ENHANCEMENT OF KANSEI ENGINEERING METHODOLOGY FOR SOUND DESIGN

YIAP SHIN YI

THESIS SUBMITTED IN FULFILMENT FOR THE DEGREE OF MASTER OF SCIENCE

FAKULTI KOMPUTERAN DAN INFORMATIK
UNIVERSITI MALAYSIA SABAH
2017

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN STATUS TESIS

JUDUL : ENHANCEMENT OF KANSEI ENGINEERING METHODOLOGY FOR SOUND DESIGN

IJAZAH: MASTER OF SCIENCE (MULTIMEDIA TECHNOLOGY)

Saya **YIAP SHIN YI,** Sesi Pengajian **2013-2014,** mengaku membenarkan tesis sarjana ini disimpan di Perpustakaan Universiti Malaysia Sabah dengan syarat-syarat kegunaan seperti berikut:-

1. Tesis ini adalah hak milik Universiti Malaysia Sabah.
2. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara insitusi pengajian tinggi.
4. Sila tandakan (/)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan dimana penyelidikan dijalankan)
☑	TIDAK TERHAD	

YIAP SHIN YI
MI1321004T

Tarikh: 30 Ogos 2017

Disahkan oleh,
NURULAIN BINTI ISMAIL
LIBRARIAN
UNIVERSITI MALAYSIA SABAH
(Tandatangan Pustakawan)

(Prof. Madya Dr. Ag Asri Ag Ibrahim)
Penyelia

(En. Jetol Bolongkikit)
Penyelia Bersama

DECLARATION

I hereby declare that this thesis is the result of my original research work except as cited in the references. This thesis has not been accepted for any degree and in any university.

23 SEPTEMBER 2016

.....

YIAP SHIN YI

MI1321004T

CERTIFICATION

NAME : **YIAP SHIN YI**

MATRIC NO : **MI1321004T**

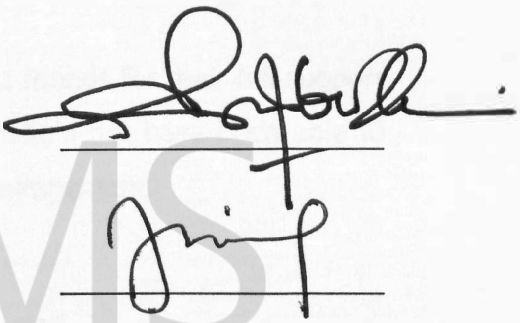
TITLE : **ENHANCEMENT OF KANSEI ENGINEERING METHODOLOGY FOR SOUND DESIGN**

DEGREE : **MASTER OF SCIENCE (MULTIMEDIA TECHNOLOGY)**

VIVA DATE : **30 MARCH 2017**

CERTIFIED BY:

1. **SUPERVISOR**
   Assoc. Prof. Dr. Ag Asri Ag Ibrahim



2. **CO-SUPERVISOR**
   Mr. Jetol Bolongkikit

ACKNOWLEDGEMENT

First and foremost, I would like to extend my deepest gratitude to my main supervisor, Associate Professor Dr. Ag Asri Ag Ibrahim for his guidance, support and understanding throughout my research journey. Without his patience, wisdom and counsel, my thesis work would have been a frustrating and overwhelming pursuit. I would also like to express my appreciation to my co-supervisor, Mr Jetol Bolongkikit for giving me many thoughtful ideas and comments in the process of writing up this thesis.

My sincere acknowledgement goes to the students from the UMS Faculty of Computing and Informatics Labuan for their voluntary participation throughout my data collection phases.

Last but not least, thank you to my parents and friends for their full support during my years of completing this master degree. I would not have been able to complete this endeavour without their continuous encouragement.

YIAP SHIN YI

23rd September 2016

ABSTRACT

Kansei Engineering (KE) is a method used to measure human feelings and emotions, and then relate these to certain product properties. Applied into many products such as automobiles, households' items and websites, this method has proven effective in linking human perceptions and design parameters to create products that address intended feelings and emotions. This method however is yet to be applied into the context of sound design notwithstanding that psychological concepts linked to feelings and emotions could be evoked by sound. A listener's main reaction would be to interpret the sound he hears with this perception and interpretation influenced by feelings and emotions. Current design processes of sound applications do not take into consideration users' feelings and emotions. This research therefore offers an investigation into embedding the right and intended feelings and emotions into sound by using the Kansei Engineering approach. By applying the Kansei Engineering approach into sound design, the physical properties of sound with selected Kansei words were examined, to establish an atmosphere whereby the user's intended feelings and emotions could be ascertained. An enhancement of the Kansei Engineering framework is thereafter presented to link Kansei and sound physical properties. The experiment used the quantitative research approach with four types of sound samples utilised to verify and support the framework. The experiment was conducted in four phases whereby users' feelings and emotions towards the physical properties of sound were generated at the end of synthesis phase. Four types of sound physical properties were chosen to induce certain feelings and emotions in users towards the sound samples. Data was obtained through in-depth questionnaires with the results used to support the idea of implementing the Kansei Engineering approach to improve sound designing processes. The incorporation of Kansei Engineering methodology into sound design practice in this study has demonstrated positive results from the users. The findings indicate Kansei Engineering as a viable method in the design of sound physical properties that could induce feelings and emotions.

ABSTRAK

PENAMBAHBAIKAN METODOLOGI KEJURUTERAAN KANSEI UNTUK REKABENTUK BUNYI

Kejuruteraan Kansei (KE) merupakan kaedah yang digunakan untuk menilai dan mengaitkan perasaan dan emosi pengguna dengan ciri-ciri produk tertentu. Kaedah ini telah digunakan secara meluas dalam produk seperti kereta, barangan isi rumah dan laman web. Walaupun kaedah ini telah terbukti keberkesannya dalam menghubungkaitkan persepsi pengguna dan ciri-ciri rekabentuk untuk menghasilkan produk yang dapat memenuhi perasaan dan emosi pengguna, ia masih belum diaplikasikan dalam konteks rekabentuk bunyi. Konsep psikologi berkaitan perasaan dan emosi dapat dibangkitkan oleh bunyi: apabila pengguna mendengar bunyi, tindak balas utama mereka adalah untuk mentafsir bunyi tersebut dengan menghubungkaitnya dengan konsep psikologi. Persepsi dan tafsiran terhadap bunyi boleh dipengaruhi oleh perasaan dan emosi. Aplikasi bunyi sebelum ini adalah tanpa mengambil kira perasaan dan emosi pengguna dalam proses rekabentuk bunyi. Justeru itu, kajian ini dijalankan untuk mengkaji bagaimana mengaplikasikan perasaan dan emosi pengguna dalam rekabentuk bunyi melalui pendekatan Kejuruteraan Kansei. Kajian ini mengaplikasikan pendekatan Kejuruteraan Kansei dalam proses rekabentuk bunyi dengan meneroka ciri-ciri fizikal bunyi dengan perkataan Kansei yang dipilih, untuk membantu mencipta suasana dalam mendapatkan perasaan dan emosi pengguna yang dikehendaki ke arah ciri-ciri fizikal bunyi. Satu rangka kerja Kejuruteraan Kansei telah dihasilkan untuk mengkaji perkaitan Kansei terhadap ciri-ciri bunyi. Eksperimen ini menggunakan pendekatan kuantitatif dan dilaksanakan melalui empat jenis sampel bunyi untuk menyokong rangka kerja Kejuruteraan Kansei. Eksperimen ini dilaksanakan dalam empat fasa di mana pada akhir fasa sintesis, perasaan dan emosi pengguna yang menjurus kepada ciri-ciri fizikal bunyi dihasilkan. Data dikumpulkan menggunakan kaedah soal selidik. Keputusan yang diperolehi daripada eksperimen dianalisa untuk menyokong idea terhadap penggunaan pendekatan Kejuruteraan Kansei dalam membantu proses rekabentuk bunyi yang lebih baik, di mana empat jenis ciri-ciri bunyi dipilih untuk mendorong perasaan dan emosi pengguna. Kajian ini menunjukkan dapatan yang positif dalam aplikasi kaedah Kejuruteraan Kansei dalam proses rekabentuk bunyi. Penemuan ini boleh dianggap sebagai salah satu kaedah dalam merekabentuk ciri-ciri bunyi yang mendorong perasaan dan emosi di kalangan pengguna.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Chapter Introduction

This chapter provides an overview to the background of the topic, with an in-depth description of the Kansei Engineering methodology proposed for incorporation into sound design. A discussion of the problem statements, aims of study, research objectives and questions, expected contributions and significance of study, and overall structure of thesis is also provided in this chapter.

1.2 Background

Sound is able to induce both positive and negative feelings and emotions in humans, a fact well supported and exploited in the film industry. The human emotion is induced through the physical properties of sound such as volume and pitch with these feelings guiding the person on the appropriate actions or behavior as they listen. According to (Hagman, 2010), the human auditory system is not only channel for emotion induction but also one of the main receptors for receiving information about the environment. The human auditory system interact with sound based on sound physical properties. For instance, in the case of physical properties such as volume, listeners can perceive the feeling of pleasant or unpleasantness. If the listeners feel unpleasant, their first reaction might be to turn down the volume of the sound immediately. Hence the importance of paying attention to the sound physical properties aspects in sound design.

This research investigated the use of the Kansei Engineering methodology to induce users' feelings and emotions when they interact with sound physical properties. Kansei Engineering is defined as a translating technology of user's feeling (Kansei in Japanese) of the product into design elements by using statistical analyses and engineering methods (Nagamachi, 1995; Lokman, 2013). The results could be used to support the development of framework structures by evaluating users'

would probably feel annoyed or stressed whether to walk away from that street or just close their ears. Such reactions are able to influence the user's perception and decision-making. Thus it is important for sound designers or researchers to put more effort to discover the implicit needs of users. For any sound to elicit the "correct" action, it should induce an emotional reaction in the user. This fact is supported by the Emotion Reaction Model (ERM) which theorises that the human brain automatically reacts to certain sound physical properties (Larsson, Opperud, Fredriksson and Vastfjall, 2009). The underlying sound physical properties must be analysed to enable their incorporation into sound design requirements that could elicit emotions.

1.3.3 Lack of emotion recognition for sound models

Another problem in emotion recognition in sound is the selection of suitable emotion representation models (Schuller, Hantke, Weninger, Han, Zhang and Narayanan, 2012). The most commonly used representation model is the discrete approach which relies on a list of adjectives each describing an emotion tag such as happy, sad or depressed. Although this approach has been used in speech and music emotion recognition for quite a long time. It has limited the emotions used to describe sounds. The Kansei Engineering methodology used in this research was found to be more accurate in representing emotions.

1.3.4 Insufficient knowledge of linking sound physical properties with emotions

Although there have been numerous researches conducted on the correlation between basic psychoacoustic parameters and urgency with similar perceptual aspects in sound design, the cognitive responses linked to sound is much less well understood (Edworthy and Hellier, 2006). It is important to systematically measure how sound is comprehended by users. (Edworthy and Hellier, 2006) suggested that abstract sound could be interpreted differently depending largely on the surrounding environment and the users themselves. Psychoacoustics utilizes three parameters to observe users' psychological reactions to sounds such as sharpness, roughness and toneless. Although these parameters are subjective, they limit the human sensation towards the sound. While psychoacoustic algorithms have been presented

feelings and emotions and incorporating these into design requirements of sound. The Kansei of sound is explored through the Kansei Engineering methodology, whereby users' feelings and emotions are considered at every phase when designing sound. Incorporating Kansei into sound design might enable the link between human feelings and emotions with sound physical properties, and ensure a large amount of information be transmitted accurately and effectively to users thus optimizing the overall sound design.

The contribution of this research could thus be viewed from the provision of a proposed framework for the measurement and incorporation of Kansei, and the design requirements within the scope of physical properties aspects for sound design.

1.3 Statement of Problems

1.3.1 Shifting from functional to emotional design of sound

The use of sound to support visualization tasks has witnessed a surge especially in human computer interfaces, system applications and products. In line with this encouraging development, many researches have been conducted to investigate ways to ensure that sound could work as well as visual elements do. This approach is different from visualization; in the absence of visual interaction, it is crucial for any product or application to focus on capturing the users' attention, and direct them to react in an appropriate way and even influence them to take further actions such as decision making. In sound design, the study of emotion in sound elements has been developed for years. While most of the sound issues had usually emphasized on functionality, the focus has shifted to the aspect of emotional design of sound in recent years. It is evident from previous literature that researchers have been emphasizing the important presence of emotion in sound design such as Emoacoustics and Psychoacoustics, whereby sound could influence users in their decision making, reactions and attention.

1.3.2 Sound evaluation based on sound designers' perspectives

The main issue here is on how to incorporate the emotions of users as they interact with sound elements instead of just based on the sound designer's viewpoint. For instance, when users hear sounds such as the loud engines of a car passing by, they

to measure the sound perceptual quality and predict user tolerance to sound there is still a need to consider the user's input at various stages of sound design.

1.3.5 Lack of measurement methods to access human emotions for sound products

Emotional product sound design tends to influence users to buy products they desire; as such, various researches have been conducted to improve the overall design of products that utilize sound. Much effort has been assigned in designing sound that meets user requirements. In the absence of physical interaction, products need to focus on how to capture the attention of users, and influence them to take proper actions such as decision making. Major studies in the field of product sound design all agree on the psychological effect of sound on users (Bodden, 1997; Özcan and van Egmond, 2006; van Egmond, 2008). Previous studies have emphasized the importance of emotion in product sound design whereby emotional engagement in product design could influence decision making, perception, attention, performance and cognition (Norman, 2002; Pettinelli, 2009; Russell, 2003). It is the user who determines the adequacy of the sound to the products. However, little is known about how the users could emotionally respond to sound and what aspects of the sound design could trigger emotional reactions. There is no specific measurement that could be used to enable the assessment of user emotion for sound and no methods to enable the discovery of how sound elements could trigger emotional responses. (Bodden, 1997) suggested that such predictions and the auditory analysis of the product sound should be done by considering user input. Hence, there is a need in the last phase or preferable throughout the whole product design process that user input need is considered.

1.3.6 Lack of appropriate method to reduce Kansei words

Previous emotion theories have shown various ways to collect Kansei words. To implement Kansei Engineering methodology, Kansei words are usually used to emotionally describe the products collected from difference sources (Marco-Almagro and Tort-Martorell, 2012). In traditional Kansei Engineering, these words are very important as they form the basis for subsequent analysis (Steinberg, Tursch and Woll, 2015). The traditional ways of collecting Kansei words usually involve the

determination of large number of words included in the synthesis phase (Steinberg et al., 2015). However, other studies conclude that these large number with the associated design elements might become a major burden for users during the evaluation process (Steinberg et al., 2015) and may reveal disadvantages particularly with regards to the Kansei words (Steinberg et al., 2015).

In addition, important emotional aspects may have been partially disregarded since direct interaction with users is missing and not all Kansei words are recorded (Steinberg et al., 2015). (Kort, Reilly and Picard, 2001) stated that the label attached to human emotions is complex and could contain mixtures of the words whether shown or hidden. It is also unclear how many Kansei words need to be evaluated or are reasonable for users (Steinberg et al., 2015). If the number of words is too low, there is a big possibility of greater loss of information, whilst too many Kansei words on the other hand might cause overstrain and a low quality of results to be obtained (Steinberg et al., 2015).

Another disadvantage highlighted by Steinberg et al. (2015) is the lack of references for Kansei words. It is not clear which component of the product properties particularly refer to user emotions since the direct interaction is missing. The synthesis phase is important where the semantic space is connected with product properties space, and the identified emotions are expressed via Kansei words (Steinberg et al., 2015). In traditional Kansei Engineering approach, users do not test the products but only evaluate them in terms of product appearance or perception (Steinberg et al., 2015).

Researcher therefore believe that the accurate identification of the human emotional state is a critical indicator to show that the smaller the set of emotions, the more likely it is to have success in the classification of the emotions towards product properties. This research may improve the Kansei words approach by applying the filtering process in steps to collate the perceptions through in-depth data collection techniques for direct user interaction with sound physical properties.

In order to fill in the gaps in sound design requirements, this research has incorporated Kansei Engineering to induce user emotions that correspond with sound physical properties. The research proposed a framework that investigated user Kansei in sound design, the visible physical properties from his point of view, and the influence of the physical properties to his Kansei to investigate the extent to which the sound physical properties could induce Kansei.

In every phase involved, the method focused on user viewpoint so that the resulting design requirements could be generated. This study will formulate the basic design requirements that elicit the target Kansei, in order that the sound could capture users' attention and influence them to react accordingly.

1.4 Aims of Study

The aim of this research is to provide evidence that Kansei Engineering methodology would be useful as a tool towards incorporating users' feelings and emotions into sound design.

1.5 Research Objectives

The three main objectives in this study are:

1. **To investigate the significant relationship between Kansei and sound physical properties;**
2. **To propose an enhancement framework of Kansei Engineering methodology for sound design; and**
3. **To evaluate the enhancement framework of Kansei Engineering methodology for sound design.**

1.6 Research Questions

Two research questions highlighted throughout this study are as below;

1. **What are the Kansei that could be induced by sound physical properties?**

   This question seeks answers on the Kansei that could be induced when users listen to sounds. Although the importance of emotional aspects in sound design has increased significantly, there is still no method to link the user's emotional responses in sound design. In order to provide better understanding of Kansei

when designing sound, users need to be included in the determination of design requirements by using the Kansei Engineering methodology.

2. **What are the sound physical properties that could trigger Kansei?**
   This question requires knowledge on the relationship between users' feelings and emotions and sound physical properties. The answer would determine
   which design elements have the most influence on their emotional responses in sound design. This knowledge will facilitate the formulation of design requirements of sound to embed target emotions.

1.7 Research Contributions

This research provides methodological, empirical and practical contributions to the sound design context. The explanations for all the contributions are presented below;

1.7.1 Methodological contributions

1. **A Kansei Engineering Sound Design (KESD) Framework, to assist in the design of sound to embed target emotions.**
   The framework is in the form of translation from the concept of emotion to sound physical properties. This method measures users' emotional responses to overcome the lack of existing approaches that link emotions in sound design. It demonstrates each of influential physical properties to embed target emotions in sound design by including the phases of identifying the concept of emotion, the design requirements of sound that could embed target emotions, and the validation of framework by testing with four types of sound samples. Such a framework would enable sound designers to draw strategies to produce sound products that embed user emotions into the design. Although the current form of the framework is might be viewed as specific to the case study domain, it could still offer a basis to the extension of the existing approach in sound design such as those which focus on functionality and do not consider user involvement during the product development process (Ozcan and van Egmond, 2009). This method will be useful to sound designers and researchers as it is able to provide details on how to embed target emotions in the context of sound design.

1.7.2 Empirical contributions

1. **Research findings on the evidence of existence of user emotional responses in sound design.**

   These findings provide important evidence that emotional responses of users do exist in sound design. Hence, there is a need to address this aspect; sound designers should not only focus on products functionality but also consider the emotional aspect of users in the design of sound products.

2. **Research findings on the influence of sound physical properties on user emotional responses in sound design.**

   These findings put forward the influential physical properties in sound to elicit emotions. Such findings are important to provide more appropriate combinations of sound physical properties to evoke different types of emotions. This could assist sound designers and researchers in establishing a viable point of reference to determine strategies to develop sounds that embed emotions.

1.7.3 Practical contributions

The findings of this research will be able to assist sound designers develop sound products with related emotions. With the implementation of this framework, sound designers would need to first ascertain the emotions of users during the sound product development process in order that products that embed target emotions and enhance user experiences could be developed and produced.