century.

The factors influencing the development of Art Nouveau include viewing daily life as an artistic subject, the invention of photography, the loathing of artists toward the crudeness of machine-made products, dissatisfaction with the oppression of humanity by industrialization, the hope of the restoration of humanity through arts and crafts, the influence of Japanese ukiyo-e, and the manuscripts of the Celtic people, whose curved themes come from Irish and Scottish culture. These manuscripts are filled with abstract animal and plant patterns, curled spirals, and the curves of the natural world. Overall, the decorative style of the "Art Nouveau Movement" can be summarized into two types of lines: curved and straight. This study lists these two styles below (Table 1):

Curved, Sensual Decorative Fashion	This type of decoration was primarily composed of imitating the sensual curves of animals, plants, or other sights in the natural world to pursue a new era of decorative fashion. Romantic thinking allowed artists to add natural patterns to the development of life and art, forming a sort of linear, sensual style of decoration.
Linear, Rational Decorative Objectives	This style primarily wove unnatural, mechanized, unpretentious, and abstract rational decorative objectives with structures formed of geometric shapes to create ideal decorations. Creations were also made with organic, rational, and abstract lines.

TABLE I. DECORATIVE STYLES OF THE ART NOUVEAU MOVEMENT

The most significant feature of Art Nouveau was the large amounts of soft, romantic curves used. Art Nouveau scholar Robert Schmutzler believed that the primary characteristic of this style was its long, sensitive, curved lines, like seaweed or vines. The art and design critic Pevsner analyzed the characteristics of "Art Nouveau" as bending, formless modeling inspired by plant life. Those slim, long, and sensual curves remind one of lily stems, the antennae of insects, flower stamens, or accidental fires. These flowing, wavy curves tangle around each other, erupting from every corner and irregularly filling the entire picture [23]. Within the Art Nouveau style, these flowing curves gave people feeling of airiness, levity, gracefulness, and freedom.

B. Fashion photography in the digital era

Since the 1980s, video media, digital design, and computer-assisted illustration have been changing continuously along with popular trends. Numerous works matching human photography with hand-drawn illustrations have gradually appeared throughout the world in the visual creations of print advertising. These have presented rich decorative visual effects, allowing the images in print advertising to display another type of romantic, natural vitality, and indirectly expanding the diversity of print advertising.

To commercial advertising, fashion photography has gradually been toppled by the convenience and diversity of technology. Technology has been mixed and improved with different schools of photography, and its shadow can be seen in manipulated, kitsch, and conceptual photography. For example, in the copied photographs of Sherrie Levine and the reproductions of film or famous illustration scenes by Cindy Sherman and Morimura Yasumasa, the designer plays a role in the art, communicating ideas and applying technology.

The rapid development of computer technology has given fashion photography different directions for development and new forms of expression. Digital technology has become an entirely new language for fashion photographers in telling stories. Fashion photography has influenced the world of images. With endless pondering and innovative convolution, it has produced wonderful qualitative changes, bringing about new expressions and experiences in commercial advertising [17].

Current fashion photography does not consist of the fashion photographs recognized by the general public. They mix and synthesize various forms and methods to achieve a kind of "different perfection." Thematically speaking, the central focus of fashion photography is on "attire." Its style of creative expression has been replaced by the narration of contemporary photography, presenting an aesthetic feeling whereby fashion is no longer merely a fixed product, but a narrative concerned with fragments of modern life [11]. These trends make fashion photography less static, instead revealing slices of dynamism through narrative design. To fashion photographers, digital technology is an entirely new language for them in telling stories. Regardless of how much technology improves, the creativity and concepts of fashion photographers are still important in pursuing personal breakthroughs and creating new trends in visual culture.

Fashion photography has been influenced by the decorative style of Art Nouveau, and the print advertising design, three-dimensional shapes, and architectural style of the early twentieth century were also influenced by decorative fashion photography. Fashion photography and illustration have been brought to new life in the present through the use of computers, such as in the perfume advertisements created by the Brazilian designer Adhemas Batista, which are similarly excellent to the image style of the Art Nouveau movement.

In short, current fashion photography has departed from pure photography and the category of fashion in the various vectors concerning trends in design, such as print advertising, webpage design, music CDs, illustration patterns, and pure art. The involvement and integration of fashion photography can be seen in all of these, verifying the diversity of postmodern photography [24]. Observing numerous factors in Art Nouveau decorations reveals that there is a great deal of feminine, soft symbolic vocabulary. If designers bring these symbols into the realms pursued by fashion photography, the idealized world in the hearts of consumers can be displayed, drawing their attention and favor, ultimately influencing their loyalty and purchasing behavior.

C. The relationship between digital illustration and visual culture

Digital advertising refers to the broad use of computer tools to create works in a nonlinear fashion, allowing designers to insert any object or graphic into the work at any time. Artists' forms of expression in illustration influence consumer preferences. The creation of style is a method of expressing illustration that allows viewers to feel that a work is innovative and unique. After attracting the attention of the masses, their collective recognition of the illustrations becomes a new style.

In general, analysts observe creations with the inductive operation essentials of universality, similarity, continuity, and constancy as a foundation, and generalize the collective nature obtained from these works to establish the essence of style groups. This study uses these analytical principles to generalize the classifications of mixed-style forms of digital illustration and fashion photography.

In examining the development of illustration from a historical viewpoint, the reading methods of consumers have gradually transformed between the industrial age and the technological era; from dependence on books that focused on text, to accepting information from images. Mass media, such as television, movies, the Internet, advertising images, and other video transmissions give continuous visual stimulation from morning to night. This makes clear that consumers have entered an age flooded with visual images, to the point that America's largest chain bookstore, Barnes & Noble, has opened up special sections within stores to sell illustrated novels because of their popularity. The trend guru Naisbitt took a positive outlook on the popularity of illustrated novels, stating that the history of civilization is the history of communication. If the forms of communication have already transformed from words to visual images, then we must learn new interactive symbols [5]. By the 1960s, the French scholar Debord held that "all things are introduced into images as soon as they begin to exist" [22]. The American scholar Parsons believed that in the current highly visual era, daily life itself is visual culture [25].

Visual culture is a product of modern society. Through technology, visual events allow consumers to obtain messages, meaning, or pleasure[3]. Visual culture has a deep influence on the masses. It subtly enters daily life, but is not easily discovered. The scholar Rogoff explained that we rarely learn through personal discovery. Most of the time, we absorb through assimilation and comparison with reality. Most commonly, our learning is unconscious [9]. Therefore, the social atmosphere has created a visual culture propagating by the popularity of illustrations. The external appearances they present trend toward diversity and rapid change. Consumers must accept, judge, and adapt to more things, and the influence they receive is greater.

In the dissemination of culture, illustrations are visual products that interpreted or created by people. Illustrations are attributed the intentions of function, communication, and aesthetics [3]. By extension, "one product poster can become a visual method of influencing the behavior of certain people." Compositions of words and graphics are used to transmit product value and social significance. Illustration can be seen as a purposive, transmissible, and cultural visual art [8]. In a general sense, illustration refers to visualized graphics outside of text that includes paintings, photographs, and charts. Narrowly speaking, it refers to the images that serve as aid to writing, or those that use visualized graphics to express concepts that the text is unable to convey. Illustrations serve to assist readers in understanding writing, serving as a foil for the content of images and text, and increase the value of books. In addition, they also encourage product sales, helping enterprises gain profit.

Observing illustration from the development of new media reveals that advances in technology impel the production of diverse dimensions of application by visual concepts. The computer has already become an indispensable design tool. Design techniques that were considered complex methods of expression in the past, such as double exposure and overlapping and fragmented collage, became much easier with improvements in technology [26]. With the maturity of computer graphics and Internet technology, the 3D and animated special effects of deformation, diversion, and exaggeration have been produced in response, allowing a dazzling array of forms of expression for illustration in addition to its traditional use for diagrams and examples. These forms include styles such as photorealism, computer graphics, computer editing, 3D animation, abstraction, clipping, decoration, printing, and surreal concepts. With the assistance of technological advancement, the image symbols of illustrations take entirely new visual structures to challenge the old, traditional styles of illustration, thus giving consumers an even more amazing visual vocabulary.

Analyzing illustrations from the angle of visual signs indicates that these signs are the knowledge and experience of the external world of reality and the internal subjective world, transformed and transferred by people through their intellects and imaginations [22]. In other words, all communication includes signs and codes. Signs are artificial products or behaviors with the goal of transmitting meaning. Codes are systems that determine the relationships of signs. Signs are the displays of imagery and the embodiment of information. To illustrators, creating symbols and signs is a particular psychological activity. Graphic images are used to visually express complex concepts and knowledge [27]. As Roland Barthes believed, the fields of learning, thought, and the spread of communication are founded on the operation of symbols and signs [28]. Expanding on Barthes's concepts, the use of visual shapes to transmit print messages is the expression by illustrators of their internal feelings and experiences by using flat lines, shapes, objects, colors, textures, and forms. In short, symbols and signs in illustrations must have conventional meanings. They are then interpreted through visual vocabulary to read the goals of message dissemination and visual persuasion.

D. Mixed-style print advertisement

The Swiss Herbert Matter was the earliest graphic designer to use photography in creative design activities. His artistic display of photography used photographic collage to compose more subjective graphic design retaining strong desire. By bringing photography as a method into design, photography was no longer merely a neutral recording tool [29]. In the 1930s, Matter designed a series of posters for the national tourism bureau of Switzerland. These posters were collages formed from a mixture of photography, layouts, and fonts. These works stressed the resources and special features of Swiss tourism, resulting in a significant response and much controversy at the time.

The development and spread of photography and advancements in paper and print led to the decline of realist illustrative styles. Conventional illustrations used lively colors and images of exaggerated perfection to establish dream worlds distant from reality. In contrast, photography is realistic, accurate, and quick, and was thus widely welcomed by the masses

During the 1950s and 60s, some designers who emphasized the concept of freedom began to attempt to mix photography and illustration to design new graphic works, expressing their own ideas and increasing their fame to obtain more generous remuneration. The 1960s pop art master Andy Warhol took photographic stills of numerous famous people and used the silk screen print method to create large quantities of representative works. Among these works, those using Marilyn Monroe were the most famous.

In the 1980s and 90s, with the rapid development of digital technology, computers were used widely in design. Software developed quickly, with a series of brand-new graphic design applications with superb capabilities. These were able to greatly reduce the time needed to produce graphic designs, while simultaneously providing more diverse media that allowed designers to nimbly put images together and create pictures with surreal environments as they pleased. They were able to attempt new design ideas without restriction, opening up an unlimited world of free creativity [6].

Works mixing fashion photography with digital illustration styles have already appeared in all forms of media. In Taiwan, the popular design magazines dpi and XFUNS combine photography with digital illustrations or composite images. This style is classified as digital illustration, with images in this form called "photographic illustrations" or "picture-images." The name clearly indicates that this is a mixed image style. Tina Tahir, who works in this style, once said, "Photography is not a pure tool, because I always integrate other elements into images, such as an 'illustration' style. I do not look at photography and illustration differently; rather, I use a new form to integrate the two, as if the two elements are in conversation" [30]. This quote shows that designers want to display digitalized characteristics in their works, increasing the diversity of their individual styles of expression and creative approaches, and enriching the development of print advertising design.

The works of decorative fashion photography created by designers are not limited to clothing. CD covers, athletic brands, technological products, and food brands are all within the scope of application. In short, the combination of the creative methods of fashion photography and illustration leads to richer imaginations and moving interpretations of postmodern style. With the influence of digitalization, mixed-style print advertising has used the decorative elements of the Art Nouveau movement to bring color and style with a certain mystique into pictures, presenting diverse visual effects, and achieving visual emotions that differ from those of conventional imagery.

RESEARCH METHODS

A. Hypotheses and research framework

1) Research hypotheses

This study reveals the new form of print advertising design in the digital era, investigating the new construction of graphic design images produced by the combination of illustrated media and photographs. The AIDA was used to measure the preferences of modern consumers toward this mixed visual form and style. The AIDA model is a marketing model presented by the international marketing expert Heinz M. Goldmann, is an important formula in the study of Western marketing, and indicates that successful marketing must draw or divert customer attention toward the product being marketed, generating interest in it. In this way, desire is also produced in the customer, encouraging purchase behavior to complete transactions. This model is frequently used in testing the effects of advertisements, suggesting that advertisements must first attract attention, create interest, and stimulate desire before finally inducing action in consumers. Thus, it is also called the hierarchy-of-effects model. In this study, this model was used to develop a questionnaire that could test consumer preferences toward advertising styles. The following hypotheses are presented in light of the research motivations, goals, and literature described above:

H1: A positive correlation exists between print advertising styles that combine fashion photography and digital illustrations and consumer reactions.

H2: Advertisements with mixed styles have a significant influence on drawing the attention of consumers.

H3: Advertisements with mixed styles have a significant influence on inciting the interest of consumers.

H4: Advertisements with mixed styles have a significant influence on stimulating the desires of consumers.

H5: Advertisements with mixed styles have a significant influence on encouraging purchase behavior in consumers.

2) Questionnaire survey and design

This questionnaire was designed using a quantitative research method. This method can describe conditions and confirm cause-and-effect relationships, with results that can be used to make inferences on the population. The researchers conducted a practical recording of the shopping malls in the Xinyi District, Taipei, identifying the shopping malls that featured comparatively more photography and digital illustrations in their store windows and billboards. The images were categorized into four types: fashion, music, technology products, and sports. A five-point Likert scale was used. The subjects could choose among “very much agree,” “agree,” “no opinion,” “disagree,” and “very much disagree,” ordered from five to one, respectively. This was used to understand the reactions of consumers toward advertisements with mixed styles. The questionnaire items are listed in Table II below:

Questionnaire and Demographic

Consumer Response Model	Question Number and Subject	
Attracts Attention	1	The design style (color, lines, and patterns) of this advertisement would draw my attention to the product.
	2	The design style (color, lines, and patterns) of this advertisement makes a deep impression on me.
	3	I know this product because the design style (colors, lines, and patterns) of the advertisement differs from the norm.
Triggers Interest	4	I like the style of expression in this type of advertising design.
	5	After seeing this advertising design, I am interested in the product.
	6	After seeing this advertising design, I am curious about the product.
Stimulates Desire	7	After seeing the advertisement for this type of product, I want to try using it.
	8	After seeing the advertisement for this type of product, I believe that it is what I require.
	9	After seeing the advertisement for this type of product, I want to recommend it to my friends.
Urges Action	10	I will learn more information about this product because I love this type of advertisement.
	11	I will purchase this product because I love this type of advertisement.
	12	Though I love the advertising for this product, I will wait until there is a discount before purchasing it.
Gender	13	□ Male □ Female
Age	14	□ 14 to 25 years old □ 26 to 35 years old □ 36 to 45 years old □ 46 or more years old

TABLE II. ITEMS ON THE CONSUMER RESPONSE MODEL

This study used a questionnaire to examine whether the characteristics of the population influence the reactions of consumers. Thus, analysis and discussion was conducted based on this research framework from three variables: gender, age, and level of education.

B. Research framework

Selection of the research subjects and methods of data analysis:

1) Research sampling

The subjects of this study were ordinary Internet users. They were used to examine whether differences existed among consumers during the reaction phase attributable to advertisement design style.

2) Questionnaire sampling method

This study used convenience sampling coupled with an online questionnaire method for distribution. The data was used to determine the behavior of the subjects. In addition to being in line with the sample correlation, this method can also be used to effectively save sampling costs when manpower and materials are limited. The only flaw is that it is not representative of the entire population.

3) Data analysis method

This study used a quantitative analysis method. SPSS statistical software was used to perform correlation analysis on the data. The analysis methods were descriptive statistics, reliability analysis, and Pearson correlation. These were used to verify the hypotheses presented.

4) The research limitations

These questionnaires were unable to reflect certain factors, such as which parts of the advertisement designs with Art Nouveau expressions that respondents were interested in, and which forms of design symbols they preferred.

DATA ANALYSIS AND DISCUSSION

This section explains the data and statistical results collected by the questionnaire while performing quantitative analysis based on the goals and questions of this study. The analytical methods included descriptive statistics, reliability analysis, and Pearson correlation analysis. The content of this section also includes a questionnaire recovery overview, questionnaire reliability analysis, and analysis of the correlation between mixed-style advertisements and consumer reactions.

1) Descriptive statistics

In this study, descriptive statistics were primarily used to perform initial analysis on the research data and understand the overall structure of the valid samples. The content included the gender, age, and education level of the subjects. This was used to understand the basic characteristics of consumers who prefer mixed-style print advertising.

2) Reliability analysis

This study measured the questionnaires primarily with the use of a five-point Likert scale, which was used to examine the subjects. We had to consider whether each dimension of the scale had consistency and stability. Therefore, reliability analysis had to be used to analyze and measure the reliability of the questionnaire.

3) Correlation testing

Correlation analysis was used primarily to test the relationship between the variables within the framework of this study. This relationship was mainly expressed using Pearson correlation coefficients to measure the degree of correlation between “print advertising styles that combined fashion photography and digital illustration” and consumer reactions.

A. Data analysis

Returned questionnaire statistics

The subjects of this research were typical Internet users. Purposive sampling was used to examine the online questionnaires. This was performed between October 12 and 25, 2011, for a total of two weeks. Samples recovered in the following conditions were considered invalid: (1) Those from identical IP addresses; (2) those with the same email addresses; and (3) those with different addresses but whose answers and submission times were extremely similar. After removing the invalid samples, a total of 516 valid questionnaires were recovered. Of these, 212 were submitted by men and 304 by women, comprising 41% and 59% of the sample, respectively. Through the independent samples t-test, the involvement of the mixed-style advertising showed differences across gender ($t = .153$, $p = .0358 < .05$); the data highlighted that women possessed a higher involvement of the mixed-style advertising. The data are shown in Table II.

The largest age group was 14 to 25 years, with 325 respondents or 63% of the sample. The next largest group was 26 to 35 years, with 164 respondents, or 32% of the sample. These two age groups accounted for 95% of the total sample. There were 27 subjects between the ages of 36 and 45, for 5% of the sample. The one-way ANOVA results showed that the involvement of the mixed-style advertising differed across ages ($F = .236$, $p = .0351 < .05$), and reached a level of significance. The relevant data are shown in Table III.

Sample T-test Analysis

Gender	Total	Proportion
Male	212	41 %
Female	304	59 %

	Gender	Mean	Std. Deviation	t-values	Sig. (2-tailed)
AIDA Model	Male	2.0315	.30241	.153	.0358
	Female	3.5470	.53084		

*p<.05 **p<.01 ***p<.001

(Source: compiled for this study)

TABLE III. The Result of the Gender Distribution and One

ANOVA Analysis

Age	Total	Proportion
14 to 25 years old	325	63 %
26 to 35 years old	164	32 %
36 to 45 years old	27	5 %
46 or more years old	0	0

	14 to 25	26 to 35	36-45	45 or more	F	Sig.
Mean	4.58	2.44	2.03	0	.236	.0351

TABLE IV. The Result of the Age Sample and One-Way

B. Questionnaire reliability analysis

Cronbach's α was used to perform reliability analysis. The values of Cronbach's α in every dimension were greater than 0.8, indicating that the questions had a high degree of consistency, as shown in Table IV below.

Dimension	Research Variables	Number of Questions	Cronbach's α Value
Consumer Degree of Response Toward Mixed-Style Advertising Design	Attracts Attention	3	0.857
	Triggers Interest	3	
	Stimulates Desire	3	
	Urges Action	3	

TABLE V. Questionnaire Reliability Analysis

C. Analysis of the correlation between "mixed-style advertising" and "consumer degree of response"

Examination with Pearson correlation analysis revealed that a correlation existed between "mixed-style advertising" and "consumer degree of response," with r = .527*** (p < .001), reaching a moderately positive correlation. Two-tailed t-test revealed that these results were extremely significant. Pearson correlation analysis also indicated a correlation between "mixed-style advertising" and "attracts attention," with r = .325*** (p < .001), a slightly positive correlation. The two-tailed t-test demonstrated that these results were extremely significant.

A correlation existed between "mixed-style advertising" and "triggers interest," with r = .430*** (p < .001), which represented a significant and moderately positive correlation. In addition, a correlation existed between "mixed-style advertising" and "stimulates desire," with r = .478*** (p < .001), also a moderate level of positive correlation. Both these results were extremely significant. Finally, there was a mildly positive but significant correlation between "mixed-style advertising" and "urges action," with r = .293*** (p < .001) (see Table V).

Advertising and Consumer Degree of Response

Pearson Correlation Analysis		
	Consumer Degree of Response	
Mixed-Style Advertising	Pearson Correlation	Significance
	r = .527***	0.000

**p < .01, ***p < .001 (two-tail)

Pearson Correlation Analysis		
	Mixed-Style Advertising	
	Pearson Correlation	Significance
Attracts Attention	r = .325***	0.000
Triggers Interest	r = .430***	0.000
Stimulates Desire	r = .478***	0.000
Urges Action	r = .294***	0.000

**p < .01, ***p < .001 (two-tail)

TABLE VI. Analysis of the Relationship between Mixed-Style

CONCLUSIONS AND SUGGESTIONS

A. Research conclusions

This research states that as mixed-style advertising designs become more innovative, they more easily capture the attention of consumers. The Pearson test was further used to examine the correlation between mixed-style advertising and "attention," "interest," "desire," and "action." The results indicate that a positive correlation exists between all of these and mixed-style advertising.

1. Attracts Attention: r = .325, a low positive correlation after Pearson correlation test (p = .000 < .001).
2. Triggers Interest: r = .430, a moderate positive correlation, after Pearson correlation test (p = .000 < .001).
3. Stimulates Desire: r = .478, a moderate positive correlation after Pearson correlation test (p = .000 < .001).
4. Urges Action: r = .293, a low positive correlation after Pearson correlation test (p = .000 < .001).

After testing with Pearson correlation analysis, the results for the study hypotheses are provided in Table VI below:

TABLE VII. The Result of the Research Hypotheses

Research Hypotheses		Results
Hypothesis H1	A positive correlation exists between mixed-style advertising and consumer response.	Established

Hypothesis H2	As preferences for mixed-style advertising increase, the behavior of "attracts attention" also increases.	Established
Hypothesis H3	As preferences for mixed-style advertising increase, the behavior of "triggers interest" also increases.	Established
Hypothesis H4	As preferences for mixed-style advertising increase, the behavior of "stimulates desires" also increases.	Established
Hypothesis H5	As preferences for mixed-style advertising increase, the behavior of "urges action" also increases.	Established

TABLE VIII. The Result of the Research Hypotheses

B. Relevant suggestions

The results of this study indicate that print advertisements with Art Nouveau styles of expression that mix photography and digital illustrations can effectively draw the attention of consumers and easily attract their interest and stimulate their desire. On this basis, we present the following suggestions:

Print advertisements with Art Nouveau styles of expression can assist advertising agencies in creating advertisements with greater product appeal. We suggest that advertising agencies use this style to promote the interest of consumers and draw the notice of players, providing substantial positive assistance for the communication of product information.

We suggest that fashion, music, athletics, and technology companies use print advertisements with Art Nouveau styles of expression to attract the focus of potential consumers. By first creating brand impressions and then establishing a sense of trust in consumers toward the business through quality, brand preferences can be increased.

The research result that less correlation with the "action" behavior. This study holds that with the impact of the global economic recession, consumers have become more conservative in their usage of money. This does not influence consumers' preferences toward new styles of advertising. As long as these styles are matched with price-cutting promotions, product sales are sure to increase.

C. Suggested directions for future research

Increase the number of research subjects and the duration of study. The subjects of this study were ordinary Internet users, and the investigation was done over just two weeks. The number of samples obtained does not necessarily reflect the overall population. In the future, investigation time and the number of questions can continue to be increased to investigate the degree of influence and understand the stylistic trends of print advertising, and to provide further research results for industry and academia.

Expand research on the types of Art Nouveau styles of expression. This study only investigates whether consumers are influenced in their consumption behavior after experiencing fashion, music, athletic, and technological advertisements. In the future, other types of advertising styles can be added to further analyze whether the advertising content of Art Nouveau expressions can elicit the attention of consumers of other product categories.

This study used a quantitative online questionnaire. In the data collection process, the items on the questionnaire were configured to understand the opinions of the respondents. However, these questionnaires were unable to reflect certain factors, such as which parts of the advertisement designs with Art Nouveau expressions that respondents were interested in, and which forms of design symbols they preferred. In the future, combining a quantitative questionnaire with qualitative research methods to perform in-depth interviews on consumers could enable a more complete investigation of the correlation between advertisement designs with Art Nouveau expressions and the interests of consumers, allowing speculation on trends in print advertising design.

D. Conclusion

Print advertisements with Art Nouveau styles can directly reflect the preferences of consumers in today's market. The research conclusion is that with the present high level of development in digital technology and new media, designers have an abundance of usable media. The concepts of single medium design are no longer able to satisfy consumers. A combination of art and technical knowledge, serving as an intermediary for the development of individual creativity, is necessary for designers in propagating their messages. Based on the results of the AIDA model, people's gender, age, and education level influences mixed-style advertising. Therefore, product vendors, advertising agencies, and advertising designers can follow trends and develop images that are relevant to consumers and attract attentions, thereby facilitating consumption.

REFERENCES

[1] R. S. Zander, and B. Zander. *The Art of Possibility: Transforming Professional and Personal life. Boston: Harvard business school press*, 2000.

[2] P. Kotler, and K. L. Keller. *Marketing Management, 14th Edition. Publisher: Pearson College Div*, 2011.

[3] Y.-L. Yu, *An Essential Aspect of Drawing Education from Dynamically Aesthetic Perception.* J. Aesthetic. Educ. vol. 178, no. 1, pp. 59-66, 2010.

[4] T.-S. Fong, *The Persuasive Power of Rhetorical Website Design: Marketing Loyalty in the E-Commerce Environment. Verlag: VDM publishing house Ltd*, 2008.

[5] J. Naisbitt, *Mind Set! Reset your Thinking and See the Future. New York: Harper Collins*, 2006.

[6] Y.-L. Yu, *The Influence of In-game Advertising and Marketing Strategies on the Purchase Behavior of Consumers*, 2010 Media and Environment International Conference, Taipei: Fu Jen Catholic University, 2010.

[7] A. Chaudhuri, and M. B. Holbrook, *The Chain of Effects from Brand Trust and Brand Affect to Brand Performance: The Role of Brand Loyalty*, J. Market. vol. 65, no. 2, pp. 81-93, 2001.

[8] G. A. Clark, D. D. Michael, and W. D. Greer, *Discipline-based Art Education: Becoming Students of Arts*, J. Aesthetic. Educ. vol. 21, no. 2, pp. 129-96, 1987.

[9] I. Rogoff, *Studying Visual Culture. in The Visual Culture Reader*, N. Mirzoeff, ed. New York: Routledge, 1998, pp. 14-26.

[10] K. Freedman, *Social Perspectives on Art Education in U.S.: Teaching Visual Culture in a Democracy*, Stud. Art Educ. vol. 41, no. 4, pp. 314-29, 2000.

[11] C. Ballengee-Morris, and P. L. Stuhr, *Multicultural Art and Visual Culture Education in a Changing World*, Art Educ. vol. 54, no. 4, pp. 6-13, 2001.

[12] P. Duncum, *Visual Culture Art Education: Why, What and How*, Int. J. Art Des. Educ. vol. 21, no. 1, pp. 14-23, 2002.

[13] B. Wilson, and C.-F. Kao, *An Taiwanese Arts and Humanities Integrated Curriculum: Problems and Prospects*, Res. Arts Educ. vol. 6, pp. 1-18, 2003.

[14] K.-C. Tsui, *The Development of Aesthetic Judgment*. Taipei: Lucky Book Store, 1992.

[15] M. L. Lo, *The Study of Relationship between Art Museum Visitors' Characteristics and Art Appreciation Ability.* Taipei: National Taiwan Normal University Master's Thesis, unpublished, 1993.

[16] C. Charlotte, *Imperfect Beauty ─ the Making of Contemporary Fashion Photographs*. London: V&A Publications, 2000.

[17] G. H. Zhang, *Copying Reality–Discourse and Practice of Conceptual Systems in Postmodern Photography.* Taipei: Garden City Publishers, 2000.

[18] C.-H. Chen, and B. *I, Psychology and Art Education*. Arts and Humanities Education, vol. 1, R.-L. Hwang, ed. Taipei: Laurel, 2002, pp. 155-183.

[19] J. S. Kuo, and H.-L. Chao, *Visual Culture and Art Education.* Arts and Humanities Education, vol. 1, R.-L. Hwang, ed. Taipei: Laurel, 2002, pp. 325-66.

[20] H.-L. Chao, *Visual Culture and Art Education*. Taipei: Lucky Book Store, 2005.

[21] S. Wang, *Modern World Graphic Design.* Taipei: Artist Publishing, 2000.

[22] E. Panofsky, *Studies in Iconology*. New York: Harper & Row Publishers, 1972.

[23] N. Pevsner, *Pioneers of Modern Design*. Taipei: Architecture & Culture Publishing, 1993.

[24] S. Kismaric, and E. Respini, *Fashioning Fiction in Photography since 1990*. New York: The Museum of Modern Art, 2004.

[25] M. J. Parsons, *How We Understand Art: A Cognitive Development Account of Aesthetic Experience*. Cambridge: Cambridge University Press, 1987.

[26] T.-S. Fong, and Y.-L. Yu, *Framework of Effective Web Site Design for Consumer Loyalty in B2C Electronic Commerce*, 2004 Republic of China Commercial Distribution Symposium, National Kaohsiung First University of Science and Technology, 2004.

[27] Y.-L. Yu, *Efficient Strategic Plan of Video Game Design. Verlag*. VDM Publishing House Ltd, 2009.

[28] R. Barthes, *Eléments de semiology*. Paris, Jonathan Cape Ltd, 1965.

[29] B. Tsai, *Art Nouveau*. Taichung: Hong Xiang Publishing, 1995.

[30] C.-J. Ye, *Artistic Language @ the Digital Age*. Taipei: Artist Collection, 2003.

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Three-dimensional variable face model formation manufacture device based on face impression evaluation

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Abstract
The authors have often experienced that impression extremely changes with slight deformation of profile and molding in the face modeling by 3DCG. Therefore, in this paper, the authors aim at clarifying how variation of the facial structure affects that of psychological impression and at proposing modeling device by determining structure of various face impression. Impression evaluation with plane illustration and photos, which are two-dimensional images, have been studied by a number of researchers so far.
In this paper, facial 3D models were produced by direct operation on monitor. Digitizing each facial part enabled to have facial images deformed at will. Moreover, quantity of transformed location can be grasped as an advantage and it is a unique system on the premise of creation of a real 3D face model

Keywords: Face impression, Three dimension computer graphic, Facial modeling

1. Introduction

There have been a lot of past studies on face impression evaluation. In most of their studies, impression evaluation factors were derived by principal component analyses with some stimulus words for figures simply consisting of facial profile, eyebrow, eyes, nose and mouth by illustration and photos for which each expression was shot and their relationship with the parts were described. For example, Abe et al. (2008) related impression evaluation factors such as fresh by shape and placement of elements such as facial profile, eyes, eyebrow, nose and mouth, using features map determined beforehand [1] and Kaneko et al. studied a portrait development system by which eyebrow, eyes, nose, mouth and profile were transformed [2]. In this study, the authors produced a three-dimensional face for real expression and designed a system that newly forms a face based on impression factors. Here, we deal with positive face creation not with a face that is already made and aim at applying the technique to creation of new characters in CG production.

2. Method and Purpose of the Study

The purpose of this study is to understand the factors that determine face impression by evaluating face impression created using 3DCG, to examine the structural features of the face that influence these image evaluations, and to deduce the regularities of facial structure that provide these images. Furthermore, we create various facial models based on the regularities deduced from the basic model and demonstrate the process for proposing a template for CG facial modeling.

In this study, it was possible to quantify facial modeling by creating an experimental face using CG and recording and reproducing the parameters that changed on each part of the face.

The study method consisted of studying modern perceptions by referring to books, etc. relating to beauty and faces that were targeted at young people and collecting words and phrases relating to facial expressions from various magazines to identify image expression trends. Using these as references, we extracted stimulus words for use in the image evaluation experiment. Then, we conducted image evaluation on a 3DCG facial model using the SD method and, while determining the mutual semantic relationship of impression words by extracting the mutual correlation of impression words and factors relating to image evaluation, we also deduced the regularities from a surface anatomical perspective.
Furthermore, we created a template for facial modeling from the regularities deduced.

3. Image Evaluation Experiment for Facial Models

3.1. Study of Impression Words

In order to conduct a face impression evaluation, we studied impression words by referring to descriptions in magazines. Specifically, we focused on current facial expressions as expressed in magazines aimed at young people and extracted words from magazines that target women from their late teens to their forties.

We studied 12 magazines; 'Be-Story,' 'Bijin-Hyakka,' 'Lips,' 'SOUP,' 'JJ,' 'KERA,' 'SEDA,' 'MAQUIA,' STORY,' 'ar,' 'BITEKI,' and 'KATY.' We also studied six books relating to

beauty or faces; 'CUTiE Make-up 2012,' 'Actress Make-up,' 'With: Super Simple Cute Make-up for Adults,' 'All about Make-up Method,' 'Reading Faces,' and 'Face Analysis.' Table 1 summarizes and classifies the impression words collected from the magazines and books. The 89 impression words were organized and classified into word groups; nouns, adjective verbs, adjectives, adverbs, and 'Other (multiple expressions).'

As a result of the classification of the impression words, we found that the magazines and books we studied, which were aimed at women, included many distinctive expressions to create a specific atmosphere.

Table 1: Impression Words Studied from Books relating to Beauty and Faces

Nouns	Adverbs
Baby face	Plump
Mature face	Soft
Mixed race face	Other (multiple expressions, etc.)
Childlike face	Elegant
Fox face	Smart image
Childish face	Refined
Lonely face	Cool beauty
Heroine face	Dependable face
Dolly face	Mature face
Princess face	Dependable-looking face
Elegant face	Haggard face
Romantic face	Grown-up cute
3-D face	Adult-like cute
Spring face	Refined and trim
Doll-like face	Cool and cute
Manly face	Healthy and bright
Pure face	Mature and gentle
Sweet face	Celebrity
Lady face	Beautiful, womanly face
Lion face	Kind and feminine
Adjective verbs	Soft and pretty
Healthy	Grown-up pretty
Neat and trim	Slightly girlie
Beautifu	Neat and sharp
Natural	Graceful image
Refined	Pampered baby face
Sexy	Innocent and loved face
Generous-hearted	Cool and enchanting
Cute	Soft, sweet face
Girlie	Mixed race celebrity-like face
Manish	Bare-faced fresh face
Formal	Orthodoxly popular face
Cold	Innocent and cute
Handsome	Urban beauty
Rich	Devilish doll face
Adjectives	Sexy and coquettish
Childish	Beautiful actress face
Sweet	Gentle and soft
Feminine	Cool, mature face
Cool	Self-assured adult image
Cute	Grown-up, smart image
Gentle	Sharp cool
Bright	Sharp and cool
Severe	Kind and gentle
Adult-like	
Childlike	
Gentle	

3.2. Creating a 3DCG Model

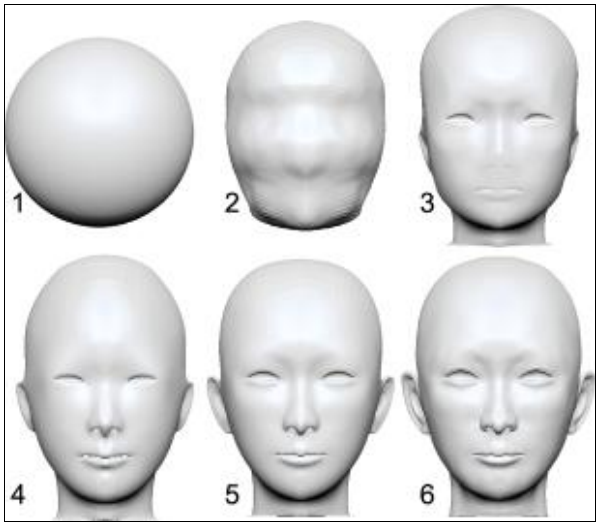

Fig.1: Creation Process for the Basic Model

We created a 3DCG facial model by expressing three-dimensional coordinate data as mesh data using a method for creating the face whereby the polygons in the sphere are increased while the positions of the parameters are changed for each part of the face. By using 3DCG to create the face, rather than a photograph or drawing, it was possible to quantify each part of the face and record the transformation process from the basic figure. It was also easier to capture the subject as an object using animation.

In the experiment, we created a total of 24 facial models by moving the positions of the parameters for each part of the face from the original basic facial model. The main parts of the face that we changed were the 'eyebrows, eyelids, the medial angle of the eye, auricular points, nostrils, the nasal point, the apex of the nose, the subnasal point, the mouth and the gnathion. Other changes were also made to the flesh on the cheeks and chin.

Fig.3 shows the 24 models created for the image evaluation experiment using the aforementioned method.

3.3. Image Evaluation Experiment for a 3DCG Facial Model

21 students aged between 18 and 26 (average age: 20.6) studying art engineering and having CG modeling experience were selected as the subjects of the experiment.

In regard to the image experiment conditions, the subjects were shown front-facing still images for 10 seconds each and then shown animated images of the faces rotated 45°to the left and 45°to the right for approximately 75 seconds on a 52 inch monitor. They completed a survey while viewing the images.

We referred to words and phrases selected from magazines, etc. and to academic journals and theses for the impression words used in this experiment. We also conducted a five-step evaluation using 18 pairs of these impression words together with their antonyms.

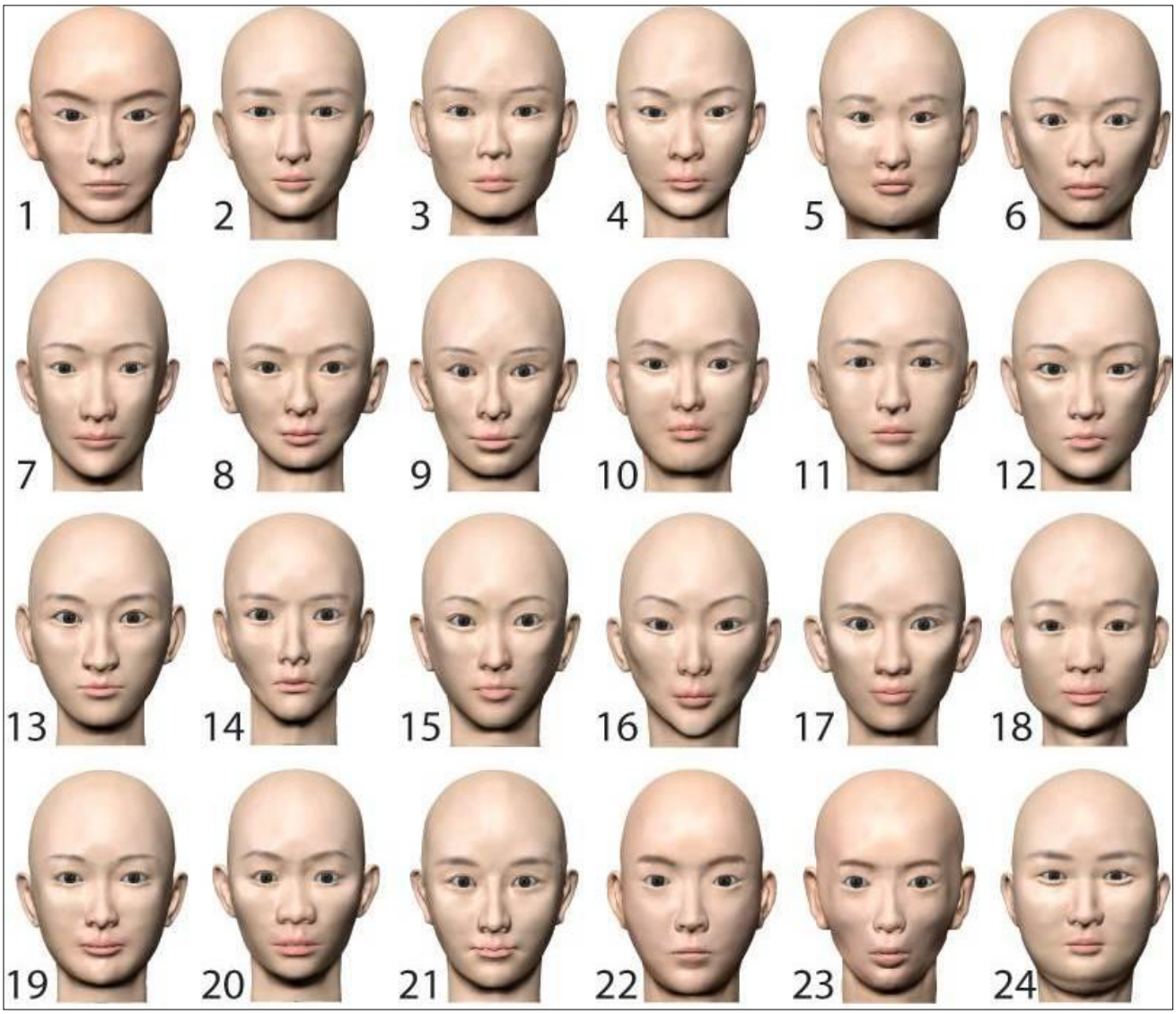

Fig.2: All Models for the Image Evaluation Experiment

3.4. Image Profile

For the image evaluation experiment, we graded the evaluation for each impression word for each model from 1 to 5 and output the average score. The impression words for which the average score was low or high represent the predominant image of that model. Fig.3 is a graph of the 24 models. Hereafter, we discuss the models that have a particularly strong image according to these results and describe the features of these models.

The features, 'large, fleshy face with a broad chin,' are apparent for images such as No.5, which was described by subjects as 'heavy, large, and vacant.'

The features 'upturned eyes, prominent cheekbones, narrow jaw and little flesh' are apparent for images such as No.16, which was described by subjects as 'individual and sharp.'

The features 'large eyes, thick lips, wide nostrils, thick eyebrows, and prominent cheekbones' are apparent for images such as No.17, which was described by subjects as 'healthy and dynamic. 'The features 'round eyes, no flesh, and thick lips' are apparent for images such as No.23, which was described by subjects as 'poor, unhealthy, and not cute.'

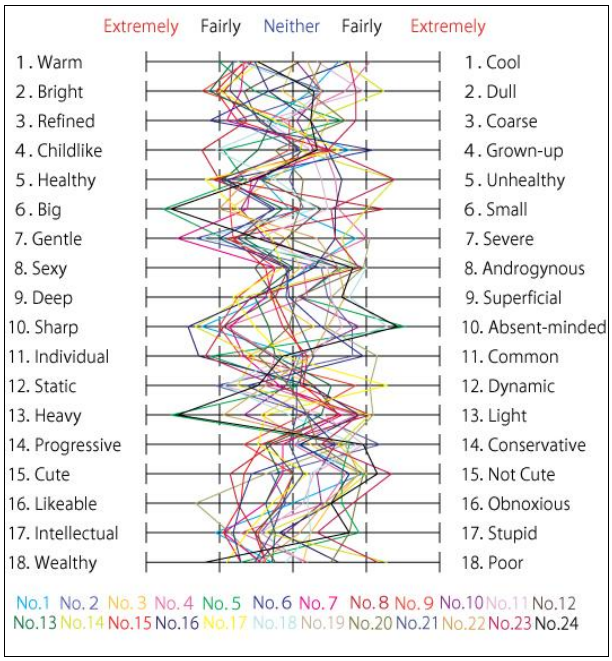

Fig.3: Graph of SD Profile Averages

In order to understand the correlation between impression words, we conducted correlation coefficient matrix analysis. Figure 4 is a diagram of the correlation coefficient matrix and shows the impression words that have a strong correlation.

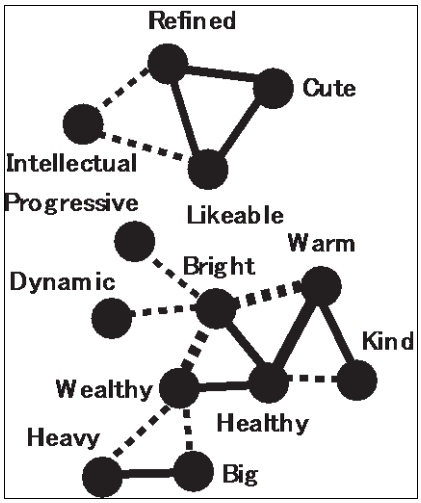

Fig.4: Correlation Coefficient Matrix for Impression Words

The impression words for which there is a strong correlation between the words and phrases according to the analysis can be grouped into three broad groups; a group relating to 'agreeable images' including such words as likeable, refined, and cute, a 'healthy and warm' group including such words as healthy, warm, wealthy, bright, and kind, and a 'large perception' group including words such as heavy and large. It is assumed that words and phrases with a strong correlation are perceived as words and phrases that conjure a similar image for the subjects.

Table 2: Principal Component Values for the Image Evaluation

		Principal component	Principal component	Principal component
1. Warm	Cold	0.802	−0.442	−0.114
2. Bright	Dull	0.841	0.170	−0.453
3. Refined	Coarse	0.776	0.197	0.566
4. Childlike	Grown-up	0.093	−0.351	−0.141
5. Healthy	Unhealthy	0.910	−0.248	−0.213
6. Large	Small	0.305	−0.618	−0.536
7. Kind	Severe	0.739	−0.427	0.114
8. Sexy	Androgynous	0.775	0.519	−0.067
9. Deep	Superficial	0.085	0.786	−0.455
10. Sharp	Vacant	−0.212	0.942	−0.114
11. Individual	Common	−0.506	0.237	−0.678
12. Static	Dynamic	−0.409	−0.366	0.792
13. Heavy	Light	0.138	−0.830	−0.408
14. Progressive	Conservative	0.416	0.740	−0.436
15. Cute	Not cute	0.878	0.114	0.315
16. Likeable	Obnoxious	0.906	0.264	0.278
17. Intellectual	Stupid	0.494	0.658	0.431
18. Wealthy	Poor	0.800	−0.420	−0.171
Contribution ratio		39.8%	27.3%	16.5%

Next, we conducted principal component analysis for 1-3 factors. Table 2 shows the numerical values for the principal component coefficient matrix after varimax rotation.

We used the three principal components in Table 2. The contribution ratio was 39.8% for principal component 1, 27.3% for principal component 2, and 16.5% for principal component 3. The total contribution ratio was 83.6%.

The words 'healthy/unhealthy,' 'cute/not cute,' bright/dull,' 'warm/cold,' and 'wealthy/stupid' were evaluated highly with regards to principal component 1 and it was designated the 'likeability rating' axis.

The words 'sharp/vague,' 'heavy/light,' and 'deep/superficial' were evaluated highly with regards to principal component 2 and it was designated the 'weight perception' axis.

The words 'static/dynamic' and 'individual/common,' were evaluated highly with regards to principal component 3 and it was designated the 'power' axis.

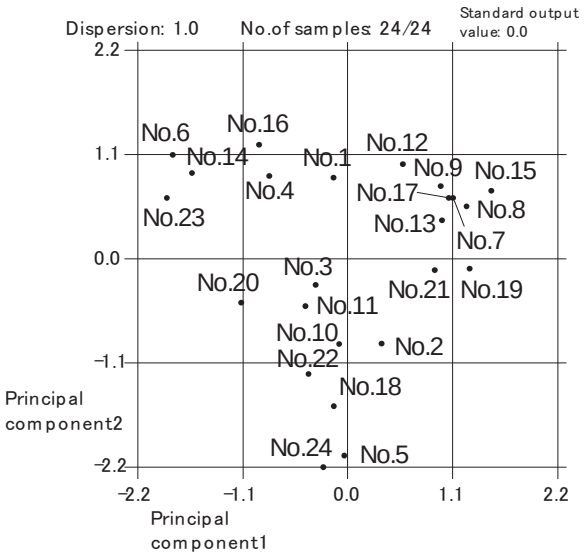

Fig.5: Score Dispersion Figure for Principal Components 1 & 2

Next, we identified the facial models that contributed significantly to each principal component and conducted analysis of structural features. Figures 5 and 6 show the principal component scores for the facial models.

The structural features apparent for principal component 1 include 'raised eyebrows,' 'prominent cheekbones,' 'emaciated,' and a 'triangular face shape.'

The structural features apparent for principal component 2 include 'size of the nostrils,' 'shape of the eyebrows,' 'prominent cheekbones,' 'flesh,' 'outline of the face,' and 'above and under the eyes.'

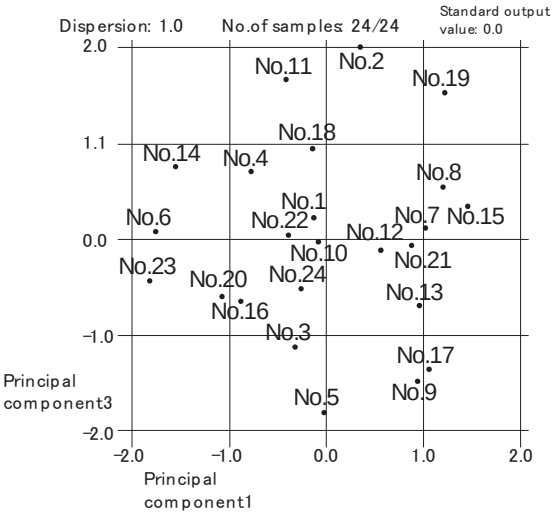

Fig.6: Score Dispersion Figure for Principal Components 1 & 3

The structural features apparent for principal component 3 include 'shape of the eyes,' 'thickness of the eyebrows,' 'shape of the eyebrows,' 'prominent cheekbones,' 'flesh,' 'outline of the face,' 'size of the nostrils,' and 'angle of the mouth.'

In order to conduct feature analysis of the numerical values for each part of the face, we measured various parts of the face. Fig.10 shows the parts of the face measured. The figure shows the item IDs as prescribed in the JIS (Japanese Industrial Standards) and the item IDs, numbers 01 to 10, that we assigned to parts of the face not in in the JIS standards.

The names of each part are defined by the JIS standards as, A3-Bitragion breadth, A8-Bigonial breadth, A10-Interocular breadth, A11-Biectocanthion breadth, A12-Nose breadth, A13-Mouth breadth, A14-Lip height, A16-Nose height, A17-Subnasale to gnathion, A18-Philtrum length, and A36-Total head height. Next, we defined the parts not specified in the JIS as 01-Glabella, 02-Eye breadth, 03-Eye height, 04-Angle of the outer corner of the eye, 05-Angle of the outer corners of both eyes from the lips, 06-Angle of the mouth, 07-Chin breadth, 08-Profile breadth, 09-Nose height, and 10-Mouth protrusion.

Next, we conducted feature analysis using the measurements for each principal component. It was found that, in the group where the principal component scores for principal component 1 were high, the subjects tended to be influenced by A3 (Bitragion breadth), A8 (Bigonial breadth), A13 (Mouth breadth), 06 (Angle of the mouth),

07 (Chin breadth), and 08 (Profile breadth). It was found that, in the group where the principal component scores for

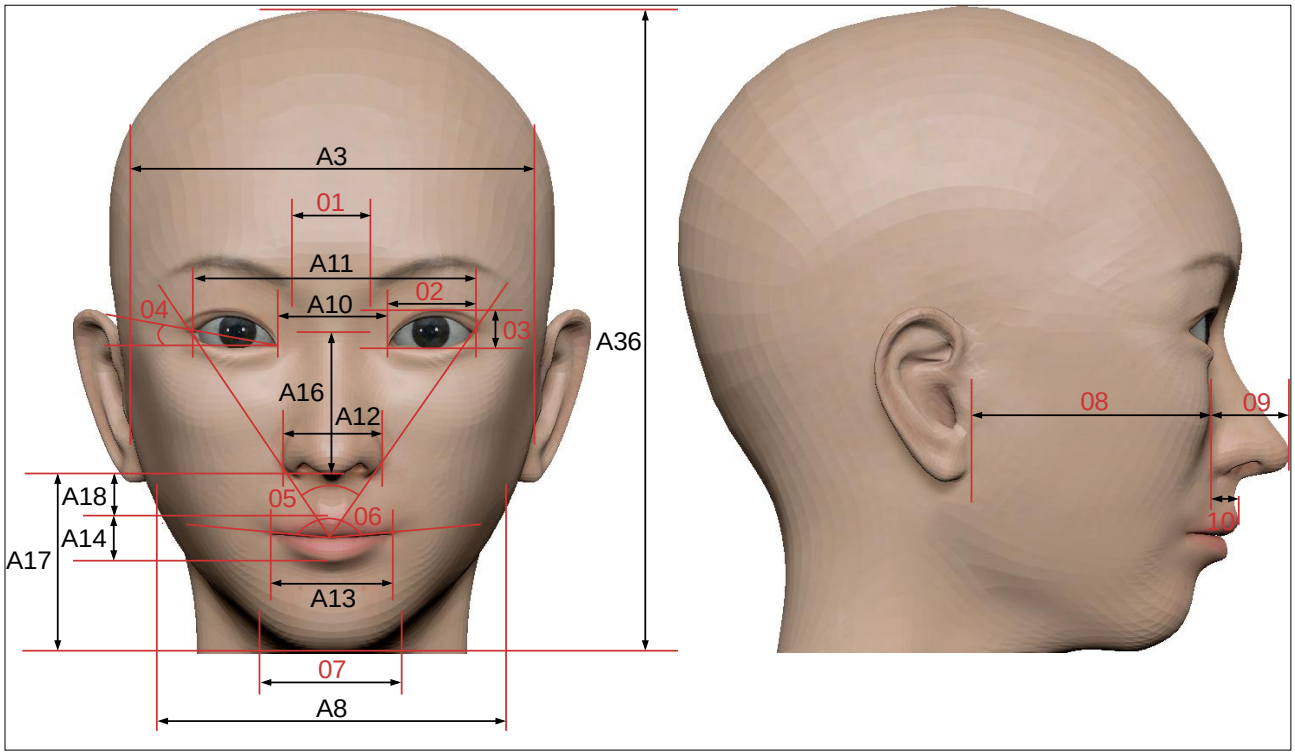

Fig.7: Measured Parts

principal component 1 were low, the subjects tended to be influenced by 02 (Eye breadth), 06 (Angle of the mouth), 08 (Profile breadth), and 09 (Nose height).

It was found that, in the group where the principal component scores for principal component 2 were high, the subjects tended to be influenced by A18 (Philtrum length), A36 (Total head height), 02 (Eye breadth), 03 (Eye height), and 08 (Profile breadth). It was found that, in the group where the principal component scores for principal component 2 were low, the subjects tended to be influenced by A8 (Bigonial breadth), A13 (Mouth breadth), A36 (Total head height), 02 (Eye breadth), 04 (Angle of the outer corner of the eye), 07 (Chin breadth), and 08 (Profile breadth).

It was found that, in the group where the principal component scores for principal component 3 were high, the subjects tended to be influenced by A8 (Bigonial breadth), A18 (Philtrum length), 04 (Angle of the outer corner of the eye), 07 (Chin breadth), and 09 (Nose height). It was found that, in the group where the principal component scores for principal component 3 were low, the subjects tended to be influenced by A12 (Nose breadth), A13 (Mouth breadth), A14 (Lip height), A36 (Total head height), 01 (Glabella), 02 (Eye breadth), 03 (Eye height), 04 (Angle of the outer corner of the eye), 07 (Chin breadth), and 08 (Profile breadth).

4. Production of variable face model

The first, second and third main components of the facial impression factors were extracted by impression evaluation. In this paper, we created a face variation system based on the increase and decrease of the three impression factors that are extracted by determining basic modeling and considered methods by which various face impression could appear. This does not simply create facial expression disorderly but face expression can be changed by operating physical values from the impression factors. With evaluation of questionnaire, numerical variation of each facial part was discussed by a face variation system based on each factor.

Fig.8: Basic Model

Figure 8 shows basic modeling to produce a variable impression face. For a production method of basic modeling, first, referring to the point that the points such as long and thin corner of the eyes, nose that is not so high, slightly blobby wings of the nose and mouth that comes out slightly over the chin, which are facial features of Orientals [3], the entire facial image was determined subjectively (note that size was not taken from photos). At that time, referring to books about beauty that list characteristics according to facial types [4] [5], a face without no features was created. As for other 24 sample images, faces which gave a different impression were created subjectively referring to stimulus words used in image research. These faces were used as sample CG images for experiments. As a result of evaluation by SD method based on this facial impression evaluation, the following three factors were obtained.

A3 (Bitragion breadth) - 12.363cm, A36 (Total head height) -20.078cm, A8 (Bigonial breadth) - 10.31cm, A10 (Interocular breadth) - 3.442 cm, A12 (Nose breadth) - 3.235 cm, A13 (Mouth breadth) - 3.82 cm, A14 (Lip height) - 1.423 cm, A16 (Nose height) - 4.619 cm, A17 (Subnasal to gnathion) - 5.505 cm, A18 (Philtrum length) - 1.192 cm, 01 (Glabella) - 2.559 cm, 02 (Eye breadth) - 2.813 cm, 03 (Eye height) - 1.152 cm, 04 (Angle of the outer corner of the eye) - 6.35°, 05 (Angle of the outer corners of both eyes from the lips) - 68.975°, 06 (Angle of the mouth) - 174.39°, 07 (Chin breadth) - 4.976 cm, 08 (Profile breadth) - 6.955 cm, 09 (Nose height) - 2.116 cm, and 10 (Mouth protrusion) - 0.819 cm

4.1. Creating a Model for Each Group

To create the Variable impression formation manufacture device, we created a model by combining the visual features with the features from the measured values for each image.
From the basic modeling, a system which was able to change to a 3DCG model with parametric information of features according to the main components was produced.
It was then possible to change the parameters for each part of the three-dimensional basic model to parameters to display each image.

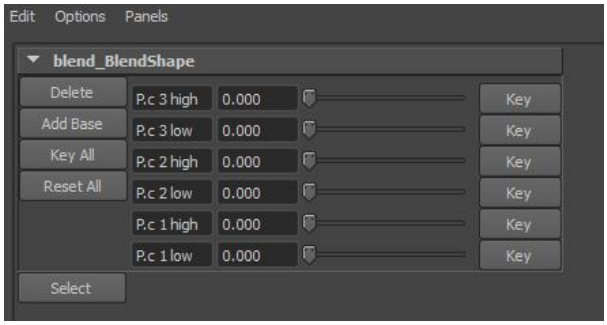

Fig.9: Variable impression formation device Menu

As shown in Fig.9, the values for the basic model template were set to '0.000' and the image modified by a third decimal place each time up to '1.000.' When extracting basic modeling by factor information of each main component, an unnatural face was obtained in the case of exceeding 1.000 and therefore the upper limit was determined 1.000

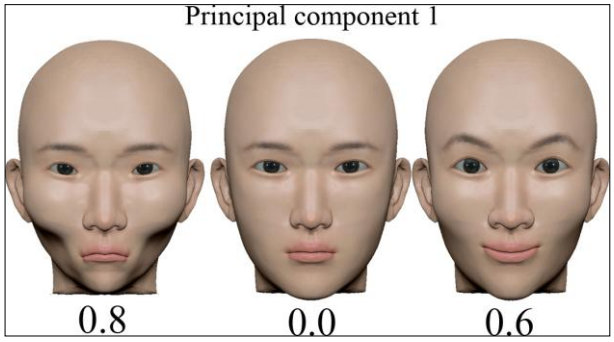

Fig.10: Verification Model for Principal Component 1

The image in the center is the basic model with the value at '0.0' and the image on the right shows the model transformed by inputting '0.6' into the characteristics of variable impression formation device that 'Favorability' scores of the principal component 1 were high.

Factors of a model having high scores of the principal component 1 relate to width of the face(A3), form of the cheekbone(08), flesh(A3・A8), form of the chin(07・A8), angle of the eyebrow, size of eyes(02・03), length of the nose(A16), size of the wings of the nose(A12), size of the mouth(A13・A14), corners of the mouth(06).

The image on the left shows the model transformed by inputting '0.8' into the characteristics of variable impression formation device that the scores for principal component 1, ' Favorability' were low.

Factors of a model having low scores of the principal component 1 relate to form of the face(07・A3・A8・A36), form of the cheekbone(08), flesh(A3・A8), form of eyes(02・03・04), thickness of lips(A13・A14), corners of the mouth(06), The width of the face(08), height of the nose(09).

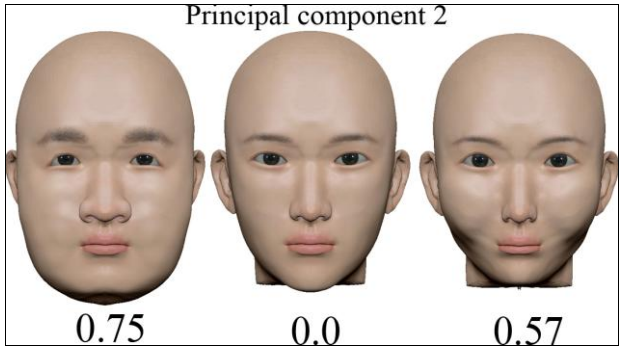

Fig.11: Verification Model for Principal Component 2

The image in the center is the basic model with the value at '0.0' and the image on the right shows the model transformed by inputting '0.57' into the characteristics of variable impression formation device that 'weight perception' scores of the principal component 2 were high.

Factors of a model having high scores of the principal component 2 relate to form of the face(07・A3・A8・A36), form of the cheekbone(08), flesh(A3・A8), form of eyes(02・03・04), length of the lower part of the nose(A18), The width of the face(08).

The image on the left shows the model transformed by inputting '0.75' into the characteristics of variable impression formation device that the scores for principal component 2, 'Weight perception,' were low.

Factors of a model having low scores of the principal component 2 relate to form of the face(07・A3・A8・A36) ,size of face(A3・A36), flesh(A3・A8), thickness of the eyebrow, form of eyes(02・03・04), size of the wings of the nose(A12), size of the mouth (A13・A14).

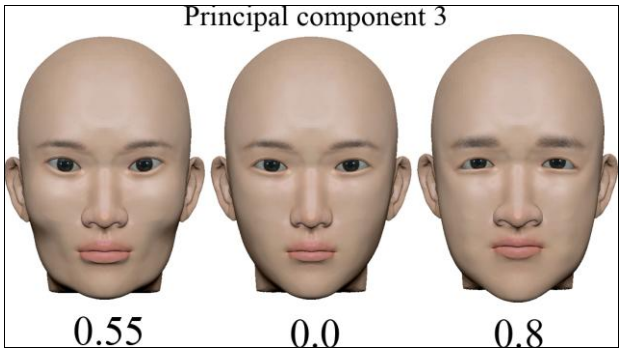

Fig.12: Verification Model for Principal Component 3

The image in the center is the basic model with the value at '0.0' and the image on the right shows the model transformed by inputting '0.8' into the characteristics of variable impression formation device that 'Power' scores of the principal component 3 were high.

Factors of a model having high scores of the principal component 3 relate to form of the face(07・A3・A8・A36), form of the cheekbone(08), flesh(A3・A8), thickness of the eyebrow, angle of the eyebrow, form of eyes(02・03・04), length of the nose(A16), height of the nose(09), size of the wings of the nose(A12), length of the lower part of the nose(A18), length of the lower part of the mouth(A17-(A18+A14))

The image on the left shows the model transformed by inputting '0.55' into the characteristics of variable impression formation device that the scores for principal component 3, 'Power' were low.

Factors of a model having low scores of the principal component 3 relate to form of the face(07・A3・A8・A36), form of the cheekbone(08), flesh(A3・A8), angle of the eyebrow, size of eyes(02・03), form of eyes(02・03・04), size of the wings of the nose(A12), size of the mouth (A13・A14),

5. Conclusion and Future Development

In this paper, the authors evaluated impression of a 3D face model using SD method and created a face transformation device based on the result. We extracted a model with the features of each main component using a face deformation device operating physical values, whose basic model originates in impression factors.

By inputting numerical values from '0.000' to '1.000,' it was possible to extract a facial model for each image. Furthermore, we found that the higher the numerical value, the stronger the resulting image. However, we also found that if we input

numerical values above a certain level, some models no longer resembled a human face.

However, when entering values above certain values, an unnatural face is obtained in some models and cases and therefore the upper limit of the value was determined 1. However, when entering values more than 1 such as 2 or 3, a realistic face is not obtained through various results are obtained.

Because the 3DCG facial model used in this experiment had no outstanding features and classification was difficult, we were not able to clarify user judgment and model feature extraction. In the future, it will be necessary to conduct the experiment using a model with pronounced features, starting with the contours of the face and including the shape and angles of the eyes, nose, and lips. The authors are going to perform further impression evaluation in the future based on the face generated by this system and improve the precision.

References

[1] Tsuneyuki ABE, Megumi OHKAWA, Ruriko TAKANO, *Effect of overgeneralization on evaluation of facial impressions*, Japanese Academy of Facial Studies,Vol. 8, No. 1, 2008

[2] Miyamoto Shin-ya, Imai Jun-ichi, Kaneko Masahide, *Description of Facial Features by Words and Its Application to Retrieval of Similar Faces*, ITE Technical Report, Vol34, No.10, pp.113-116, 2010

[3] Turuoka TAKAO, *Super Dessin3*, Graphic Ltd., p30, 2002

[4] Yokoyama KEIKO, *All About Make Up Method*, Mynavi Ltd., pp12-20, 2011

[5] Kamata MAKOTO, *Facial Analysis*,Kodansha Ltd. pp65-66, 2008

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Generating Wayang Beber of Pacitan Character's Outline Using Renderman Interface

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Abstract
Wayang is a traditional medium for storytelling in Indonesia. Wayang isn't popular today. The Digital technology gives opportunities to develop new types of wayang which could be interesting to the new generation. Our research attempts to develop a new form of wayang using 3D computer graphics animation technology. We want to make a CG animated wayang based on the visual form of wayang beber especially wayang beber of Pacitan.
Wayang beber is a distinct type of wayang. Unlike the other types of wayang, wayang beber is not a puppet, but a sequence of picture drawn on several scrolls. Wayang beber is known as the oldest type of wayang. One of the wayang beber types is wayang beber of Pacitan.
Wayang beber of Pacitan especially the character figure has a unique visual form. It is a flat 2 dimensional graphic with limited colors but rich with ornamental details. We use a non-photorealistic rendering technique to simulate the wayang beber of Pacitan visual features on a 3D CG model. One of the important wayang beber of Pacitan visual features is the outline.The wayang beber of Pacitan outline has some incorrectness qualities, such as a variation of thickness and wiggliness. These qualities are typical characteristics of a human drawing. The first step of our research is generating an outline of a 3D CG figure that has these incorrect qualities. In this paper we explain the development of the shader for generating the desired outline qualities that could work in the Renderman interface. We developed a shader algorithm that can displace an object's surface point with the gradual and random distance. This algorithm can be used to generate an outline with a variation of thickness and wiggliness.

Keywords: computer graphic, animation, non-photorealistic rendering, renderman, traditional picture

1. Introduction

Wayang is a traditional medium of storytelling from Indonesia. According to Hazeu [1], wayang originated from the pre-historic era of Java in Indonesia. Wayang evolved for many centuries as a tool for religious ceremonies, affected by Hindu and Islamic culture.

Wayang was very popular in Indonesia, particularly in Java. This was realized by the wali, Islamic leader of Java in the 16th century. They used wayang to disseminate Islamic religion in Java [2]. The popularity of wayang also can be seen in the late 18th century; in this era many Javanese traditional illustrations were influenced by the wayang visual style [3].

The popularity of wayang is decreasing today and several types of wayang are rarely performed. Some of them even can no longer be seen. The younger generation seems uninterested in the old form of wayang. Digital technology gives opportunities to develop new types of wayang which is more interesting to this younger generation.

Our research attempts to develop a new version of wayang using 3D computer graphics animation technology. We want to make a CG animated wayang based on the visual form of wayang beber especially wayang beber of Pacitan.

Wayang beber is one type of wayang. It is a sequence of pictures drawn on several scrolls. One type of wayang beber that remains today is wayang beber of Pacitan[4]. Wayang beber of Pacitan tells the story of Jaka Kembang Kuning, so it is also known as wayang beber Jaka Kembang Kuning (see Fig. 1).

We choose to develop wayang beber because it is the origins of animation. As we know, the sequential drawing of human or animal figures such as wayang beber has been considered as the origins of animation [5]. Wayang beber of Pacitan especially the characters also has a unique visual form. It is a flat 2-dimensional graphic with limited colors but rich with ornamental details. Compare to modern pictures, wayang beber of Pacitan has a distinct way of depicting human figure.

Figure1. Part of a fifth wayang beber of Pacitan scroll

We use 3D CG technology because of several advantages, such as free inbetweening, free perspective, unlimited revisions, and an economy of scale [6]. Nowadays, the 3-dimensional computer graphic animation technology is commonly used to produce 2-dimensional graphics using a process called non-photorealistic rendering. This process needs several steps. This paper is only focusing on the first step: render the outline of the 3D computer graphic figure. We rendered the image using Renderman, an Application Programing Interface designed by Pixar studios for animation production. In this paper we explain the development of the shader for generating the wayang beber of Pacitan outline on the 3D CG figures that can be worked in the Renderman interface.

2. The Features of Wayang Beber of Pacitan Outline

According to Curtis, the most important thing in non-photorealistic rendering is defining the art direction. The art direction is the mental image of what the finished product should look like, down to the tiniest detail [6]. To define the art direction, we needed a good reference image. We used a replica of the wayang beber of Pacitan painting as the reference image. This replica is made by a modern artist, a member of the wayang beber metropolitan community in Jakarta, Indonesia (see Fig.2).

We used the replica because the original wayang beber of Pacitan painting is difficult to access. The original painting is believed as a sacred thing by the local community. It can only be seen in a certain occasion. We have access to a representative copy of wayang beber of Pacitan painting, as can be seen in figure 1. This copy is made by royal painter by the order of the King of Mangkunegaran in 1939. This painting is kept in Mangkunegaran Palace, Surakarta city, Indonesia. However the condition of the painting is not good, so we needed to look for another painting as a reference image.

We found a replica of the wayang beber of Pacitan painting made by a member of wayang beber metropolitan community. The quality of the painting is very good and imitates the original painting very well. Therefore we used this painting as a reference image.

Figure2. The replica of the wayang beber of Pacitan painting [7].

We examined the reference image using a theory by Professor Primadi Tabrani from Bandung Institut of Technology (ITB), Indonesia [4]. Professor Primadi Tabrani studied several Indonesian traditional pictures including the wayang beber of Pacitan and then developed a theory called visual language. This theory described the traditional picture as visual language; the picture doesn't only represent an object but is also used to communicate a message or story. The most important concepts in visual language theory are the image and the visual grammar. The image is the smallest unit in visual language; it is equal with words in verbal language. The visual grammar is certain rules to form, organize, or arrange the image in order to be able to communicate the message.

Since this research focused on the wayang beber of Pacitan character figure, we only needed to understand the image. In visual language theory the image consists of the image content and the image way. The image content is the object which is depicted by the image, and the image way is the way to draw the image. For example, we took a look at the reference image of Gandarepa (see Fig.3). The image content of this image is the character of Gandarepa, one of the protagonist characters in the wayang beber of Pacitan story. The image way of this image is the way to draw the character of Gandarepa.

Professor Primadi Tabrani discovered many ways to draw the image in traditional pictures. He classified the ways into four types: the drawing size, the drawing angle, scale and the drawing technique. In this paper we focus on the drawing technique.

Figure3. the image of Gandarepa character

The drawing technique is a way to draw the image using the visual elements, such as line, color, and shape. According to Primadi Tabrani, the Gandarepa image in wayang beber Pacitan is drawn using a drawing technique called "blabar" [4]. Blabar is the way to draw the image by using lines to form the shape. This drawing technique uses limited colors.

In another literature, we found that wayang beber of Pacitan is made using Javanese traditional painting technique called "sungging" [8]. The complete explanations of sungging painting technique can be found in the paper by Ahmadi [9], Purbasari [10], and the book by Sukir, written in 1980[11].

Basically, this sungging technique has similarities with the blabar technique which is explained by Primadi Tabrani. Purbasari[10] in her paper said that the sungging technique begins by coloring the figure, and is followed by adding the outline on the image. The outline is used to form and fix the image shape.

The sungging technique has certain rules to make the painting. These rules cause distinct qualities of lines, colors, and patterns; we described them as visual features of wayang beber of Pacitan. We need to simulate all of the visual features in computer graphics to create a wayang beber of Pacitan animated film. However, in this paper we focus on the outline features. The complete explanation about the other features can be seen in [12].

The outline of the wayang beber character image has three important features. Firstly, the outline is relatively thick. There is no literature explaining how thick the outline should be made. However the outline should be thick enough so it can be seen clearly from a distance. The thick outline has a function to emphasize the character shape, and to separate it from the background.

Secondly, the outline has a variation of thicknesses (see Fig.4.). The outline thickness, usually called the line width, is not uniform. The artist paints the outline by hand. During the painting process the pressure by the artist's hand on the brush may change, and as a result the line width is changed (see Fig.5a). Thomas Strohotte and Stefan Schlechtweg described this as the incorrectness qualities of human drawing [13].

The third feature is wiggliness. Wiggliness is some irregularities that occurred on the outline shape (see Fig.4.). This is also one of the incorrectness qualities of human drawing. The lines drawn by a human artist are never completely straight, especially if the artist doesn't use any aids, such as a ruler. The lines are more or less wiggly (see Fig.5b). The wiggliness is caused by a small irregular movement of the artist's hand when he or she is drawing the image; the wiggliness also can be caused by the paper structure [13].

We intended to generate the wayang beber character using 3D CG. In contrast with a human drawing, 3D CG generate perfectly smooth and straight lines with a uniform thickness, as we see in the works of Hajagos [14], De Wolf [15], and Apocada [16]. Therefore we need a new algorithm to generate a line with incorrectness qualities as we see in wayang beber of Pacitan.

Figure4. Outline of Gandarepa image

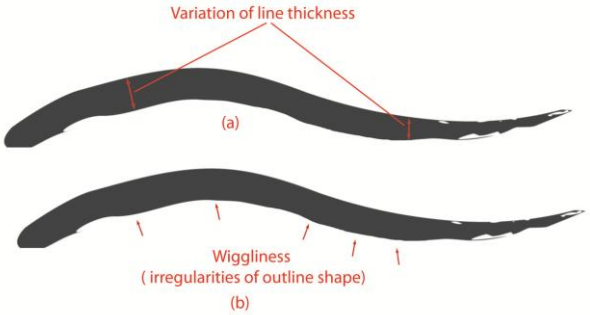

Figure5. Sample of hand drawn line. (a) Variation of thickness in hand drawn line. (b) Wiggliness in hand drawn

3. Related Works

This research tried to develop a shader that could generate the wayang beber of Pacitan outline in a 3D CG model and worked on Renderman interface. The reasons why we use the Renderman are: it can produce a high quality image, it has great programmability (great amount of control) and it is designed for animation.

There are two shaders in the Renderman interface that can be used to generate an outline. The first is cel shaders, developed by Apocada and Gritz [16], and the second one is ID outline shader, developed by Ivan De Wolf [15]. However these two shaders don't fit our purpose. Although they can generate a variation of thickness, the Apocada and Gritz's shader sometimes produce an undesired dark area on the rendered image (see Fig.6a). Meanwhile, Ivan De Wolf's ID outline shader can produce a good and clean image, but it doesn't generate any variation of thickness and wiggliness (see Fig.6b). Therefore we need a new shader to generate the outline.

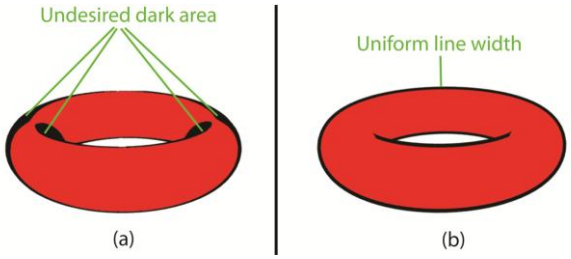

Figure6. (a) Rendering result of Apocada and Gritz's shader. (b) Rendering result of Ivan De Wolf's shader

The important concept for creating an outline in a 3D CG object is the silhouette edges. The outline is created by finding and displaying the silhouette edge. One of the methods to do this is two-pass rendering. This method was used by Gooch [17] and Raskar [18].

The two-pass rendering method works in the image space. This method uses a two layer set of polygons; the first layer is a layer of front-facing polygons and the second layer behind is a layer of backfacing-polygons. Back facing-polygons are rendered first, and then the front-facing polygons are rendered on top. The intersection of these two layers in the image space creates silhouette edges. Raskar and Cohen increased the area of the intersection by pulling the back-facing polygons slightly forward towards the camera [18]. This method is easy to

implement. The time to write and debug the code was very short, the visual quality was good, the speed was fast, and the method scaled well.

We are interested in Raskar and Cohen's method to render silhouette and are looking forward to doing a similar approach that can be applied in the Renderman interface. As we found, Ivan De Wolf's ID outline shader has quite a similar algorithm to Raskar and Cohen's. However, instead of using two layers of images in the image space, De Wolf's algorithm used two objects in the object space. Ivan De Wolf's algorithm used two identical objects; one of the objects was scaled and rendered as the outline. This shader can produce a thick outline on the 3D graphic figure. However it still can't resemble the incorrectness qualities of a human drawing. We create a new shader based on the algorithm of the ID outline shader. Our new algorithm was implemented in Renderman Shader Language (RSL) to develop a new outline shader for Renderman.

4. Generating The Wayang Beber of Pacitan Character's Outline

To generate the outline, firstly, we duplicated the object, and then we labeled them as object A and B. A became the outline and B became the fill. Our approach had some similarities with Rascar and Cohen's two-pass method [18]. However, instead of rendering two layers of images, our approach rendered two identical object in object space. Next we will explain the process, beginning with the fill.

The fill consists of one solid color, and has a wiggly shape. We rendered the fill (object B) using a shader with the following algorithm.

Creating the random wiggliness

1. Input s and t; the texture coordinate.
2. Input W; the frequency of wiggliness
3. Scale the s and t by multiplying them with W.
4. Apply Perlin noise function to scaled result of S and T to get a random number (H).
5. Input K; the amplitude of the wiggliness
6. Scale H by multiplying it by K
7. Calculate Nn by normalizing the surface normal.
8. Randomly displace the surface point P in the direction of its normal

$$\vec{P}' = \vec{P} - \vec{N}n \times H \times K$$

Shade the fill color

9. Input Cs; the fill color
10. Input Os; the fill opacity
11. compute the Ci output color
    Ci = Cs × Os

Then we rendered the outline (object A) using a shader with the following algorithm.

Displace the surface

1. Input width
2. Calculate Nn by normalizing the surface normal.
3. Add the new vector V
4. **Compute D; the dot product between normalized V and Nn.**
5. **Input MinWidth; the minimum width value of the line**
6. Compute S; the parameter to create a displacement ramp

   S= (1-D) + D × MinWidth
7. Displace the surface point P in the direction of its normal

$$\vec{P}' = \vec{P} + \vec{N}n \times (\text{width} + (\text{width} \times S))$$

Creating the random wiggliness

8. Input s and t; the texture coordinate.
9. Input W; the frequency of wiggliness
10. Scale the s and t by multiplying them with W.
11. Apply Perlin noise function to scaled result of S and T to get a random number (H).
12. Input K; amplitude of the wiggliness
13. Scale H by multiplying it by K
14. Randomly displace the surface point P in the direction of its normal

$$\vec{P}' = \vec{P} - \vec{N}n \times H \times K$$

Shade the outline

15. Detecting silhouette edges by computing D1, the dot product between Nn and normalized I; the viewing direction vector.
16. If D1 > 0, then set the output opacity to 0
    If D1 < 0, then set the output opacity to 1
17. Input Cs; the outline color
18. Set the Output color
    Ci = Cs;

We wrote our algorithm based on the ID outline algorithm [14]. To explain our algorithm first we will explain about the ID outline algorithm.

4.1. ID Outline Algorithm

In the ID outline algorithm, the surface of A is displaced by moving the surface point in the direction that is parallel to its normal. Normal is a vector that describes the surface orientation. The surface normal can have varying length, so it must be normalized to ensure its length doesn't affect the displacement.

In the displacement process, the surface point is moved with a distance that is equal to the value that is defined as line width. The process described in the following equation:

$$\vec{P}' = \vec{P} + \vec{N}n \times \text{width} \qquad (1)$$

Where $\vec{P}'$ is the new surface point, $\vec{P}$ is the old surface point, $\vec{N}n$ is the normalized normal, and the width is the displacement distance.

After displacement, the displaced object (object A) will be bigger than the other object (object B). Since the position coordinate of the two objects are exactly the same, object B will be placed inside object A, so object B will be invisible (see Fig 7).

To make object B visible, the front facing polygons of object A must be invisible.

The orientation of the object A polygon can be detected by computing the dot product between its surface normal and the viewing direction vector [19]. This process is described in

$$\vec{N}n \cdot \vec{I}n = |\text{Nn}|\,|\text{In}|\cos(\theta) \qquad (2)$$

Where $\vec{N}n$ is the normalized normal, $\vec{I}n$ is the normalized viewing direction vector, and θ is the angle between two

vectors.

If the dot product is positive then the polygon is back facing, otherwise if the dot product is negative then the polygon is front facing.

After the polygon orientation is known then the opacity of the polygon can be set. The back-facing polygon opacity was set as 1, so it was visible, and the front-facing polygon opacity was set as 0, so it was invisible.

As a result the object B that is placed inside object A was visible. The viewer will see the object A's back-facing polygon as the object's outline (see Fig. 8).

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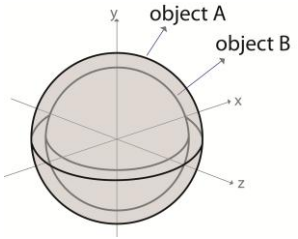


Figure7. Object B was placed inside object A after displacement

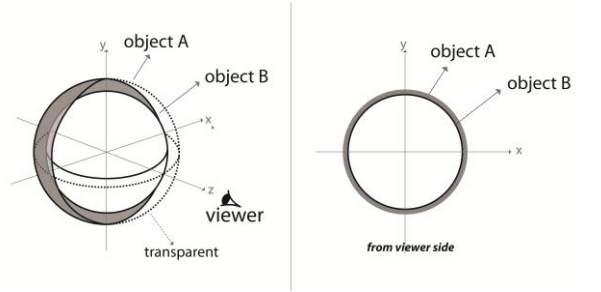


Figure8. The front facing Polygon of object A is invisible; object B inside object A is visible

4.2. Creating Variations of Line Thickness

The ID outline shader generate a smooth outline with a constant thickness, but the outline in the Wayang Beber of Pacitan character has a variation of thickness and wiggliness. We modified the IDoutline shader to produce these qualities. To produce a variation of thickness, every surface point in object A should not move in the same distance. We created a displacement ramp based on the surface point position. Using a displacement ramp the distance of surface point displacement could be changed gradually.

To create a displacement ramp, we added a new vector as the parameter. The direction of the new vector can be various. We can define the x and y coordinate, but the z coordinate must be 0. In this paper we added a vector that pointed downward, perpendicular with the x axis, as seen in Fig.9.

Then we computed the dot product between the normalized new vector ($\vec{V}n$) and the normalized surface normal ($\vec{N}n$) as in

$$D = \vec{V}n \bullet \vec{N}n \qquad (3)$$

Where D is the dot product between the normalized new vector ($\vec{V}n$) and the normalized surface normal ($\vec{N}n$), $\vec{V}n$ is the normalized new vector, and $\vec{N}n$ is the normalized normal.

If the normalized new vector ($\vec{V}n$) and the normalized surface normal ($\vec{N}n$) are perpendicular, the dot product will be 0 and if they are parallel the dot product will be 1.

The new parameter to create the displacement ramp was obtained using the following equation:

$$S = (1-D) + D \times 0.1 \qquad (4)$$

Where S is the new parameter to create the displacement ramp.

Then the displacement ramp was created using the following equation:

$$\vec{P}' = \vec{P} + \vec{N}n \times (\text{width} + (\text{width} \times S)) \qquad (5)$$

Where $\vec{P}'$ is the new surface point, $\vec{P}$ is the current surface point, $\vec{N}n$ is the normalized normal and the width is the displacement distance.

As a result object A displaced gradually and we got the variation of line thickness (see Fig. 10)

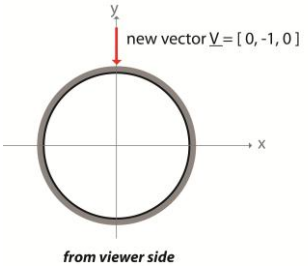


Figure9. The New Vector

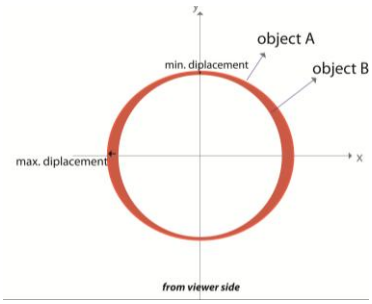


Figure10. Displacement ramp

4.3. Creating Wiggliness

When the artist paints the wayang beber of Pacitan, a small irregular movement of his hand causes the outline to be more or less wiggly. We displaced the surface point once more using a random number to resemble this wiggliness.

We generated the random number using the Perlin noise function. This noise function generates values which can be used to create randomness on a surface [20]. The noise function can take a varying number of parameters, and return a range of types. The values returned are guaranteed to be between 0 and 1. Nevertheless, in practice the output values are generally in the range of 0.27 to 0.7.

We applied the Perlin noise function to the texture (s and t) coordinates. The default values of s and t generated a low noise frequency. Therefore we scaled the values by multiplying them with a new parameter called *W*. Then to control the amplitude of the noise, we scaled the noise function output by multiplying it with a new parameter called *K*. Each surface point was displaced by the output of this noise function. As a result we achieved a wiggly outline (see Fig.11)

5. Discussion

The algorithm of our shader can generate the wayang beber of Pacitan outline. This shader simulates the incorrectness qualities of a human drawing.

We added some parameters to control several attributes of the outline, such as the thickness, the variation of thickness, and the wiggliness.

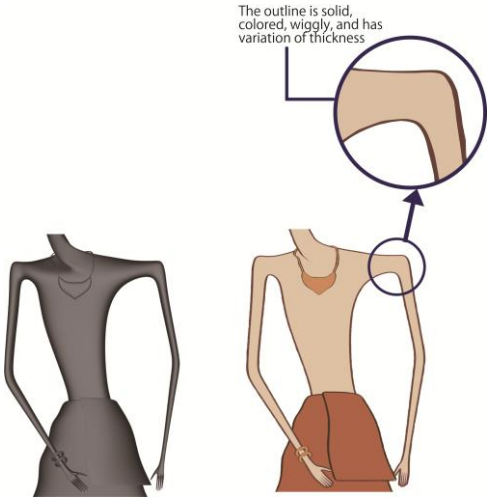
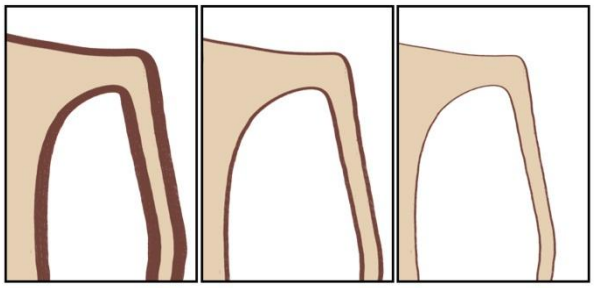


Figure11. The result of our shader

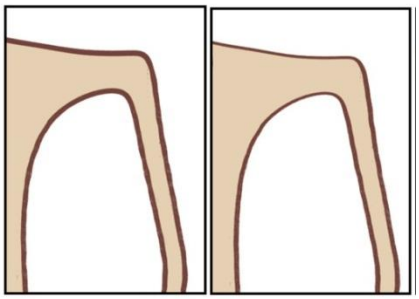
We rendered the object several times using different thickness values to get the good result. A comparison of the rendering result with different thickness values can be seen in Fig.12. The Fig 12a was obtained by thickness value of 0.3; the Fig.12b was obtained by thickness value of 0.1; and the Fig 12c was obtained by thickness value of 0.05. The desired result is Fig.12b.



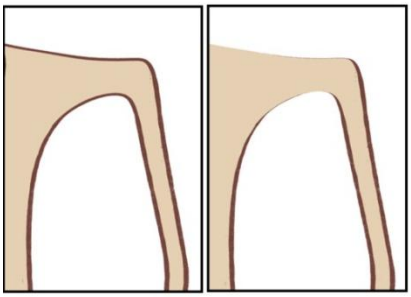
(a) **(b)** **(c)**

Figure12. Comparison of rendering result using different thickness parameter

We rendered the object several times to get a good balance of variations of thickness. The compared result can be seen in Fig.13.



(a) **(b)**

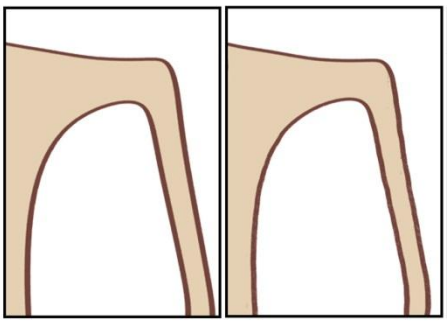


(c) **(d)**

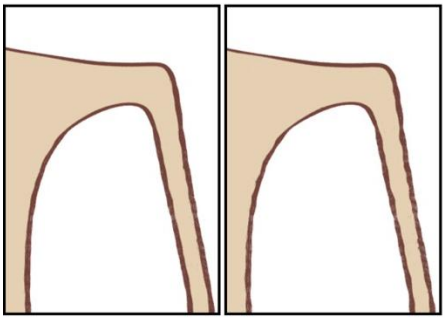
Figure13. Comparison of rendering result using different thickness variation parameter

The outline with uniform thickness can be seen in figure 13a which is obtained by a thickness variation value of 1. Fig.13b was obtained by the thickness variation value of 0.1. Fig.13c was obtained by the thickness variation value of 0.005. Fig.13d was obtained by the thickness variation value 0. The most appropriate result is the Fig.13b.

We also did an experiment using different values of wigglimess. The compared results can be seen in Fig.14.



(a) **(b)**



(c) **(d)**

Figure14. Comparison of rendering result using different wiggliness parameter

Fig.14a was obtained by the wiggliness value of 0. Fig.14b was obtained by the wiggliness value of 0.6. Fig.14c was obtained by the wiggliness value of 1. Fig.14d obtained by the wiggliness value of 1.5 . The best result is Fig 12b.

The comparison of our desired rendering result and the reference image can be seen in Fig.15.

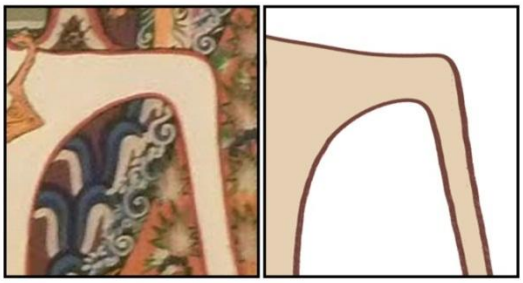
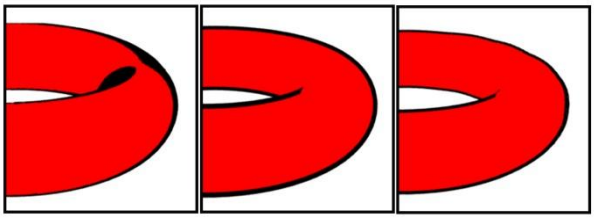


Figure15. Comparison between the reference image (left) and the rendering result (right)

We compared the rendering result of our shader with the result from another shader that was also developed using renderman. The comparison can be seen in Fig.16.



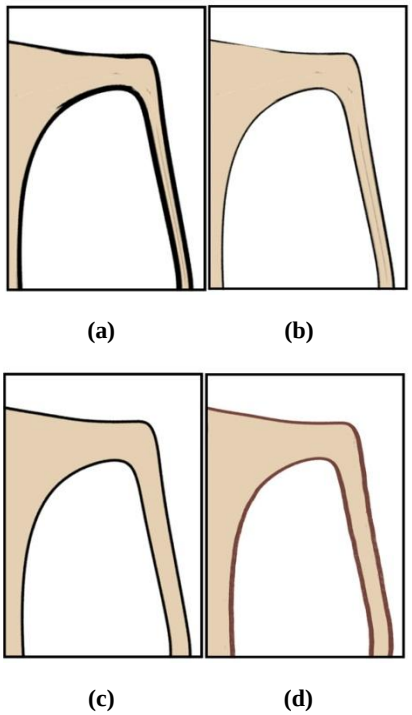
(a) **(b)** **(c)**

Figure16. Comparison of rendering result using different shaders. (a) Apocada and Gritz's shader, (b) ID outline shader, (c) our shader.

The shader developed by Anthony Apocada and Larry Gritz (Fig.16a) generates an outline with a variation of thickness. However, it also produced an unwanted shadow or dark area in the high curved edge. The contrast between the thick part and the thin part of the line is also difficult to control.

The shader developed by Ivan De Wolf (Fig.16b) generates a smooth thick outline. The rendering result is good, but not suitable for our purpose. Our shader (Fig.16c) tries to solve this problem. Our shader generates a relatively thick line with a variation of thickness and wiggliness which are suitable for our purpose.

Another comparison between the rendering result of these three shader can be seen in Fig.17.



(a) **(b)** **(c)** **(d)**

Figure17. Comparison of rendering result using different shaders. (a),(b) Apocada and Gritz's shader, (c) ID outline shader, (d) our shader.

6. Conclusion

The final goal of our research is to make CG animated wayang based on the visual form of wayang beber of Pacitan characters. This paper is the first step of the process. In this paper, we explained two things: first, the wayang beber of Pacitan outline features, and second, our algorithm to develop the outline shader.

Wayang beber of Pacitan is drawn by a drawing technique called "blabar". This technique created typical outline attributes, such as:

- thick
- variation of thickness.
- wiggliness.

These three attributes can be identified as incorrectness qualities of human drawing.

To simulate these qualities we developed our shader algorithm based on Ivan De Wolf's ID outline algorithm. We used a displacement ramp function to get the parameter to displace the surface point gradually. As a result we got a variation of line thickness. We displaced the surface point using a random number that was obtained by applying the Perlin noise function to the texture (s and t) coordinate. As a result we got a wiggly outline.

Our algorithm was implemented in the Renderman shading language (RSL). However there are some limitations in this algorithm. First, our algorithms produce a good result for rendering a curved object, but some problems occur when

rendering an object with sharp edges.

Second, our algorithm can easily control the outline attribute such as line width, variations of thickness, and wiggliness. However it is difficult to create a good balance between the object size and the outline attributes. We control the attributes parameter using an arbitrary number, but sometimes the resulting outline can be too thick or thin

7. Future Works

There are still many things to do to reach our goal. Our outline shader algorithm also has some limitation. It needs more improvement in the future.

There are several features of the wayang beber of Pacitan visual form that haven't been explained in this paper, such as the detail lines, colors, patterns, and textures. The next research should be able to explore all of these features, and develop algorithms to generate them using CG technology.

Rendering is just one stage of CG animation production. The animation process itself has its own problem. We intend to translate a 2D picture into 3D graphic animation. Our work has some similarities with Chan and Chen's [21]. Using the computer medium, we add a third dimension to the world of wayang beber of Pacitan paintings, which until now have traditionally been restricted to two dimensions. This is a new visual aesthetic different from the original one. Certainly, some problem will occur related to the shape deformations. Some 2D images have a distorted shape that will be difficult to simulate in 3D CG animation from a certain angle. We have found an approach to solve the problem using an algorithm to create a view-dependent model [22]. The view-dependent model is 3D CG models that will deform the shape depending on the viewer's current position. However, this may need more specific research.

References

[1] Mulyono, S., "Wayang; Asal Usul, Filsafat, dan Masa Depannya". Penerbit Alda, pp.53,1975.

[2] Van Dijk, K., Nas,P., *"Dakwah and indigenous culture; The dissemination of Islam"*. Bijdragen tot de Taal-, Land- en Volkenkunde, Globalization, localization and Indonesia, Vol.15, No.2, pp 224, 1998.

[3] Adisasmito, N. D., *Karakter Visual dan Gaya Ilustrasi Naskah Lama di Jawa Periode 1800-1920*, ITB Journal of Visual Art and Design, Vol. 2, No. 1, pp 64, 2008.

[4] Tabrani, P., *"Meninjau Bahasa Rupa Wayang Beber Jaka Kembang Kuning dari Telaah Cara Wimba dan Tata Ungkapan Bahasa Rupa Media Rupa Rungu Dwimatra Statis Modern dalam Hubungannya dengan Bahasa Rupa Gambar Prasejarah, Primitif, Gambar Anak dan Relief Cerita Lalita Vistara Borobudur"*, unpublished Ph.D. Dissertation, pp. 208, 1991.

[5] Cavalier, S., *The World History of Animation*, University of California Press, pp. 34, 2011.

[6] Curtis, C., *Non–photorealistic Animation,* SIGGRAPH 1999 Course no.17: Non-photorealistic Rendering, pp 3, 1999.

[7]Salmagundi, M., Magpie Salmagundi Personal Webpage, http://www.magpiesalmagundi.com/2012/03/wayang-beber.html, Accessed 12/Jul/2012.

[8] Salim : Warna Sunggingan dan Komposisi Wayang Beber Pacitan. Canthing Journal, Vol.1, No.1, pp. 1-9, 2012

[9] Ahmadi, A., *Identifikasi Pola dan Sunggingan Wayang Kulit Purwa Gaya Surakarta*, Research report, STSI Surakarta, p.206, 1997.

[10] Purbasari, T., *"Kajian Aspek Teknis, Estetis, dan Simbolis Warna Wayang Kulit Karya Perajin Wayang Desa Tunahan Kabupaten Jepara."*, Arty Journal of Visual Art, vol. 1, No.1, pp 1-7, 2012.

[11] Sukir, *Bab Natah Sarta Nyungging Ringgit Wacucal*, Departemen Pendidikan dan Kebudayaan, p.65, 1980.

[12]Grahita, B., Komma,T., Kushiyama, K., "Visual Analysis of Wayang Beber Pacitan Character Figure", JSGS 2012 conference proceeding, pp.71-74, 2012.

[13] Strohotte, T., Schlechtweg, S., *Non-phororealistic Computer Graphic*, Elsevier, pp84-85, 2000.

[14]Hajagos, B.,Szecsi, L., Csebfalvi, B., *Fast Silhouette and Crease Edge Synthesis with Geometry Shaders*, Proceedings of the 28th Spring Conference on Computer Graphics, ACM,pp 71-76,2012.

[15] Wolf, I. D., Ivan De Wolf Shaders PAGE, http://www.renderman.org/RMR/Shaders/IDShaders/index.html, accessed 2/Aug/2012.

[16]Apocada, A. A., Gritz, L., Andvanced Renderman Creating CGI for Motion Picture, San Diego: Academic Press, pp. 329-331, 2000.

[17]Gooch, B., Sloan, P., Gooch, A., Shirley, P. S., Riesenfeld, R., *Interactive Technical Illustration*, 1999 ACM Symposium on Interactive 3D Graphics, ACM SIGGRAPH , pp 31-38, 1999.

[18] Raskar, R., Cohen, M., *Image Precision Silhouette Edges*, 1999 ACM Symposium on Interactive 3D Graphics, ACM SIGGRAPH, pp 135-140, 1999.

[19] Apocada, A. A., Gritz, L., *Andvanced Renderman Creating CGI for Motion Picture*, Academic Press, pp. 22, 2000.

[20] Stephenson, I., *Essential Renderman*, Springer, pp 201-203, 2007.

[21]Chan, C., Akleman,E., Chen,J., *Two Methods for Creating Chinese Painting*, In Computer Graphics and Applications, Proceedings. 10th Pacific Conference on IEEE, pp. 403-412. 2002.

[22] Strohotte, T., Schlechtweg, S., *Non-phororealistic Computer Graphic*, Elsevier, pp299, 2000.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A Study of Digital Media Art Utilizing the Contents of The Architecture Cultural Property

Digital video expression using Projection Mapping techniques at Mojiko station

Abstract
This research is about creating contents about the origin and history of Mojiko station using Projection Mapping one of the new digital media techniques, and designing video expression and evaluation in order to develop a new genre of Projection Mapping. We investigate the characteristics of recent various Projection Mapping creations expressed in each purpose and method, then we test Projection Mapping through experimentation and propose the process of using cultural property as a material for contents and a way to develop contents using cultural property and validate the outcome. In order to perfect the techniques based on this research we think it is important to clarify how to develop the contents of Projection Mapping and techniques by testing them and experimenting under various conditions.

Keywords: Digital Media Art, Projection Mapping, CG

1 Introduction

Recently three-dimensional Video Projection as well as augmented reality, which consists of video and 3D objects projected on a display, they are both developed. The hardware and video contents using both technologies attract attention.

By making objects which do not physically exist look as if they were in existence, we aim to fuse real space and virtual space, contributing to the improvements of the entertainment and artistry of the contents. In particular, Projection Mapping is proposed as dramaturgy by CG images and lighting. This technique enables projector art that combines the real and virtual to be finished by programming the structure and dimensions to precise measurements and projecting CG images and lights. [1][2]

This research is about creating contents about the origin and history of Mojiko station using Projection Mapping one of the new digital media techniques, and designing video expression and evaluation in order to develop a new genre of Projection

developments for contents of diverse cultural relics, historic

sites and cultural assets and developing a new genre of Projection Mapping.

1-1 Research background

Architecture is a subject with complex meanings. Sometimes, it is evaluated as public art beyond one for human convenience. Currently, there are cultural assets with the traces of history at Mojiko Retro in Kitakyushu City. Architectural heritages, in particular, among cultural properties are ones that show cultures and histories best, which reflect the images of each period well. Architecture has characteristics of each country, but the flow of the recent world architecture homogenized in external aspect. In addition, the present world shows complex multi-cultural characteristics along with each country's own culture, and among them, young generations are losing the meaning of historical and cultural identities. Based on this phenomenon, using the contents of cultural heritages with cultural and historic values is considered as a nice opportunity of increasing people's interests in and values of the cultural heritages that are being forgotten. In addition, it is expected that a secondary effect by which the meaning of architectural heritages through works become more educative and corresponding values.

1-2 Purpose of research

This research is about creating contents based on the origin, history and image of cultural architecture heritage using Projection Mapping one of the digital media techniques. First we investigate the characteristics of recent various Projection Mapping creations expressed in each purpose and method, then we test Projection Mapping through experimentation and propose the process of using cultural property as a material for contents and a way to develop contents using cultural property and validate the outcome.

2 Projection Mapping

2-1 Projection Mapping

In modern projection technology, slide projectors were popularized in the 20th century, in the 21st century projection image expression rose explosively by increasing popularity of computers and digital projectors. The developments of computer graphics enabled us to project images easier by the developments of digital projectors. Projection Mapping was born in the process of the developments of projection techniques. It has the exact same form of “projecting images onto something” as the former projection techniques. However, the major difference is to project images onto three-dimensional and textured surfaces. The definition of Projection Mapping by Projection Mapping Association Japan (PMAJ) is an imaging technique synchronizing objects (real) with images (virtual), which is not simply projecting images or computer graphics on the screen or a plane, but projecting them on a building, 3D structure or artifact with a projector. Images created with former projection techniques have only the virtual side of images. The screen is the only real object and projection medium to capture images. Viewers were limited to two-dimensional virtual images.

On the other hand, Projection Mapping can even represent three-dimensional impressions and a special feeling as if objects that cannot move were actually moving, objects look more realistic, different expressions stood out by giving casting light and shadows of the images as well as utilizing information such as parts and irregularities that the object has. It enables us to enjoy not only images projected but also objects that are being projected onto. The fantastic and illusive visual expressions can make audiences feel like the objects move, change shape and glow by itself with the moves and changes of the images[3]. Figure 1 shows a schematic diagram of Projection Mapping. Projection Mapping enables complex expressions including the representation of the surrounding environment combining seeing a real object and watching images.

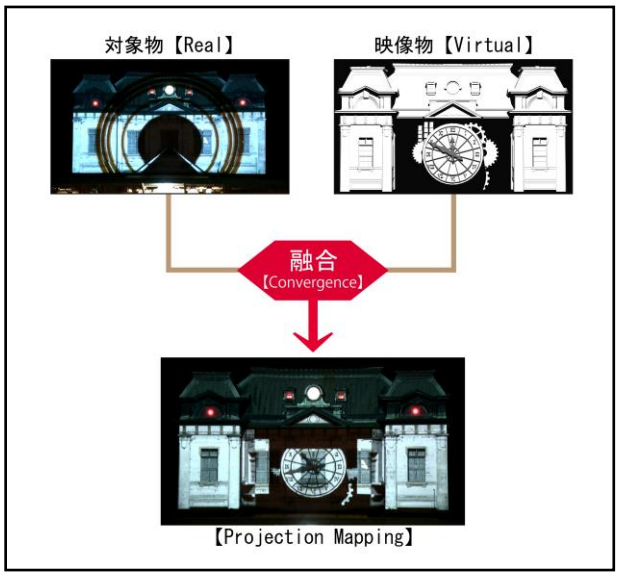


Fig.1 Projection Mapping conceptual diagram

2-2 Projection Mapping cases

We investigated the case of existing Projection Mapping works while we created our work. Expression methods of Projection Mapping have been diversified. It is categorized into several types such as the methods of projecting onto buildings, projecting onto rooms and passages, projecting as stage direction, and projecting onto shaped objects.

2-2-1. Method to project onto buildings

This Projection Mapping at the Ralph Lauren building in London. (Figure 2)The images were projected onto the large Ralph Lauren buildings. It shows off the images effectively with the color of the building and characteristics of the shape. Projection Mapping onto buildings varies from large buildings like those of Ralph Lauren to relatively small buildings. We create a CG model with the same scale based on the blueprint of a building, and produce the images for the projection surface that has been selected in advance. As with outdoors, it depends on ambient lighting, weather, positions of the building, and the situation around them. A high number of high-intensity projectors need to be prepared depending on the

size of the building. This can be extensive work in many cases. This large-scale Projection Mapping has been used by advertizing companies.

Fig.2 <<Ralph Lauren>> Projection Mapping

2-2-2. Method to project onto rooms and passages

In 2011, the German Projection Mapping expert group Mr. beam announced 360 degree three-dimensional Projection Mapping new technology as a testing form. This test video "living room" is directed as the furniture and the carpet placed in the room change as time goes by.[5] The living room is different from Projection Mapping methods of projecting images on the surface of buildings that they used to project onto and now it focuses on small objects such as furniture. It points out Projection Mapping as a space direction of projecting the images onto an area and an entire passage. Viewers can experience the images as a space, it makes them feel as if the virtual and real were fused.

Fig.3 <<Living Room>> Projection Mapping

2-2-3. Method to project as stage direction

Projection Mapping as stage direction is used on a stage like a live performance and fashion show. It has benefits such as the radical change of the stage and atmosphere with one image as well as decreasing spending except screen installation and projectors. In recent years, as depth sensor-based device technology such as Microsoft Kinect, media art such as open Frameworks and processing, open source programming environment for interactive contents, game engine such as Unity have spread explosively, see media art used by these equipment.

Some Projection Mapping are applied with these techniques. In the music video of American artist Nosaj Thing's song "Eclipse blue" by Manabe, Projection Mapping has been done interactively applying the people by image processing the approximate shape of a human with a depth sensor. As it receives the shape of the human in real time, the images move to the dance. It brings on a strange impression that cannot be brought with video synthesis by post-production as it combines the human and the images on the spot.

Fig.4 <<Eclipse Blue>> Music Video

2-2-4. Method to project onto Sculptures

"Polygon playground" is an interactive video installation produced by WHITE void as a "large scale interactive lounge" at the SMUK fest music festival in Denmark. According to their website, they made a large-scale polygon object glow that offers room for up to 40 people at a time using 360 degree Projection Mapping. An additional sensory system detects people's positions[6].

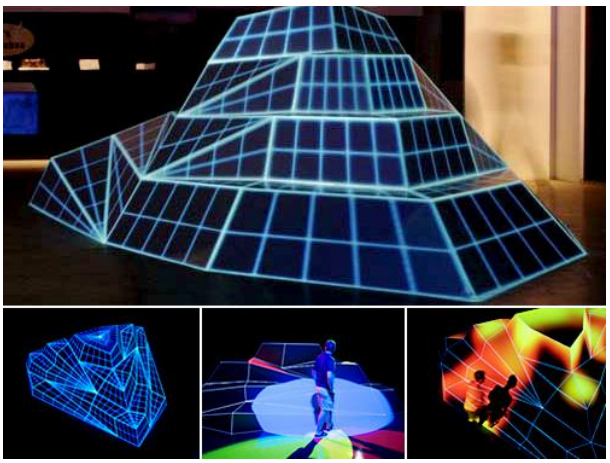


Fig.5 << Polygon Playground >> Projection Mapping

As described above Projection Mapping has various types and ways to produce change depending on projection objects, surrounding environment, and equipment.

It is important to have a clear vision before starting to work on a project. Mechanism of Projection Mapping is so simple that the object is changed from a screen to a three-dimensional object, but as projectors emit light to the object theoretically it can project any three-dimensional object. Therefore, when an object changes it can widen the range of expression. The potential is attractive as a research subject, to explore unseen Projection Mapping is valuable artically as we explore the possibility of media, especially video. To derive the common characteristic from the above cases of Projection Mapping, advertisements of companies, products, events and disposable Projection Mapping, so we focus on expressive space to fuse both objects (real) and video (virtual) that Projection Mapping has, and propose a way to develop contents with the origin and

history of cultural property without existing Projection Mapping and explore the possibility of a new genre for Projection Mapping using appropriate contents and elements of design.

3 Work Production

Existing Projection Mapping can be classified by whether the object of projection is “static or dynamic, and the video is either interactive or non-interactive.” This study will produce a work with the static technique which is most often used among the existing Projection Mapping methods. Since a static object is one that is not moving such as a building or furniture, an interactive device is not specially necessary for the production of projection images. The characteristic of the Projection Mapping of a static object is a method of pre-rendering[1] for the object is not moving. Figure 6 shows a brief diagram of the flow of the projection images: This is to trace one object at a time and produce images fit with the traced data.

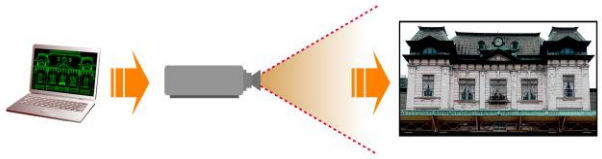


Fig.6 Static target Projection Mapping flow

3-1 Summary of the projection object

We selected Mojiko station located in Mojiko, Northeastern Kitakyushu as the cultural asset for which contents will be produced. Mojiko station is a bisymmetrical, Neo-Renaissance style, two-story wooden building constructed in 1914.

Fig.7 "Mojiko station" important cultural properties

Remaining intact as it had been built, it was designated as an important national cultural asset first as a station building. In the station, there are various historic assets such as basins which have been used since before the war and a fountain where people can wash their hands, etc. In this study we selected Mojiko station as the object of projection because of its historic value designated as one of Japan's important cultural assets and because the station will enter a preservation and maintenance project from September 2012 to March 2018, it would be the very building from which residents or tourists could reflect on memories. In addition, the contents of the work were produced using subject matters related to the history of Mojiko station [7].

3-2 Production process

As briefly described above, the Projection Mapping of a static object is described with an example of Projection Mapping at Mojiko station was carried out on December 24, 2011. It is a Projection Mapping by making contents with the value and historic materials of the station building which is just as it was in the old days. Generally, Projection Mapping uses pre-rendering movies. The flow of production is as follows in Figure 8.

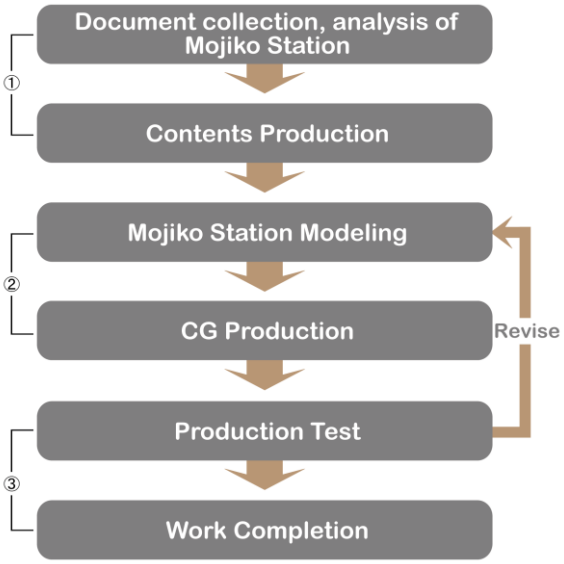


Fig.8 Production process to static target

The flow of production is shown below.

① Trace the shape of Mojiko station. This includes the method of making data the shape as it is using a 3D digitizer or measuring and tracing numerical values from Photographs. In this study we will trace them using the former and in the traced data, the images of Mojiko station should accurately overlap with the Station Building when projecting images.

② Produce images based on the traced data. Since in this study we produce the images with the Pre-rendering movie production technique, use Adobe After Effects or Autodesk Maya, etc. to produce images.

③ Conduct an image projection test in the field if the prepared free rendering movies exactly match with the

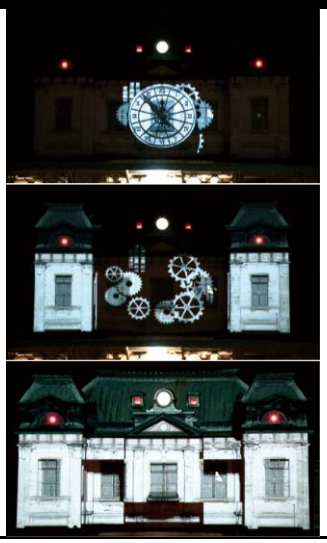
[1] Pre-rendering is the process in which video footage is not rendered in real-time by the hardware that is outputing or playing back the video. Instead, the video is a recording of the footage that was previously rendered on a different equipment (typically one that is more powerful than the hardware used for playback). Pre-rendered assets (typically movies) may also be outsourced by the developer to an outside production company. Such assets usually have a level of complexity that is too great for the target platform to render in real-time.

actual Mojiko station. If they do not match, trace correction is necessary, and if the images exactly match with Mojiko station and there is no problem of their movements, they are complete [8].

3-3 Contents

Use Mojiko's specialties such as rickshaws, banana characters, a train and historic materials as the contents, then produce them so that they can make the audience who visit Mojiko station feel the charms of the station. The concept of the production is Projection Mapping digital image expression using attractive images such as Mojiko's unique retro images which induce the audience's emotional changes or romantic Mojiko's night view images. The flow of the stories of the image expression is as follows in Figure 9.

Scene. 1

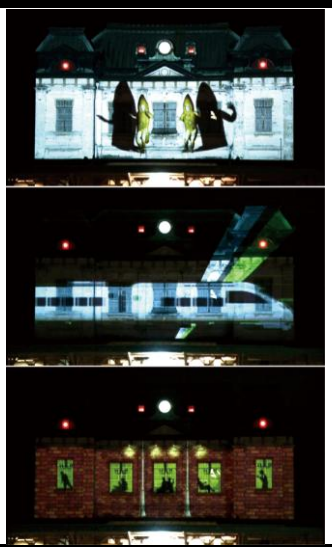


・Clock makes a ticking noise
・Clock will begin to sound mad
・A wall of Mojiko station protrudes and goes down

Scene. 2

・Graphic Image direction
-The outline of the station is replaced by various colors
-A ball exits from the window and falls from the top
-A picture moves to the rhythm of BGM on a wall
・A wall of Mojiko station protrudes and goes down

Scene. 3



・Banana man character appearance
・A train runs backed by the night view of Mojiko Retro historical district
①A train departs from Mojiko Station
②A train runs and is replaced by various backgrounds
③A train arrives at Mojiko station
・Darkness falls
・Time passes by at night in Mojiko

Scene. 4

・A snowy image falls slowly from the top
・Christmas ambience image
-Direct it with a candle, illumination, ribbon

・Fireworks direction
-Merry Christmas message
-Romantic MOJIKO message

Fig.9 Contents

3-4 Correction process of projection target

In Projection Mapping, we construct a 3D virtual space a computer and carried out a simulation test in the same environment as reality to deliver stereoscopic visual effects to the audience. We then grasp the shape of the projected object and the positions of the projector and audience's viewpoint in advance and distribute each of them in the virtual space on the computer. Then we carry out projection texture mapping of the rendering images obtained from the audience's viewpoint on the object in the virtual space in the same condition and obtain the position of the projector and the rendered image. Projecting the image obtained this way in the actual environment as the simulation makes it possible for 3D Projection Mapping. (Figure 10)

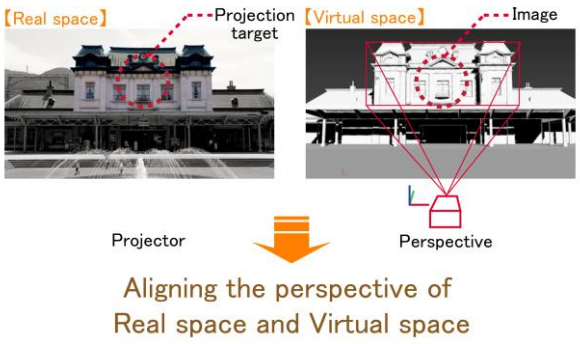


Fig.10 Aligning the perspective of real space and virtual space

3-5 Video production

It is common to project images using a projector on a flat screen. Projection Mapping projects them onto a three-dimensional structure rather than a flat surface, and the point is to make it look like a 3D motion. The method of production is first to select an object and accurately measure the shapes of the selected object or sculpture. And then, produce an image to project based on the data. To construct a 3D virtual space, we use mental-ray software that is broadly used to produce video contents such as films or games to construct the scenes of the necessary modeling and lighting. We also use a mental-ray rendering engine for rendering.
Finally, Adobe After Effects is used for adjusting styles or synthesizing the work. Using the images based on this image producing technique can realize the effect of direction by Projection Mapping. (Figure 11)

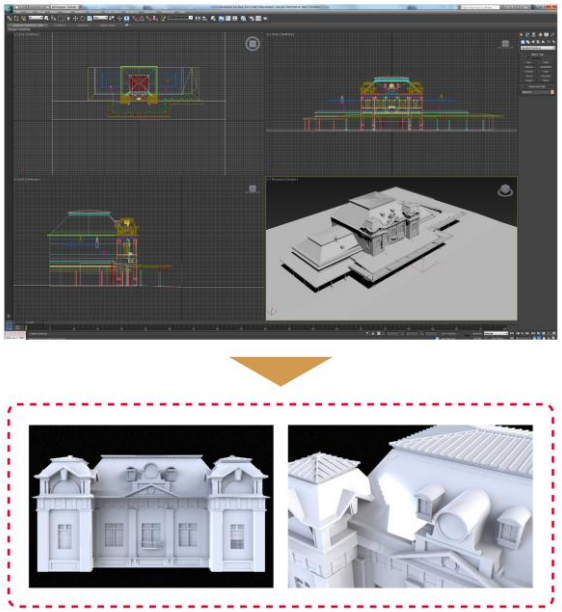


Fig.11 Video modeling

3-6 Structure of the System

In this study we installed a system like Figure 12. Panasonic PT-D7700 was used, which is a projector supporting Full HD resolution with brightness of 7000 ANSI and contrast of 1300:1. The projection image and sound effect (BGM) was controlled by portable switcher “Any Cast Station.” The system in this study is characterized by installing two workstations and projecting images simultaneously to prevent the images from halting in their projection.

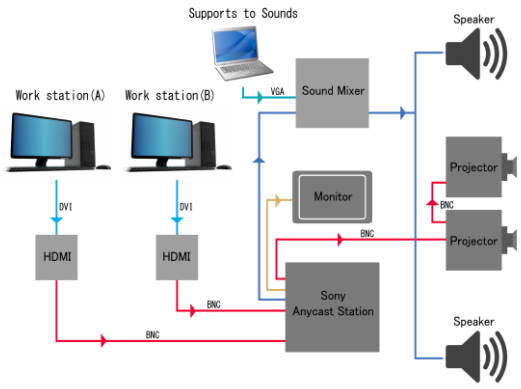


Fig.12 Structure of the System

In addition, two overlapped projectors were used so that the system can respond to the brightness of the surroundings at the place of projection.

4 Experiment Overview

This chapter is about the detailed experiment of the production and design of Projection Mapping. The experiment took place twice on December 2nd, 2011 and December 20th, 2011. The first one took place at a sports field at Graduate School of Design, Kyushu University and the second one took place at the field of projection object (Mojiko staion).

4-1 Experiment 1

In the first experiment, we checked the distance between a projector and the projection object , the size (height x width) of the surface of the projection object (Mojiko station) , brightness of a projector installed with the number and width of video. We installed the equipment based on the blueprint of the projection object and the size we investigated in advance. The distance between the projector and projection object is 66.8m. The height and width of the projection object is 13m and 20.6m. This is one of the important initial steps for accurate matching of the projection video and projection object in the process of projection mapping. We prepared high-definition(1920*1080) still photograph images and short videos and had an experiment to test performance brightness of the projector. As a result, we didn't have any problem with the size of the surface of the projection subject but found out that the brightness of the projector is not enough. The reasons could be the brightness of the surrounding environment, the performance of the projector, the image of the created contents etc but in this case we discovered it is because the brightness performance of the projector is not sufficient. As a solution to this problem, using a high performance projector is the fastest solution, but this study was able to solve the problem of the brightness of a projector at a low price using two projectors currently held (Panasonic PT-D7700). We can say this method is suitable for small-scale Projection Mapping research without expensive equipment.

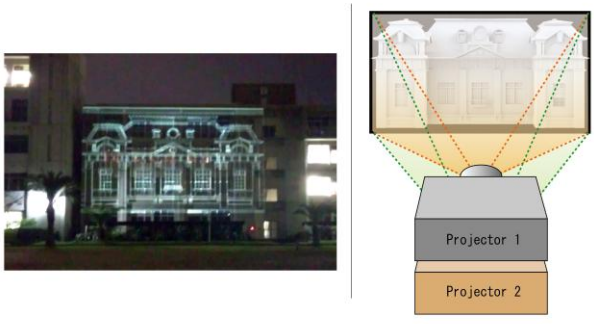


Fig.13 1st Experiment Image

4-2 Experiment 2

In the 2nd experiment, we conducted the experiment at the projection target (Mojiko station); we set the projectors and the projection object with accurate distance and positioning and conducted a matching experiment. We checked how well the projection object and the projection video match on the images of wire frame model and worked on making 2 projectors focus. At the time, some parts didn't partially match but by using Adobe After Effects program we were able to correct them on the spot. We were able to focus 2 projectors by using the data we calculated beforehand and adjusting the lens control function. On the other hand, in the middle of the second experiment, we saw that the projection video stopped and the stereoscopic effect of the video was poor. It was difficult to control the video with the overloading program and project the normal video contents when we played the video stored in Full HD, but in this study we handled it with the system configuration (Figure 12). We set up 2 workstations played the video at the same time, switched the screen with a portable switcher "Any cast station" to handle the situation. And as for colors of the stereoscopic effect of the video, comparing the colors of the video projected by a projector and those of the video on a computer, in some cases those by a projector looked faded. It is important to consider the coloration when creating a video. In this study, we modified the intensity and contrast and fixed remaining issues.

In the meantime, during the second experiment, a phenomenon of stopping images or a problem of reduced 3D effect was found. It turned out that it was caused by a phenomenon of the overload of program in playing images produced in Full HD resolution. A normal image control and projection of image contents were difficult, but this study responded to the phenomenon of stopping images with system configuration of Figure 12 as a solution. Images were played simultaneously with 2 Work Stations, and when the images stopped, the display shifted to portable switcher Sony Any Cast Station to respond to the problem of stopping images. In addition, with the effects of surroundings and changes in weather, when the 3D effect of the images projected from the projector was compared to that of those on the computer monitor, there was a phenomenon in which the 3D effect of those projected from the projector looked lower. The present study responded to the problem of low 3D effect by correcting the images by increasing the contrast of brightness in Adobe After Effect editing program. By the nature of Projection Mapping, which is sensitive to the brightness of surroundings and changes in weather, in producing images, the 3D effect and the brightness of the projector should be sufficiently considered, and in the future, this should be studied more in depth.

Fig.14 The state of Projection Experiment

4-3 Performance

On December 24th 2011, we performed Projection Mapping methods at Kyushu Mojiko station as the projection object in Mojiko, Kitakyushu-city. The video was about 10 minutes long. In this performance we started projecting at 18:30 and we played it 7 times for 1.5 hours. Because of the media report the day before, we were able to have a large audience. We published the entire video of this performance on the internet.

With this work, we won a special award in "Kitakyushu Digital creator contest 2012" presented by Human Media Creation Center / KYUSHU and a prize in "2012 ASIA DIGITAL ART AWARD" we were able to obtain a certain level of achievement.

Fig.15 The state of Mojiko Station Projection Mapping

5 Conclusion

This study produced contents that are differentiated from existing commercial or advertising works, which were for cultural heritages using Projection Mapping technology and approached Projection Mapping technology in the aspect of providing people with interesting experiences. As a result, the expression combining images with real objects was made for cultural heritages as the objects of projection, and the methods of expressing contents based on the cultural heritages could be obtained. By presenting works, it is considered that social evaluation was obtained as even people who did not know the histories and stories about the cultural heritages could enjoy and watch them and they could look back on the history of Mojiko with many others. Moreover, it is considered that by making experiments of Projection Mapping, it is necessary to express the materials of cultural heritages with image contents and to study the problems that occur during the process of production more in the future.

In the near future, in order to perfect the techniques based on this research we think it is important to clarify how to develop the contents of Projection Mapping and techniques by testing them and experimenting under various conditions. We especially need to identify specific issues such as light source issues by using Projection Mapping and the reproducibility of the contents and solve them in future research.

References

[1] Junichi Sakurai, *Interactive 3D Projection Mapping with Ultra-Realistic Effects*, The Institute of Image Information and Television Engineers, 2012

[2] Toshiki Nagamoto, *Research and Development about the Direction Method of the Projection Mapping*, The Institute of Image Information and Television Engineers, 2012

[3] Projection Mapping Association of Japan
http://www.projection-mapping.jp/?page_id=45

[4] Mr.beam.
http://www.mr-beam.nl/project/2,February 2012

[5] Mr.beam.
http://www.mr-beam.nl/project/1,February 2012

[6] White void.
http://www.whitevoid.com/category/architecture-and-spaces,February 2012

[7] http://ja.wikipedia.org/wiki/門司港駅

[8] Satoshi Kawabata, *The Visual Entertainment Using Real time Projection Mapping on Moving Objects*, Graduate School of Design, Kyushu University, 2013

[9] Jeremy Brin, *Digital Lighting & Rendering: 2 Nd Edition*, Person Education, London, 2008.

[10] Christiane Paul, *Digital ART, Thames and Hudson Ltd.*, London, 2003

[11] Ho won Shon, *The Influence of Background Color on Perceiving Facial Expression*, KSES, 2009.

[12] Kana Haruta, *A study on activity community planning which utilized historic environment as tourist attractions*, Architectural Institute of Japan, 2007

[13] jung mi Ha, *Sensibility Classification of Flower Texture by Physical Properties*, 2010.

[14] Keiko Yamamoto, *Designing Physical Objects as if They Were Digital*, Information Processing society of Japan, 2007

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