The Cross-Cultural Aspect of Gesture-based HCI

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Summary

With the flourish of HCI, the application of it thriving and expanding into an apparent diverse and enriching field. Recent studies about gesture-based HCI, paid more attention to the technical means; however, with the development of detecting and tracking technology, the lack of consideration about cultural aspect in user-centered HCI design generally emerged. The contrary between users' cultural meaning of gesture and system definition of gesture, can't be solved by any technical method. Based on the fast-growing technical foundations today, we could focus on providing a better user experience by considering the user's cultural background.

Therefore, the aim of this research paper was to explore the effect of cross-cultural aspect in gesture based HCI design. For this purpose, the first step was a literature review to analyse and sort out literature in the field of cross-cultural aspect, gesture-based HCI, and cross-cultural aspect in gesture based HCI design. As a next step, after exploring the possible effect of cross-cultural aspect in gesture based HCI design, this study classified it into both positive and negative side. According to the possible effect of the cross-cultural aspect, from the review of previous research, there were three representative problems of cross-cultural gesture-based HCI been found out, as the misapply of local gesture in the HCI design; the meaning collision between local gestures and global gestures; the cultural collision between mono-cultural users and multi-cultural users, respectively. Furthermore, from the classification of gestures, this study compared a case of Eastern and Western gesture-based HCI design, discovered the differences between Westerners and Easterners in ways of thinking, self-conception, and communication, resulting in the diversification of gestures in HCI design. Finally, for the purpose of this research paper, a set of guidelines for the cross-cultural gesture-based HCI design were suggested, in order to provide a point of reference for developers, designers and future researchers regarding the incorporation of cross-cultural aspect in HCI design.

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HCI	human computer interaction
UCD	user-centered design
AR	augmented reality
UI	user interface
GI	gesture interface

1. Introduction

1.1 The importance of this research paper

In the past 40 years, the relevant fields of Human-computer interaction have been thriving and expanding into an apparent diverse and enriching field-for-all[1]. Human-computer interaction (HCI) researches the design and use of computer technology, focused on the interaction between users and computers. As a field of research, human-computer interaction is situated at the intersection of computer science, behavioral sciences, design, media studies, and several other fields of study. As it flourishing and developing into a diverse field-for-all, the HCI's relevant products, such as games, VR technology, all enhanced the application range of it. In order to evolve into striving for satisfactory usage, there are more and more researchers pay their attention to the global perspective in HCI, to approach the cross-cultural HCI.

Cross-cultural HCI is via cross-cultural design, that applies iterative analysis to take the target users and their cultural needs into account to approach better user experience[2.] As Kralisch said: "Intercultural research in Information Systems is a relatively new research area that has gained increasing importance over the last few years"[3]. After categorizing the main research topics in culture-centered human-computer interaction, cross-cultural HCI becomes more and more well-known in this area since the year 2000. Using the keywords "cross-cultural HCI" when searching the ACM digital library reveals an exponential rise of publications[4], to show that the cross-cultural HCI design gradually catches the researcher's' research interests; however, how do cross-cultural factors relate to the ways for HCI design or even for gesture-based HCI design?

[1] Daniel G. Cabrero, Arminda Guerra Lopes, and Barbara Rita Barricelli, HCI Within Cross-Cultural Discourses of Globally Situated Rhetorical and Etymological Interactions. CCD 2016, LNCS 9741, pp. 16–25, 2016.

[2] Rüdiger Heimgärtner, Intercultural User Interface Design –Culture-Centered HCI Design –Cross-Cultural User Interface Design: Different Terminology or Different Approaches. DUXU/HCII 2013, Part II, LNCS 8013, pp. 62–71, 2013.

[3] Kralisch, A, The Impact of Culture and Language on the Use of the Internet Empirical Analyses of Behaviour and Attitudes, Berlin, 2006.

[4] Rüdiger Heimgärtner, Intercultural User Interface Design –Culture-Centered HCI Design –Cross-Cultural User Interface Design: Different Terminology or Different Approaches. DUXU/HCII 2013, Part II, LNCS 8013, pp. 62–71, 2013.

The gesture recognition techniques can be classified into two groups: glove-based and vision-based gesture recognition[5].The glove-based gesture recognition methods require users to wear data or color based glove to avoid or simplify the segmentation and tracking task. On the other hand, the vision-based methods rely on computer vision techniques without any sensors or hardware device, just segmenting and tracking human behavior, which is naturalized in the Gesture-based HCI design. However, when the interaction system specifies users' gestures with the developers' cultural background rather than a worldwide common definition, it may cause a wide range of misleading or the reception of incorrect instructions when a cross-cultural audience is involved.

Furthermore, academia widely accepts the concept that User-Centered Design (UCD) is a core concept of Human-Computer Interaction (HCI) and a well-established framework for designing user interfaces that focus on usability, accessibility, and inclusion, with the aim of delivering a smooth and seamless user interaction[6]. Owing to the user interaction could be effective by the framework of the interface, it's necessary to approach a more natural, intuitive, friendly interface which leads to being less intrusive for the user. Compared with the traditional HCI devices (mouse, keyboard, remote control, etc.), the gesture-based HCI system especially the visional gesture-based HCI, required no intermediary equipment, only segmenting and tracking the human behaviour, could cooperate with a natural interface offering a perfect user-friendly HCI system. For this purpose, cross-cultural design as one aspect of user-centered design, which focuses on the user and his specific needs which are dependent on their cultural content and specific gesture use will have a direct impact on the interactive experience.

So, it's essential to pay attention to the global perspective in gesture-based HCI design, to approach the cross-cultural gesture-based HCI; however, there still lack of researchers focusing on this area. Therefore, this essay based on the cross-culture aspect, try to explore the effect of it in gesture-based HCI design, to search the possible problem in

[5] George Awad, Junwei Han, Alistair Sutherland. A Unified System for Segmentation and Tracking of Face and Hands in Sign Language Recognition. In ICPR (1), pages 239–242, 2006.

[6] Romeo, Pietro,2016. Cross-Cultural HCI and UX Design: A Comparison of Chinese and Western User Interfaces. 10.13140/RG.2.2.18547.63525.

interactive design, to search a set of guidelines for the cross-cultural gesture-based HCI design, to specified useful cross-cultural gesture module in it, and to offer the perspectives for future work in this field.

1.2 Research Context

The recent study about gesture-based HCI, pay more attention to the technical means; however, with the development of tracking technology, the lack of consideration about the cultural aspect in user-centered HCI design generally emerged. The contrary between users' cultural meaning of gesture and system definition of gesture can't be solved by any technical method. The designer should think out what kind of gesture could be used in my system, what is the meaning of this gesture should be defined at the very beginning of the framework.

In the context of recent research, this essay attempt to provide researchers with a new way to study gesture-based HCI design – Cultural field: cross-cultural aspect.

For the purpose of approaching natural user-centered HCI interface, this essay considered users' background aims to study the following research problems:

1. The Effect of Cross-cultural Aspect in Gesture based HCI Design.

Is there any advantages and disadvantages of considering cross-cultural aspect at the initial framework in gesture-based HCI design?

2. The Possible Cross-cultural Problem in Gesture-based HCI design.

Is there any case about misapplying of Local Gestures and Global Gestures; meaning collision of Local Gestures and Global Gestures; or cultural collision between mono-culture users and multi-culture users?

3. Search the promising progress in this field.

What is the difference between Eastern and Western Gesture-based HCI Design module, and if it’s possible to root out a set of gesture guideline for cross-cultural gesture-based HCI design?

1.3 Methodology

To discover the cross-cultural aspect of gesture-based HCI design, considering the given time frame for the completion of this research paper, the most reliable method to produce this paper is a literature review.

From the chapter 2, this paper based on the existing, relatively limited, literature and comparing the previous gesture design case or gesture-based HCI product, searching involved books, dissertations, journals and policy documents to comprehensively research the dynamics of this field.

Following the theoretical basis guidelines, this study engages to go through literature and case studies, in order to explore the positive side and negative side of considering cross-cultural aspect, at the initial framework in gesture-based HCI design.

By searching and comparing the example of gesture application in HCI, in chapter 4 this paper undertakes to explore and summarize misapply of local gestures and global gestures in the HCI design, then analyze the possible reason why the misused those gestures.

Explore the meaning collision of local gestures and global gestures, and track down what is the difference.

Attempt to search when mono-culture users or multi-culture users face the same cultural collision, which is the most confusing part for them to comprehend the meaning of gestures.

And finally, using case study to compare the eastern and western gesture-based HCI design, observed superficies in interface design and the gesture used, analyze the reason of the cultural difference between gesture used in those two different areas.

Summing up, this study attempts to enrich the expansion research between gesture design and HCI; to explore the possible effect and problem of cross-culture gesture design in HCI, and to provide a possible guideline for cross-cultural gesture module in HCI.

2. Literature Review

2.1 Introduction

Gestures, widely accepted as a humans' natural mode of interaction with their surroundings, have been considered for use in human-computer based interfaces since the early 1980s[7]. They have been explored and implemented in a variety of fields, with a range of successes and maturities, and are driven by numerous technologies. Gestures are used for communication and accompany speech in many different forms, hand gestures in particular, in including use of fingers and arms, are widely explored as a natural and intuitive interaction modality for a variety of applications. It is believed that gesture-based interfaces can reduce the complexity of interaction between humans and computers[8].In different HCI interface, the motivation of the gesture choice could be effective by the nature and appropriateness of gestures used, and the ease of technology implementation. The participants' choice of gesture is affected by personal characteristics such as expertise, general knowledge, cultural background, and characteristics of the referent such as task complexity, context, and size of the manipulated objec[9]. However, recent research hardly ever motioned the cultural aspect influence of gesture-based HCI design.

2.2 Cross-cultural Aspect and its effects

Some researchers argued the culture-centered design due to the argument of that

[7] Vuletic, T. (2019) 'Systematic literature review of hand gestures used in human computer interaction interfaces', International Journal of Human - Computer Studies. doi: 10.1016/j.ijhcs.2019.03.011.

[8] New, J.R., Hasanbelliu, E., Aguilar, M., 2003. Facilitating user interaction with complex systems via hand gesture recognition. In: Proceedings of the 2003 Southeastern ACM Conference. Savannah, GA.

[9]ts Urakami, J. (2014) 'Research Report: Cross-cultural comparison of hand gestures of Japanese and Germans for tabletop systems', Computers in Human Behavior, 40, pp. 180–189. doi: 10.1016/j.chb.2014.08.010.

technology is the product of specific culture, has the marking of culture's value orientation, moral, world view, self-perception, and communication practice[10]. Society through normal value effect object-oriented tasks, which retain fully cultural imprint given by community situation. These tasks accomplished by technology. And then, the technology through machine affect interaction medium (HCI), as the cultural oriented design shown by object-oriented action. That is how the cultural affect effect human-computer interaction process. When this kind of interaction widely spread, the different cultural imprint will have interaction, merging or conflicting.

Cultured-centered interfaces design make use of the shared knowledge of target culture and incorporate culture-specific symbols, metaphors and conventions into interface design. For the cross-cultural HCI design, a general guideline for choosing gestures in HCI design is "semantic intuitiveness"[11].Gestures must have a clear cognitive association with the semantic function they perform[12]. However, to be an intuitive semantic should be connected to meaning in their cultural background or language. For this reason, the cross-cultural diversity of gestures used is a considerable aspect of HCI design.

Cross-cultural HCI is via cross-cultural design, that applies iterative analysis to take the target users and their cultural needs into account to approach better user experience[13]. As Kralisch said: "Intercultural research in Information Systems is a relatively new research area that has gained increasing importance over the last few years [14]". After categorizing the main research topics in culture-centered human-computer interaction, cross-cultural HCI becomes more and more well-known in this area since the year 2000. Using the keywords "cross-cultural HCI" when searching the ACM digital library reveals

[10] Inkster, I., & Satofuka, F. (2000). Culture and technology in modern Japan. London: I.B.Tauris.

[11] Urakami, J. (2014) 'Research Report: Cross-cultural comparison of hand gestures of Japanese and Germans for tabletop systems', Computers in Human Behavior, 40, pp. 180–189. doi: 10.1016/j.chb.2014.08.010.

[12] Stern, H. I., Wachs, J. P., & Edan, Y. (2008). Designing hand gesture vocabularies for natural interaction by combining psycho-physiological and recognition factors. International Journal of Semantic Computing, 2(1), 137–160.

[13] Rüdiger Heimgärtner, Intercultural User Interface Design –Culture-Centered HCI Design –Cross-Cultural User Interface Design: Different Terminology or Different Approaches. DUXU/HCII 2013, Part II, LNCS 8013, pp. 62–71, 2013.

[14] Kralisch, A, The Impact of Culture and Language on the Use of the Internet Empirical Analyses of Behaviour and Attitudes, Berlin, 2006.

an exponential rise of publications[15]. That is to say, cross-cultural HCI gradually catch the researcher's' attention.

The previous study found out that cultures differ in color associations, preferred text layouts, and the use of icons or metaphors. For example, van der Sluis, Luz, Breitfuß, Ishizuka, and Prendinger (2012) found differences in the perception of ''human likeness'' of a virtual agent between Japanese and Irish participants. Shen, Woolley, and Prior (2009) tested a ''Chinese Garden'' metaphor as an alternative interface to a ''desktop'' metaphor and received positive feedback from Chinese users. Overall, a high degree of agreement has been observed in selecting gestures across cultures. The only difference found was that Chinese participants generated more symbolic gestures than participants from other countries such as Finland, France, Germany, India, Spain, the UK and the US[16].

Furthermore, that of user-centered design (UCD) is a core concept of Human-Computer Interaction (HCI) and a well-established framework for designing user interfaces that focus on usability, accessibility, and inclusion, with the aim of delivering a smooth and seamless user interaction (Romeo, Pietro,2016). Cross-cultural design as one aspect of user-centered design, focus on the users and his specific needs which is dependent on their cultural content. Therefore, the user's background-culture recognition will have a direct impact on the interactive experience.

Due to this difference, and it's well-known that Asia people use hand gestures much more than westerns. This article focuses on how does the cross-cultural aspect of Eastern and Western country affects the gesture-based HCI design.

2.3 Gesture-based HCI Design

The recent studies about gesture-based HCI, paid more attention to the technical means, such as the researcher Cai Linqin, who aimed to develop low-complexity and real-time

[15] Heimgärtner, R.: Intercultural User Interface Design. In: Blashki, K., Isaias, P. (eds.)Emerging Research and Trends in Interactivity and the Human-Computer Interface (2013)

[16] Urakami, J. (2014) 'Research Report: Cross-cultural comparison of hand gestures of Japanese and Germans for tabletop systems', Computers in Human Behavior, 40, pp. 180–189. doi: 10.1016/j.chb.2014.08.010.

solutions of dynamic hand gestures recognition using RGB-D depth sensor for natural human-computer interaction applications; Maqueda developed a robust vision-based hand-gesture recognition system using volumetric spatiograms of local binary patterns to approach a less intrusive Human–Computer interactive system; Kılıboz used a six-degrees-of-freedom position tracker to collect trajectory data and represent gestures. However, with the development of tracking technology, the lack of consideration about the cultural aspect in user-centered HCI design generally emerged. The contrary between users' cultural meaning of gesture and system definition of gesture couldn't be solved by any technical method. The designer should think out what kind of gesture could be used in the HCI system, what are the meaning of those gestures should be defined, at the very beginning of the framework.

2.3.1 Gesture categorization

In previous thesis some researchers defined hand gestures into one hand gestures, according to the technical limitation, for example, lower bandwidth or processing power of devices used. However, with the sensor-tech developing, the recognition of both hands becomes easier and more common. Therefore, in this article hand gestures are defined as gestures performed using one or both hands, including finger gestures when they were performed along with a number of other varied gestures. In recent research, Kang[17] et al. Invented an operating system referring to different finger gestures for different operations, developed a gesture interface using the left hand to perform the operations the designer wants to perform, and the right hand performs the dynamic operations specifying its parameters. On the other hand, Bourdot[18] et al. Invented the operation of the object on the one hand and the scene on the other, explored the use of one hand to manipulate 3D objects, while the use of slave hands to control 3D scenes. This was related to both hands being applied in everyday life. We could notice that some gestures are on hand gestures unimanual (e.g. gesture of Number 1), some gestures are both hands gestures bimanual symmetric (e.g. Throwing with both hands), in particular sometimes

[17] Kang, J., Zhong, K., Qin, S., Wang, H., Wright, D., 2013. Instant 3D design concept generation and visualization by real-time hand gesture recognition. Comput. Ind. 64,785–797.

[18] Bourdot, P., Convard, T., Picon, F., Ammi, M., Touraine, D., Vézien, J.M., 2010. VR–CADintegration: multimodal immersive interaction and advanced haptic paradigms for implicit edition of CAD models. Comput. Aided Des. 42, 445–461.

both hand act symmetrical (e.g. rope skipping), sometimes not (e.g. dealing cards). In general, the gestures are represented by both hands with different movement to endure more useful meaning to the gesture without repeat.

Tijana Vuletic (2019) divided the gestures into three verified systematics, based on their temporal characteristics, contextual characteristics and the levels of instruction present[19].

The temporal characteristics classified gestures into a static or dynamic one.
The contextual characteristics classified gestures into communicative or manipulative one. The definition of communicative gestures and manipulative gestures are diverse due to different authors.
The levels of instruction present classified gestures into prescribed or free-form gestures.

And then Tijana Vuletic (2019) explained the proposed expansion of gesture classification and typification, shown as the figure.1. She divided the gesture-based research into two catalogs:

1. Gestures observed in the context of speech;
2. Speech-independent gestures used for ergodic and epistemic gestures.

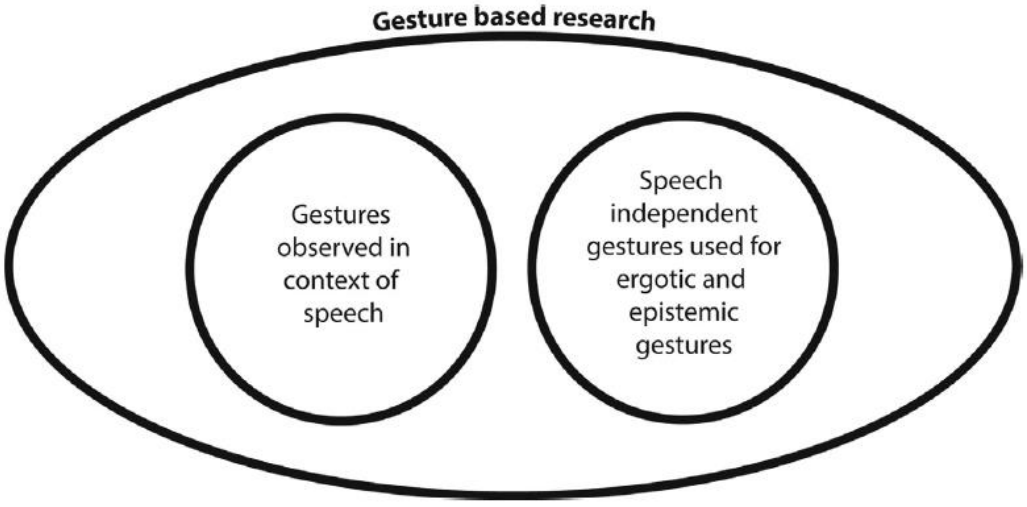

Fig. 1. Expansion of gesture classification and typification
Image from:(Tijana Vuletic, 2019)

[19] Vuletic, T. (2019) 'Systematic literature review of hand gestures used in human-computer interaction interfaces', International Journal of Human - Computer Studies. doi: 10.1016/j.ijhcs.2019.03.011.

Therefore, In this article, I employed a classification system, which was derived from Wobbrock[20] et al. (2009); Freeman, Benko, Morris; Wigdor [21](2009) and Urakami(2012), then adapted to the purpose of my study. The classification system contained three dimensions: form (physical description of hand shape and motion), nature (the quality of the gesture), and frame of reference (orientation of the gesture).

2.3.2 Gesture-based HCI Design

Recent research has focused on developing user interfaces (UI) that provide a natural human input experience through gestures. This so-called Gesture Interface (GI) is able to recognize and interpret a specific set of gestures performed by a human user. Gesture recognition systems use mathematical algorithms to analyze the shape and movement of the user's hand and match the performed gesture with a predefined set of gestures, the so-called gesture vocabulary[22].

Furthermore, there are three fundamental phases required to translate a gesture from physical activity into an input for an interface: detection, tracking, and recognition[23]. The systems used for detection and tracking appear to be highly dependent on the capabilities of the technology used.

2.3.3 The Application of Gesture-based HCI

How to use gestures in a particular interface seems to be influenced by the type of application, the purpose its services, the type of technology that facilitates its implementation, as well as the impact of the basic types of gesture capture, tracking and recognition support, to a certain extent[24]. Those three sorts could be main considerations

[20] J.O. Wobbrock, M.R. Morris, A.D. Wilson User-defined gestures for surface computing Proceedings of the 27th international conference on human factors in computing systems, ACM Press, New York (2009), pp. 1083-1092.

[21]D. Freeman, H. Benko, M.R Morris, D. Wigdor ShadowGuides: visualizations for in-situ learning of multi-touch and whole-hand gestures Proceedings of the 3rd international conference on interactive tabletops and surfaces, ACM Press, New York (2009), pp. 165-172.

[22] Urakami, J. (2014) 'Research Report: Cross-cultural comparison of hand gestures of Japanese and Germans for tabletop systems', Computers in Human Behavior, 40, pp. 180–189. doi: 10.1016/j.chb.2014.08.010.

[23] Rautaray, S.S., Agrawal, A., 2015. Vision based hand gesture recognition for human computer interaction: a survey. Artif. Intell. Rev. 43, 1–54.

[24] Vuletic, T. (2019) 'Systematic literature review of hand gestures used in human computer interaction interfaces', International Journal of Human - Computer Studies. doi: 10.1016/j.ijhcs.2019.03.011.

when designing a gesture-based HCI interface.

As mentioned before, considering the role of gestures in the application, and how it affects the contextual classification. The gestures could be classified contextually based on the motion performed by the hands.

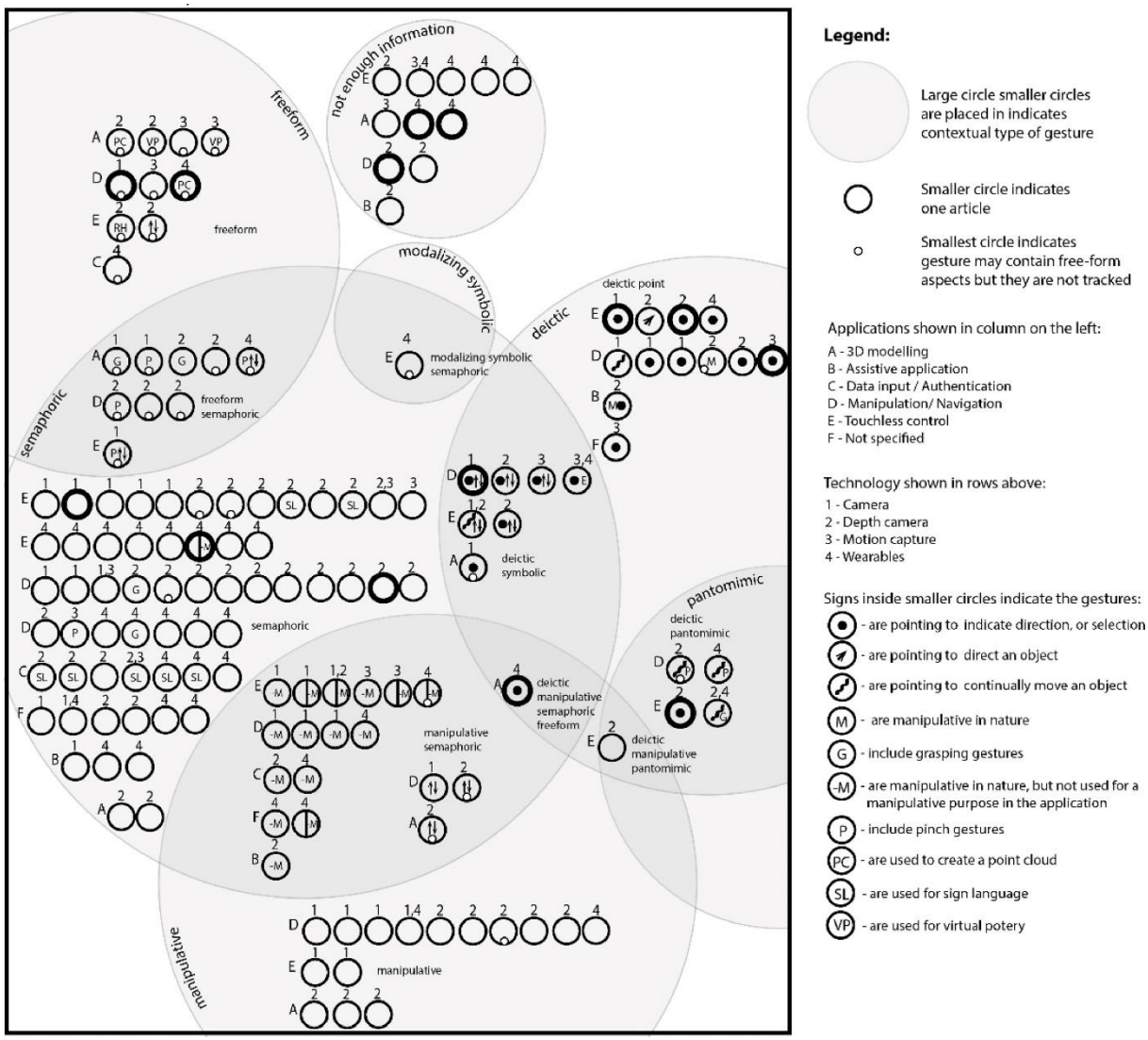

Fig.2 Venn diagram nature of gestures

Image from:(Tijana Vuletic, 2019)

The researcher Vuletic, T(2019) used a Venn diagram for the analysis, shown in Fig.2, In this diagram, each small circle represented an article which reported a type of gesture used in an application. Each large circle represented one of the six contextual gesture types identified as :

1.Manipulative(control function, e.g. achieving translation, rotation, scaling/zooming, or object size manipulation);

2. Pantomimic(emulated similar object in real life);

3. Semaphoric(added predefined);

4. Deictic(provided positioning and selection function);

5. Modalizing symbolic(modalizing symbolic semaphoric);

6. Freeform(completely unrestricted gestures);

7. Not enough information.

Arrange both types of circles for articles implementing the same type of gesture, and then group together those articles. This has identified 11 sets of types of gestures. The darker the shadow of a particular zone, the more types of gestures are used. Some application use one of those gesture types(e.g. deictic gesture, manipulative gesture, free-form gesture, or semaphoric gesture); however, in their design, a large number of applications used more than one type of gesture and combined it in a conscious arrangement. Vuletic, T(2019) identified 11 distinct gestures or combinations of gestures in total:

1.Deictic - The Deictic gesture is used to indicate the point direction or selection, or the pointing gesture is used to move the object continuously along the man-made path.

2.Deictic and pantomimic - They were used for various types of representation interaction and manipulation or for touchless control.

3. Deictic and semaphoric - The Deictic gestures indicated gestures used for selection, and various predefined semaphoric gestures were used to manipulate or trigger specific commands.

4. Deictic, manipulative and pantomimic - The deictic gesture is used for game characters to indicate where the character is, manipulative gesture for intercepting the virtual button, and the pantomimic gesture for pushing the virtual button.

5. Deictic, manipulative, semaphoric and free-form - Deictic was used to select or move, several semaphoric gestures to create 3D objects, free-form gestures to create surfaces, and manipulative gestures to change the dimensions of objects.

6. Manipulative - It is typically used for contactless interaction and is based on a set of

gestures designed to implement pan, rotate, zoom/zoom, or object size operations.

7. Manipulative and semaphoric - Semaphoric gestures provide additional predefined functions that can be triggered to assist manipulative gestures by performing specific gestures.

8. Free-form - They were used with the completely unrestricted gestures for 3D modeling and touchless control.

9. Free-form and semaphoric - The semaphoric gestures were added to allow for added functionality to assist free-form gestures to set up.

10. Semaphoric - They worked based on a user performing an abstract, predefined motion representing a concept using their hands, which triggered a predefined activity assigned to them.

11. Semaphoric and beat - Semaphoric to control a recording of music, and an auxiliary gesture was the beat gesture.

It is worth noting that most of the large circles in the figure have semaphoric and deictic gestures. Typically, the deictic gesture provides a positioning and selection function, while the semaphoric gesture adds a predefined, usually abstract, added function that can but need not, correspond to the performed gesture.

2.3.4 The Patterns of Gesture-based HCI

Although there were some techniques that been used more prominently for certain types of applications; however, there were no clear normative links between the techniques used (or the gestures performed) and the applications used. For this reason, some patterns have been identified in how to combine the use of specific gestures, technologies and application, which is shown in figure 3 below.

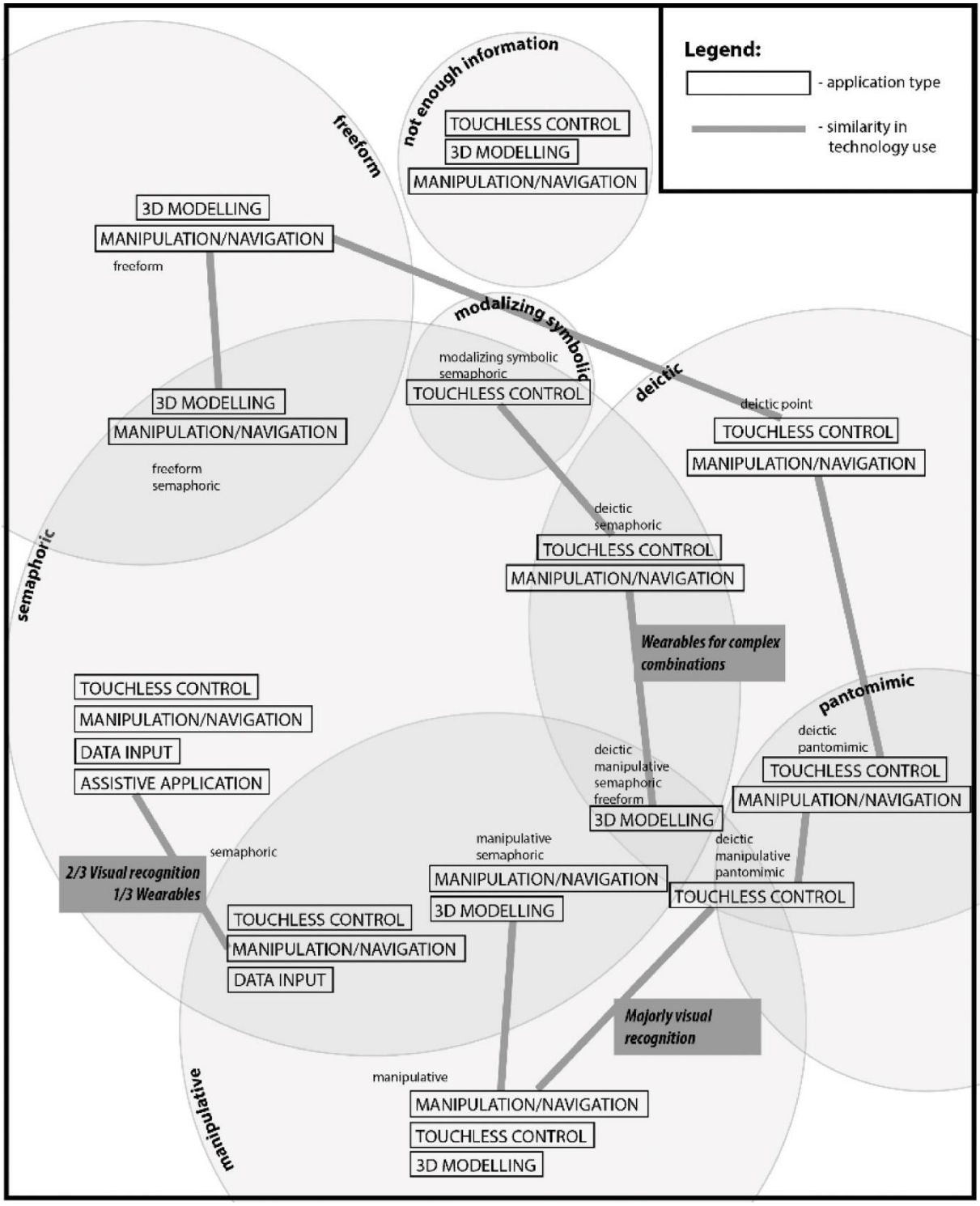

Fig.3 Patterns in gesture use

Image from:(Tijana Vuletic, 2019)

Using a higher-level view of the Venn diagram given in Fig,3, this diagram was derived by Vuletic, T. These application-based packets are then linked into 11 gesture type packets based on promotion techniques used in most of each group's articles. Vision-

based technology for gesture-based interfaces is the main type of technology. About 2/3 of the supporting technologies were visual-based in these applications, and 1/3 were wearables. Using gestures in interface extensions appears to be inspired by affordable depth cameras and motion sensors that may affect their usage frequency. Cameras, 3D cameras, and motion sensors also facilitated free-form gesture-based 3D modeling and the combination of free-form and semaphoric gestures for 3D modeling.

In conclusion, facilitated by a number of technologies, gestures are widely used in interface design in areas such as 3D modeling, assisted applications, data entry, manipulation or navigation, and contactless interaction and control. Technology can be broadly divided into vision-based sensors and cameras, as well as physical wearable devices. The former need not rely on equipment to provide natural movement opportunities, while the latter is usually more accurate and easier to set up and track, but may hinder the movement of the wearer. The most common techniques were depth cameras and accelerometers. However, sensors and cameras are prevailing now because they make interface require less intrusive physical contact, making them user-friendly and intuitive. These may become the main technology for future gesture interfaces if accuracy and reliability are enhanced. Typically, freeform gestures were associated with 3D applications. And Deictic gestures were more often associated with interaction with different display types and robot controls[25]. In general, however, there are no clear leaders or prescribed methods for different applications in techniques, gestures or methods of recognition, but different combinations of these show promise.

2.4 Cross-cultural Aspect in Gesture-based HCI Design

Researcher Alicia Y. Kwon indicated that communicative gestures reflect not only the universal interests and skills of people in social interactions and communication with others but also the specific cultural contexts in which these behaviors develop. Culture influences the timing of certain gestures ' development, even the deictic gestures that are considered flexible in their use and more universal in their value. Gestures are influenced

[25] Vuletic, T. (2019) 'Systematic literature review of hand gestures used in human computer interaction interfaces', International Journal of Human - Computer Studies. doi: 10.1016/j.ijhcs.2019.03.011.

by culture as part of the larger system of human language and can reflect the values, priorities, and perspectives of those who use them, even as communication skills first emerge[26].

And it's well known that gesture Interface (GI) is able to recognize and interpret a specific set of gestures performed by a human user. The environmental and cultural background affects the usage of gestures from cross-cultural users' experiences. In daily life, gestures are obtained in interpersonal discourse. Therefore, gestures are deeply ingrained upon the personal knowledge reserve, physical and cultural interrelations. Recent research in cross-cultural psychology implies that the Eastern residences (especially China) and West residences (e.g., German, France, Ireland) perceive and process the different gestures with the same gestures, which could lead to ambiguity or misconception[27].

Furthermore, cross-cultural design as one aspect of user-centered design, focus on the users and his specific needs which is dependent on their cultural content. When design a gesture-based HCI interface, the user's cultural background will have a direct impact on the interactive experience as well.

The cross-cultural aspect, as mentioned before, the one hand or both hand factor could endow the same meaning as a result of cultural background altered. The Chinese people use one hand gesture to represent the whole on digit number(from 0 to 9), but western residents use both hand gesture to do the same things. Thus, this article focus on how does the cross-cultural aspect of Eastern and Western country affect the gesture-based HCI design.

[26] Kwon, A. Y. et al. (2018) 'Cultural diversification of communicative gestures through early childhood: A comparison of children in English-, German-, and Chinese- speaking families', Infant Behavior and Development, 50, pp. 328–339. doi: 10.1016/j.infbeh.2017.10.003.

[27] Urakami, J. (2014) 'Research Report: Cross-cultural comparison of hand gestures of Japanese and Germans for tabletop systems', Computers in Human Behavior, 40, pp. 180–189. doi: 10.1016/j.chb.2014.08.010.

2.4.1 The way of thinking

Nisbett identified that the ways of thinking could be distinguished into the analytic approach and the holistic approach[28]. Analytical thinking focuses on the application of abstract rules and is a theoretical way of thinking. The world is seen as consisting of specific objects that exist independently of its background. The overall thinking, on the other hand, focuses on the relationship between objects, which is an associated way of thinking. Any object related to its intrinsic meaning can be considered to be related to the world.

In a study by Ji, Zhang, and Nisbett (2004), participants were given three words, such as "monkey," "panda," and "banana," and were asked to choose the two most closely related words. Westerners tend to choose "monkeys" and "pandas." This response is a typical taxonomic classification as both words belong to the category of "animal." Easterners, on the other hand, are more likely to choose "monkeys" and "bananas." This response is based on a typical topic classification of their relationship because of monkeys like bananas. Many similar studies (eg, Nisbett, Peng, Choi, and Norenzayan, 2001; Norenzayan, Smith, Kim, and Nisbett, 2002) reveal the same pattern of responses, suggesting that Westerners are more likely to adopt analytical thinking, while the Easterners are more possible to use the overall way of thinking[29].

From the difference between Westerners and Easterners, it's noticeable that the way of thinking could affect the behavior of participants. For the purpose of User-centered gesture design, it's essential to take those thinking methods into account, when designing a cross-cultural gesture-based HCI interface.

2.4.2 Self conception

Cross-cultural assessments of peoples' self-concept suggest that people see themselves

[28] Nisbett, R. E. (2003). The geography of thought: how Asians and Westerners think differently and why. New York, NY, US: Free Press.

[29] Urakami, J. (2014) 'Research Report: Cross-cultural comparison of hand gestures of Japanese and Germans for tabletop systems', Computers in Human Behavior, 40, pp. 180–189. doi: 10.1016/j.chb.2014.08.010.

in at least two different ways, being ‘‘independent’’ or ‘‘interdependent’’[30]. As a unique and sovereign self, the independent part of the self-behavior focuses on self-perspective, with their perspective, observing the entire world. They regard their own self as the most important indicator. And through this standard, they judge and evaluate the world in which they exist. On the other hand, as the interdependent self part, their way of judging and evaluating the world is believed by their interdependent self, and others come from the perception of others in the thinking and behaviors of relations.

In 1954, experimenters have used the Twenty-Statement Test to test self-assessment[31] , and participants selected several statements to describe themselves in 20 statements. Westerners (for example, Canadians, Swedes, Australians, Americans) have chosen more about self-reporting and have given themselves a single attribute, such as "I am creative," "I like ethnic music." Or “I am very humorous” (Bochner, 1994; Ma&Schoeneman, 1997), While East Asians (such as Chinese, Korean, and Japanese) tend to describe themselves more closely through roles and relationships with others, they pay more attention to interdependence. self. For instance, "I'm a brother" or "I'm a tennis player team member"[32].

From the difference between Westerners and Easterners, the obvious difference in self-conception could be notion as the Westerners willing to be seen as an independent self, on the contrary, the Easterners tend to be seen as an interdependent self which belongs to the society or any other community.

2.4.3 Communication

Hall (1976) identified that communication culture could be distinguished into low context and high context cultures [33] . Residences with a low context culture (e.g.

[30] Markus, H. R., & Kitayama, S. (1991). Culture and the self: implications for cognition, emotion, and motivation. Psychological Review, 98(2), 224–253.

[31] Kuhn, M. H., & McPartland, T. S. (1954). An empirical investigation of self-attitudes. American Sociological Review, 19, 68–76.

[32] Urakami, J. (2014) ‘Research Report: Cross-cultural comparison of hand gestures of Japanese and Germans for tabletop systems’, Computers in Human Behavior, 40, pp. 180–189. doi: 10.1016/j.chb.2014.08.010.

[33] Hall, E. T. (1976). Beyond culture. Oxford UK: Anchor.

Westerners) are used to clarify in a clearer way what they mean. In a foolproof and straightforward manner, they handled their topic and then verbalized their meaning. People communicate in order to explain and obtain opinions from others. However, in some cultural background, the sentence or words already contain a lot of information in the high context culture (e.g. China). So the meaning doesn't have to be clearly explained. The speaker does not say the information already received by the listener but explains the meaning behind the words of the metaphor or background. Individuals communicate to establish and maintain their relationship. They pay more attention to the discourse's emotional connection and prefer to use the metaphorical metaphor to express their own semantics euphemistically.

For the reason that the Easterners hide their semantics behind the metaphor, it might be more difficult for HCI to process in a computer-mediated space with the Chinese cultural background. Furthermore, the Chinese translate could also be a big problem, as the computer language is based on English, which is more similar to or from the western language system.

In summary, previous studies have shown that there are differences between Westerners and Easterners in ways of thinking, self-conception, and communication. Current research focused on whether these differences affected the gestures that users chose when HCI was happening, and how were its effects.

3. The Effect of Cross-cultural Aspect in Gesture-based HCI

3.1 Introduction

Society through normal value effects object-oriented tasks that retain a fully cultural imprint given by the circumstance of the community. technology has accomplished these tasks. And then, machine-based technology affects the interaction medium(HCI), as it’s shown by the object-oriented action in the cultural-oriented design. This is how the cultural aspect affects the process of interaction between people and computers. When this type of interaction spreads widely, there will be interaction, merging or conflicting between different cultural impressions. Thus, when gesture-based HCI is affected by the

cross-cultural aspect, the same interaction, merging or conflicting might happen. That is the reason why this chapter focuses on how this effect influences the gesture-based HCI design.

For the purpose of user-centered GI design, to build up the GI which is able to recognize and interpret a specific set of gestures performed by a human user. Figuring out the effect of cross-cultural aspect in gesture-based HCI could be an essential initial preparation work before design. From the literature review, I combed its structure, and understand there is a huge divergence between Westerners and Easterners in ways of think, self-conception, communication, and the frequency of gesture usage. According to previous research, I believe that cross-cultural aspect has both positive and negative effects on gesture-based HCI.

3.2 Positive side

3.2.1 Satisfy the requirement of users

Designing the user interface in multi-language version, for the purpose of user-centred GI design could satisfy the requirement of mono-culture-user, who came from different native country, to recognize and understand the interactive interface in gesture-based HCI. Therefore, users could participate in the process of interaction without any equipment and use their own gesture language to communicate. That is a perfect way to take users into consideration and then generate better global users experience.

For the way of users thinking, due to the difference Westerners and Easterners, their way of thinking could affect the behavior of participants. Westerners are more likely to adopt analytical thinking, while the Easterners are more like to use the overall way of thinking[34].For the purpose of User-centred gesture design, when designing a cross-cultural gesture-based HCI interface, the gestures which represent more analytical thinking might occupy the majority of all. For the reason of analytical thinking, the style

[34]Urakami, J. (2014) 'Research Report: Cross-cultural comparison of hand gestures of Japanese and Germans for tabletop systems', Computers in Human Behavior, 40, pp. 180–189. doi: 10.1016/j.chb.2014.08.010.

could be easier for users who used to overall way style to understand; however, for people who get used to analytical thinking, they need to guess to understand. That is to say, it's hard for them to comprehend the gesture's meaning and use them as a natural language. Furthermore, it could be easier to operate the computer to process relevant instructions dealing with analytical thinking.

For the users' self-conception, as the Westerners willing to be seen as an independent self, on the contrary, the Easterners tend to be seen as an interdependent self which belongs to the society or any other community. The independent self behavior as a unique and sovereign self. On the other hand, the interdependent self believes the way of them to judge and evaluate the world and others comes from the perception of others in the relations' thinking and behaviors. Due to the difference between Westerners and Easterners, when designing a cross-cultural gesture-based HCI interface, the users could be placed in the position as an independent self. This sort of self-conception leads to less technique problem when cross-cultural users participate in the experiment. Thus, the HCI system could enhance process frequency no matter the cultural background.

For the convenience of users communication, due to the diversity of communication culture. Westerners are used to clarifying what they mean in a clearer way. They handled their topic in a foolproof and straightforward way and then verbalized their meaning. People communicate to explain themselves and obtain other opinions. On the other hand, Easterners hide their semantics behind the metaphor, it might be more difficult for HCI to process in a computer-mediated space with the Chinese cultural background. Furthermore, the Chinese translation could also be a big problem, as the computer language is based on English, which is more similar to or from the western language system. It might lead to another problem, if the designer takes more Chinese figures into the gestures library, as the westerners might not be aware of the convenience of using so many gestures during communication, which does not match their daily life.

3.2.2 Fulfil the requirement of globalization effects.

With the development of globalization, cross-cultural communication occurs in a variety of interaction occasions. The diversity of nationality leads to the diversification of interface language and users experience. Thus, to popularize a global application, the interaction needs to enhance the promotion of their cross-cultural usage function, which could improve global communication, lead to globalization development.

For software promotion, the gesture-based HCI design in the cross-cultural field will have inherent advantages in the promotion. Because the application of cross-cultural gestures could provide clear user experience, users can use their daily, no-translation and no comprehend gestures to operate and control when using the system. In the software promotion process, the translation process is reduced, the use of the system is simplified, the difficulty of getting started of the software is reduced, and the user training is also made simpler.

For the update of the gesture library, the use of cross-cultural gestures in the field of human-computer interaction provides a basis and reference experience for the establishment of a cross-cultural gesture library, providing a selectable sample for enriching the cross-cultural gesture library, and also promoted The development of cross-cultural gestures in the field of human-computer interaction could also provide the case for later researchers, which were rarely mentioned in previous studies..

3.3 Negative side

3.3.1 Increasing Complexity of Systems.

Cross-cultural design (“design for all”) gesture-based human-computer interaction system demand designer to square up the user's cultural background. The designer should carefully consider the meaning of every gesture usage or interactive medium, and the interface required to furnish specific cultural version for distinct users, which entirely demand to increase of design difficulty and prompting the complexity of the system transformation. Furthermore, increased software size increases transmission pressure.

3.3.2 Not friendly to new users

The complexity of gestures is increased, and it is difficult for some users to learn. In most cases, the use of gestures or shortcuts for any piece of software takes a while to learn and adapt. The use of natural gestures can make up for this deficiency to a certain extent, but it still cannot be avoided. So, the more gesture used in the system, the harder it is to use for the beginner. However, each gesture or shortcut is designed to be user-friendly, so the balance between usage and complexity is a question worth considering.

4. The Problem of Cross-cultural Gesture-based HCI design

We consider semiotics as a foundation of interaction and communication design in HCI because it is concerned with the meaningful arrangement of UI elements across space and time[35]. When considering the gestures as a meaningful symbol and using them in gesture-based HCI design, the meaning and the arrangement across space and time of those gestures might cause the understanding problem. And those gestures can work well only when we acknowledge the influence of our native language and culture on our thoughts and actions.

Therefore, the background culture could probably cause the problem below in the gesture-based human-computer interaction process.

4.1 The Misapplication of Local Gestures in the HCI Design

Different culture has its own semiotics and language system. Some of their representation are identical and some of them are independent. In gesture-based HCI design, the diversity of semiotics might cause ambiguity or even misleading when users use gestures to interact with the interface.

Almost every country has its own national enterprise/designer, which devise cultural local gestures for their own use; however, this kind of design couldn't be used on the

[35] *Heimgärtner, R.: Intercultural User Interface Design. In: Blashki, K., Isaias, P. (eds.)Emerging Research and Trends in Interactivity and the Human-Computer Interface (2013)*

international stage. Some researchers in HCI are now working on defining general-purpose gesture sets that are intended to be universally accepted by most people. To this aim, a specific meaning has to be assigned to each gesture. This results in symbolic gestures, i.e. a gesture becomes a symbol for communicating the particular meaning that is assigned to it[36].

However, in practical applications, the problem is how to ensure that the designer assigns an application or a request to the visual expression that is readily understood by the user; however, due to the cultural background or the usage habit, the user always misapplies it in another way.

Taking Yes "✓" or No "✗", as a good example, every country has their own official gestures for accepting and rejecting an item, respectively; however, some cultural background user has a different dynamic motion to write the No "✗".

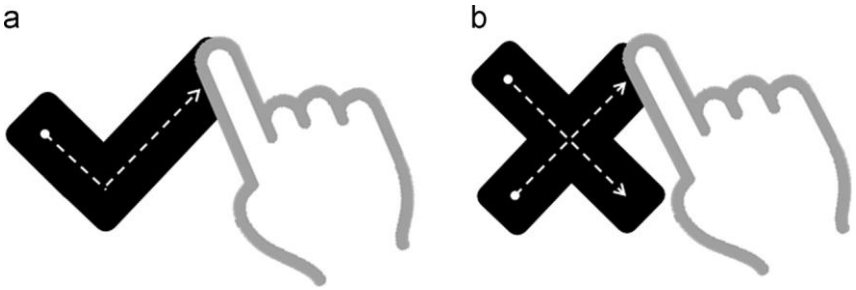

Fig. 4. Examples of symbolic gestures
Image from (Carmelo Ardito, 2014)

Researcher Carmelo Ardito mentioned an expression of dynamic motion of Yes "✓" or No "✗" shown in Fig 4. The arrows in (a) and (b) show possible ways to draw the gestures through a finger movement on a physical surface. There is no doubt that local people of his cultural background will familiar with these gesture motion. And the Yes "✓" gesture seems more like an international design, it's readily accepted for the general public around the world, which might lead to better performance in HCI as a prompt or action trigger. However, the No "✗" gesture could have more way to draw the gestures through a finger movement to express the gesture motion, as is shown below. It could be noticed

[36] H.-C. Jetter, J.Gerken, H.Reiterer, Natural user interfaces: why we need better model-worlds, not better gestures, in Presented at CHI'10WorkshoponNaturalUserInterfaces,2010.

that the same gesture meaning could lead to different gesture motion due to different culture-background, which could bring about unsuccessful or incorrect recognition of gesture capture. This could be an example of misusing local gestures as an global gesture.

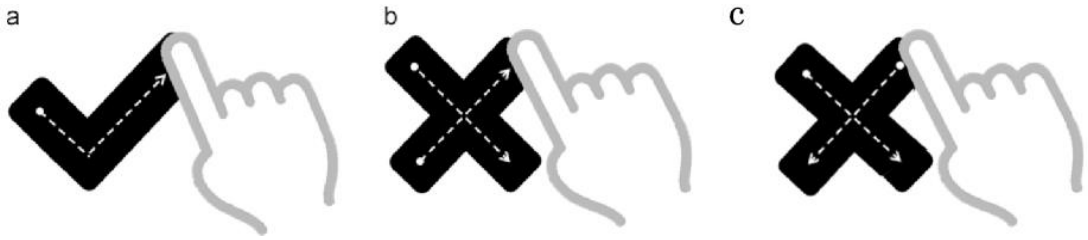

Fig. 5 Examples of symbolic gestures 2

4.2 The Meaning Collision of Local Gestures and Global Gestures

As mentioned before, different culture has its own semiotics and language system. Some of their representation are identical and some of them are independent. In gesture-based HCI design, the diversity of semiotics might cause ambiguity or even misleading when users use gestures to interact with the interface.

That is, the problem is how to ensure that the designer assigns a meaning to the visual expression that is readily understood by the user and the receiver of the message (either human or computer). In particular, depending on context, users, and tasks the pictorial component of visual expression can be understood in different ways.

However, the main difference between local gestures and global gestures is readability and comprehensibility. That is to say, the readable global gestures are that everyone who sees them who understand the meaning of them. Rather than the local gestures carrying the accumulation of history, full of cultural marking. Being used in the gesture-based human-computer interaction interface, the gesture-usage with readability and comprehensibility could provide better users experience when this interaction happens worldwide. yet, during the use of gestures, some local gestures will be treated as a misuse of international gestures.

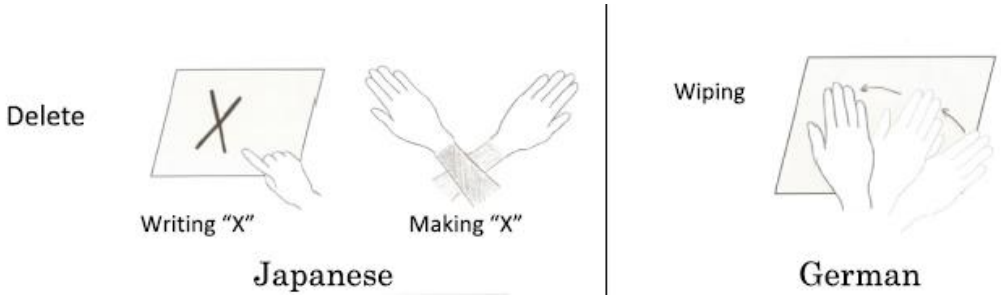

Fig.6 Pictographs of typical gestures performed by Japanese and German participants
Image from: (Jacqueline Urakami, 2014)

Researcher Jacqueline Urakami comparison the hand gestures of Japanese and Germans for tabletop systems, shown in Fig 6. He mentioned that gestures' agreement scores suggest that German and Japanese participants differed especially in how they depict gestures for abstract functions and the perspective they were taking when interacting with the tabletop. Taking the delete function, for example, the difference between Easterners and Westerns could be obvious. As shown in the figure, the Japanese use finger writing a "X" or use both hand motion making a "X" to activate the delete function; however, the German get used to wiping one hand to activate it. That is to say, different gestures express the same meaning. Which gesture should the designer choose as a delete function gesture for cross-cultural HCI design? It's a question. But at least the designer should choose a gesture that does not create huge ambiguity. And it is best not to choose the German gesture as shown above because this gesture (hand wiping) is usually used to indicate page turning in China.

4.3 The Cultural Collision of Mono-culture Users and Multi-culture Users

4.3.1 For the mono-culture users

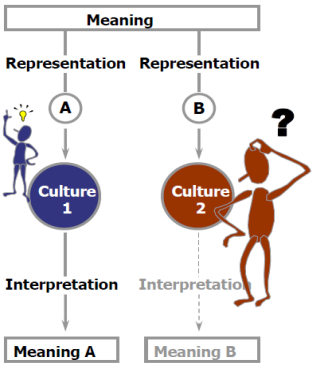

Fig.7 Pictographs of mono-culture users' representation

When gesture was used in HCI, the meaning of it could have its correct representation for culture 1; therefore, the culture 1 users could easily get the interpretation of meaning A. But sometimes we couldn't deduce whether it's sending the same representation, for another cultural background users. Thus, those kinds of cultural background users couldn't comprehend the gesture symbol correctly, they might interpret it for meaning B.

4.3.2 For the multi-culture users

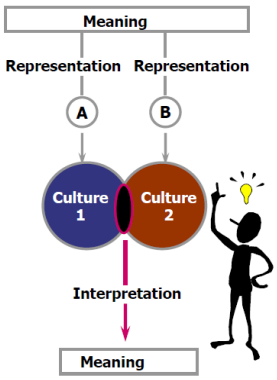

Fig.8 Pictographs of multi-culture users' representation

For the multi-culture users, the multiculturalism they've gain could assist the comprehension process advancement. There is no doubt that they could understand the multi-cultural gesture meaning, which leads to better meaning interpretation when the interaction is processing; furthermore, cross-cultural blending could upgrade the correct rate of guessing metaphor.

5. The Approach of Cross-cultural Gesture-based HCI design

From the literature review, the gestures in HCI could be divide by temporal characteristics, contextual characteristics and the levels of instruction present.

That is to say, gestures could be classified into static or dynamic one; communicative or manipulative one, or prescribed or free-form gestures. Furthermore, there are three fundamental phases required to translate a gesture from physical activity into an input for an interface: detection, tracking, and recognition. Benefited from the development of detecting and tracking technology, both hand recognition for any operation (no matter it's static or dynamic; communicative or manipulative; prescribed or free-form) becomes reality.

Based on these technical foundations, for the cross-cultural gesture-based HCI design, compared with the past, we should not only consider the implementation of technology but also focus on providing a better user experience by considering the user's cultural background.

5.1 A Comparison of Eastern and Western Gesture-based HCI Design

As mentioned before, the researcher Jacqueline Urakami comparison the hand gestures of Japanese and Germans for HCI systems, shown in Fig.9. On this basis, the author analyzed the differences of it between Chinese and Western countries based on her own experience.

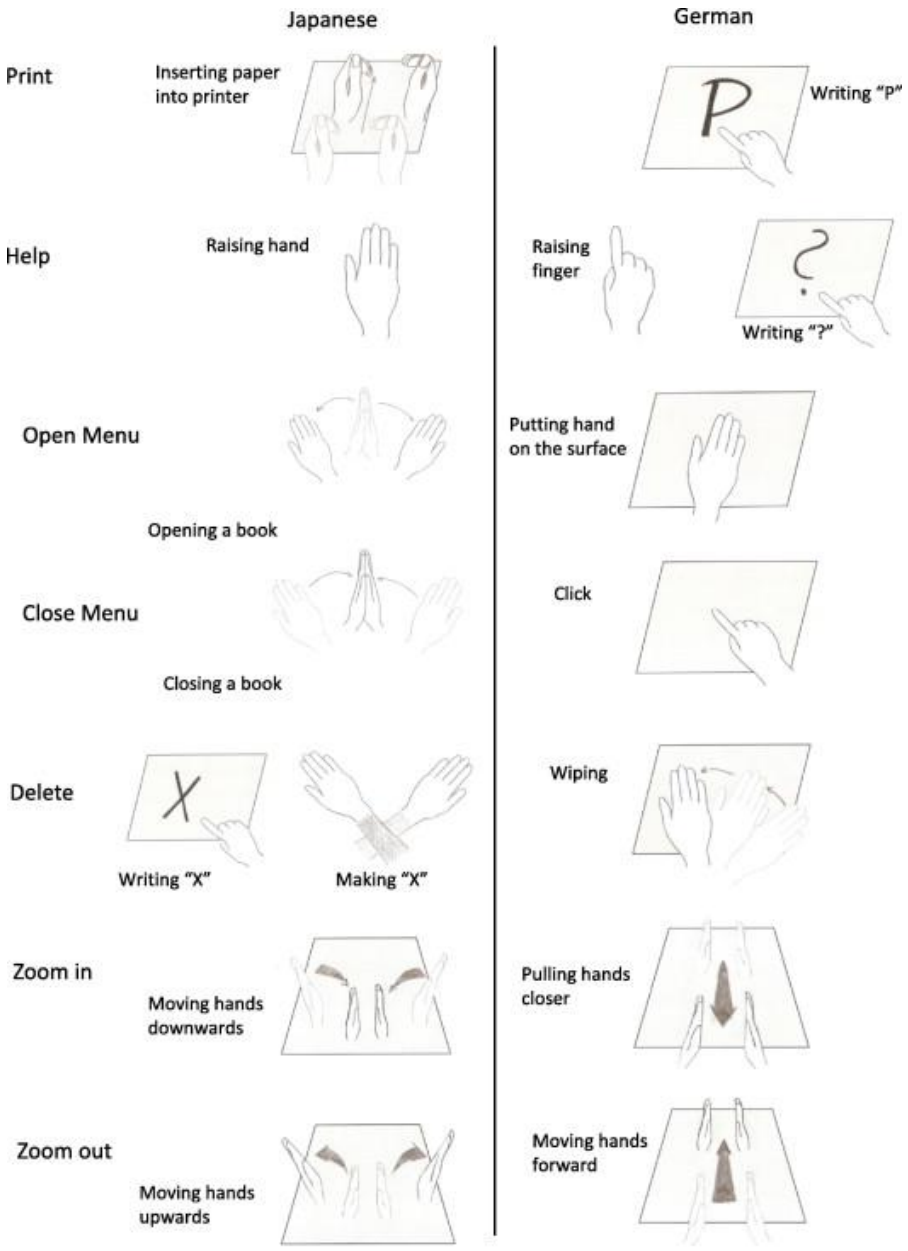

Fig.9 Pictographs of typical gestures performed by Japanese and German participants.

Image from: (Jacqueline Urakami, 2014)

In Urakami's research, participants in Germany and Japan are particularly concerned with how they depicted abstract functional gestures and the perspectives they taken when interacting with the interface. Figure 2 illustrated a pictogram of typical gestures performed for abstract functions by German and Japanese participants, showing the differences below:

1. Japanese use the gesture: insert the paper into the printer for Paint, while German is accustomed to writing a "P" letter.

2. The Japanese use the gesture: raising a hand for Help; however, German get used to

raise index finger, which is a common gesture in German classrooms, and then write a “?”, for the same meaning.

3. For Open Menu, the Japanese use the gesture to simulation open a book; while German Intuitive put the hand on the table surface.

4. Analogously for Close Menu, the Japanese use the gesture to simulation close a book; as well as the German get used to click the close button.

5. Japanese have two gestures to express deletion, one is writing an "X", another one is using both hands to make an “X” look to activate the delete function; however, the German get used to wiping one hand to activate it.

6. For Zoom In, the Japanese are accustomed to moving hands downwards, and the German likes to pull hands closer to their body.

7. For Zoom Out, the Japanese get used to moving hands upwards, while the German will move hands forward from their body.

As can be seen from this figure, these differences between Japanese and German were obvious. But some the Japanese gestures couldn't represent the gestures of the Easterners. As a Chinese, from the reference, I still haven't found any gestures that specifically express “Print” this feature in the gesture-based HCI system. And we use the same gestures with Japanese for Help, Close Menu, Zoom In, and Zoom Out. For the Delete function, as I mentioned before, the stroke order of the “X” may be different due to the culture-background, which could bring about unsuccessful or incorrect recognition of gesture capture. Here the researcher didn’t mention the stroke order of the delete function, so we could deem the system as being able to accept multiple stroke sequences, so it could also considered the same gesture. Therefore, the only difference between Japanese and Chinese is the gesture for Open Menu, Chinese simplified the operation of their hands and were more accustomed to using one hand to express the action of opening the book. That is, the main hand is turned down from the palm down clockwise to the palm up. In other words, the gestures of the Easterners are relatively uniform, but

they are quite different from those of the Westerners.

Furthermore, from this case, it's noticeable that Western performed more gestures of symbolic and deictic such as drawing a ‘‘P’’ for Print, or a ‘‘?’’ for Help. On the one hand, Westerners are more inclined to just click on the table surface, declared that they'd like to have a button here, expressing the natural semaphoric and manipulative gestures they take advantage of. However, on the other hand, Easterners operate more metaphorical pantomimic gestures such as “inserting paper into a printer” for printing, “raising a hand” for Help, “opening and closing hands like opening and closing a book” for Open Menu and Close Menu, “making an X mark” or “X” sign for Delete. This also comes from the difference between the way of thinking. Westerners are more likely to adopt analytical thinking(click), while the Easterners are more possible to use the overall way of thinking (an associate of opening a book from the open menu).

Some of these metaphorical gestures are clearly specific to cultural background. For example, for the Delete, Eastern writes the "X" because the Japanese "X" mark, also known as "batsu," has the meaning of "no," "wrong" or "incorrect" and the Chinese "X" mark also known as "cuo," the meaning is exactly the same as in Japanese. However, in western culture, this meaning of X-link is not shared. The Germans, on the other hand, use “?” mark, a symbol not used in Japanese writing, but in simplified Chinese, it is still a common symbol.

The zoom in / zoom out gestures revealed similarities as well as some basic differences between Easterners and Westerners. We believe this difference indicates that a different perspective has been taken by them. While Westerners use their own body as a reference point for a “self-centered” perspective, moving their hand around their body, being ‘‘independent’ as a unique and sovereign self. Easterners use the HCI system interface or table as a reference point for a “me perspective”, been seen as an interdependent self which belongs to the society or any other community.

In summary, this case has shown that there are differences between Westerners and Easterners in ways of thinking, self-conception, and communication, which could lead to the diversity of gestures in HCI system.

5.2 A set of Guidelines for the Cross-cultural Gesture-based HCI design

The potential differences are further accented by globalization because when using communication technology, we are facing more and more with UI coming from rather different cultural backgrounds. In order to tackle the differences in a meaningful manner, there is a growing demand to design UI that are usable and well accepted in the target culture.

5.2.1 based on our commonly shared spatial and physical experiences

From the previous experience, it is better to provide users with a bright system representation and a clear conceptual model in the form of a simple but powerful visual-based "model world" interface. Thereby the rules that govern this model-world should be based on our commonly shared spatial and physical experiences. For example, almost every user has experienced how it feels to use the hands to move and arrange physical objects on a desk. We should also endeavor to take advantage of this fact when designing the gesture user interface. Instead of introducing a human gesture language, we could attempt to lead the user directly manipulate, organize, and stack objects on the screen, inquiring the user to learn symbol gestures first and then execute them to indirectly tell the system what to do.

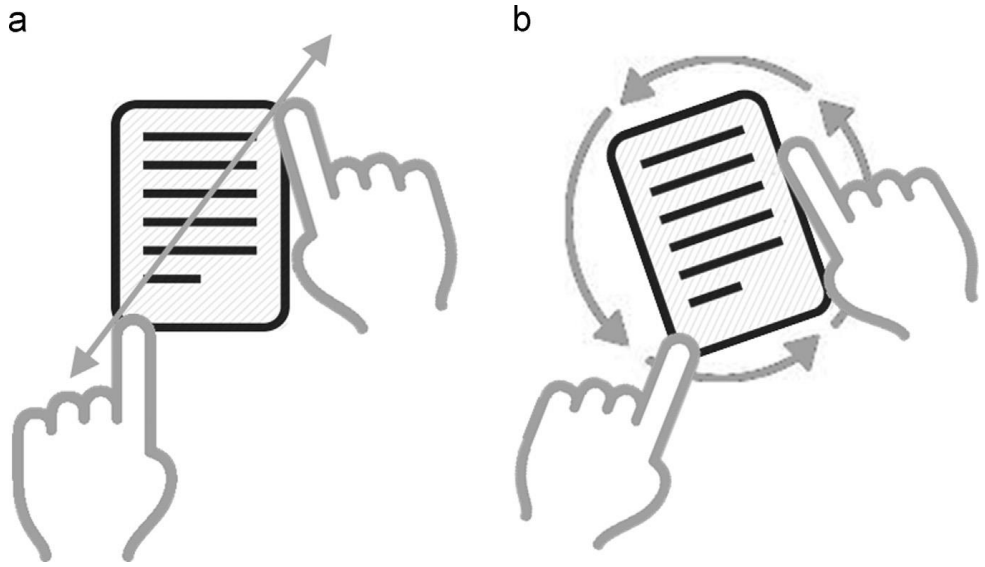

Fig. 10. Examples of manipulations to zoom (a) or rotate (b) an object visualized on a display.
Image from (Carmelo Ardito, 2014)

The well-known "two-finger zoom" or "two-finger rotation" structure shown in Fig. 10, is probably the most common multi-touch gesture in today's user interface and is a great example of a user-familiar operation with natural space and physical principles.
Even when there is no real material that stretches and contracts like a simulated rubber sheet during Zoom-in/Zoom-out, users can understand their spatial and physical properties in seconds. If applied successfully, this approach can shift the focus of gesture interaction from learning and performing symbol gestures to using almost direct manipulation of objects on the screen with little effort. Therefore, we believe that the key to a better gesture language is this manipulation.

The operations we designed are effective because they absorbed the way of everyday physical and space world works, or more accurately, the way we experienced the everyday in the physical and space world. They didn't depend on the user's familiarity with cultural gestures and HCI gestures, nor on the well-designed metaphor of the simulated real world on the screen, but based on our most basic sensory and spatial experiences. As human beings, we may have experienced such experiences, and our senses receive a similar natural physical space due to the physiological similarity of human beings. In the physical space, this naturally formed early learning environment stimulates our senses and produces so-called upbringing. If a large number of symbol gestures are introduced in the system instead of focusing on the functional enhancement of gesture operations, this is equivalent to expecting the user to learn a large number of keyboard shortcuts or command line expressions or new languages. For users, especially new users, there is no way to produce the most basic sensory and spatial experience. It also makes it impossible for users to acquire and operate the HCI system easily and freely in the natural environment as a child.

5.2.2 The designer should carefully consider the meaning of the gesture

As mentioned before, Westerners are more likely to adopt analytical thinking, so that, they might more prefer to use manipulative/deictic gestures to achieve translation, rotation, scaling/zooming, or object size manipulation; while the Easterners are probably to use the overall way of thinking, therefore, they might be willing to use pantomimic gestures to emulated similar object in real life.

Westerners willing to be seen as an independent self, so they might prefer to use freeform gestures to complete more unrestricted gestures; on the contrary, the Easterners tend to be seen as an interdependent self which belongs to the society or any other community, therefore they could desire to use modeling symbolic semaphoric gestures.

Westerners are used to clarifying what they mean in a clearer way, so that they could likely to operate deictic gestures to provide positioning and selection function, but Easterners prefer to use the metaphor to euphemistically express their own semantics, therefore, they could more prefer to use semaphoric gestures to added more predefined, although they need to study to gain the instructions.

It's noticeable that the westerners seem to be an independent self who like to adopt analytical thinking, and get used to clarify what they mean in a clearer way. So, they might prefer to use manipulative, deictic and freeform gestures. On the other hand, the Easterners seem to be an interdependent self who might possibly use the overall way of thinking and prefer to use the metaphorical metaphor to euphemistically express their own semantics. Therefore, they might get used to applying pantomimic, modalizing symbolic, semaphoric gestures.

Although the westerners and easterners have different gesture orientation, each classification of gestures could be combined together, to enrich the gesture-based HCI system. For the globalization of HCI application, all those features demand to be considered in the design, and every gesture should have a global meaning, which shouldn't mislead users into ambiguity or double entendre. The gesture using should consider universal audience's daily custom, satisfied the general public requirement.

5.2.3 The interface should prompt its usability for all.

The interface should prompt its usability for all, especially for the disabled population, considering the accessibility of HCI. We could expect to think of universal design (or design for all) as the working philosophy of creating interactive products: like other areas, the design is focusing on simplifying users' daily tasks, building products, services, and environments, which is more useful for everyone and requiring minimal effort to learn it.

This means allowing automatic custom interface and gesture-based HCI processes to detect the user's personal characteristics (hearing impairment, blindness, etc.) and to adapt to the environment they placed at a given time (low light, excessive noise, mobile devices). It supports all workplaces and has perfect accessibility (AAA level), using gestures to communicate and control the HCI interface.

5.2.4 Cross-cultural testing of UIs

Cross-cultural testing of UIs is the most useful method to evaluate the accessibility of the target culture. The most effective approach is to use the cross-cultural testing of the UI to examine all gesture-based HCI designs and evaluate all the requirements of the code and the user interface to meet the accessibility guidelines for specific cultural goals. In addition, the user experience is the most valuable quota in the evaluation criteria.

6. Conclusion

With the flourish of HCI, the application of it thriving and expanding into an apparent diverse and enriching field. The recent studies about gesture-based HCI, paid more attention to the technical means; however, with the development of detecting and tracking technology, the lack of consideration about the cultural aspect in user-centered HCI design generally emerged. The contrary between users' cultural meaning of gesture and system definition of gesture, couldn't be solved by any technical method. Based on the fast-growing technical foundations today, we could focus on providing a better user experience by considering the user's cultural background.

Therefore, this study explored the effect of cross-cultural aspect in gesture-based HCI design. It found out that the positive side of considering the cross-cultural aspect in gesture-based HCI system were that it satisfied the requirement of users and fulfilled the requirement of globalization effects. But also, corresponding deficiencies have followed, such as increasing complexity of systems and not being friendly to new users. So, the balance between the usage and complexity is a question worth considering. Then, this study considered the problems in cross-cultural gesture-based HCI could be the following: the misapplication of local gesture in the HCI design. The meaning collision between local

gestures and global gestures; and finally, the cultural collision between mono-cultural users and multi-cultural users. Furthermore, from the classification of gestures, this study compared a case of Eastern and Western gesture-based HCI design, observed the differences between Westerners and Easterners in ways of thinking, self-conception, and communication, which could lead to the diversity of gestures in HCI system. Finally, for the purpose of this research paper, a set of guidelines were suggested for the cross-cultural gesture-based HCI design - all the gestures should be based on our commonly shared spatial and physical experiences, and the designer should carefully consider the meaning of the gesture, especially considering that the westerners seem to be the independent self who like to adopt analytical thinking, and used to clarify what they mean in a clearer way. So, they might prefer to use manipulative, deictic and freeform gestures. On the other hand, the Easterners seem to be the interdependent self who might possible to use the overall way of thinking and prefer to use the metaphorical metaphor to euphemistically express their own semantics. Therefore, they might get used to applying pantomimic, modalizing symbolic, and semaphoric gestures. The interface should prompt its usability for all, using the cross-cultural testing of UIs to evaluate the accessibility of the target culture. In general, this study suggested the guidelines in order to provide a point of reference for developers, designers and future researchers regarding the incorporation of cross-cultural aspect in HCI design.

This research hasn't attempted any revision according to the interview process or experiment in order to gain more users behavior data for the analysis; but is based on the literature review, case study, and analysis of causes to study the research problems. As a result, any future work should definitely include more research on searching the promising progress in this field, compiling and perfecting more systematic guidelines, based on a large number of behavioural data of cross-cultural users.

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