

An exploratory study of facial expression recognition as applying to consumer attitudes of cultural goods

Chia-Yin Yu*, Chih-Hsiang Ko**

Department of Industrial and Commercial Design, National Taiwan University of Science and Technology

** lisayu1202@gmail.com*

*** linko@mail.ntust.edu.tw*

Abstract: Cultural and creative industry has strong characteristics and is highly modernized in mostly more well developed countries, which makes the industry unstable in the market, and is hard to build trust for consumers because the profitability of cultural goods relies on whether consumers are interested in purchasing them. Since consumers' purchasing attitudes affect the design of cultural goods, several research methods have been developed for evaluating consumer attitudes. It is believed that physical signals can be used for understanding consumer feelings, which are reliable because emotions are highly involved in purchasing attitudes. This paper discusses the possibilities of facial recognition in evaluating consumer attitudes by taking different designs of Chinese dragon images as stimuli. Research subjects viewed sample images and were instructed to verbalize their feelings after each type of images was shown. FACS, as introduced by Ekman, was considered as a possible tool for recognizing consumer attitudes toward different types of cultural images. A research method was developed to evaluate its usability. It is proved that consumer attitudes can be understood by facial recognition, which will help designers to improve the communication with consumers and to link the design of cultural goods with consumer interests.

Keywords: *consumer attitudes, facial recognition, cultural goods*

1. Introduction

Cultural and creative industry not only reflects the quality and lifestyle of a country, but also highlights its cultural images. Taiwan's cultural and creative industry has paid equal attention in knowledge/innovation, and economy/humanities. Cultural goods have many purposes, serving educational functions, promoting local cultural values, and adding values to local economy. However, this industry has strong characteristics and is highly modernized, which makes it unstable in the market and hard to build trust for consumers. The profitability of cultural goods relies on whether consumers are interested in purchasing them. However, producers of these goods often have difficulties understanding consumer preferences. Therefore, designers need to have a clear grasp of consumers' interests and attitudes in order to maximize the value of cultural goods.

Since consumers' purchasing attitudes affect the design of cultural goods, several research methods have been developed for evaluating them. The traditional research methods measure subjects' oral responses or answers to understand their emotions or attitudes for different stimuli. However, researchers can only collect data of the subjects' rational responses or explanations instead of their immediate emotional reactions, which Peter Goldie called "post-rationalization" because the responses could have been filtered out by the subjects [4]. Nonetheless, for understanding consumer attitudes, emotional reaction could be a more accurate gauge. It is believed that

physical signals can be used to understand consumers' feelings and is a more reliable assessment since emotions are highly involved in purchasing attitudes. According to a previous research, 55% of human communication relies on facial expression [12]. Cultural goods need to attract consumers from emotional aspects, such as building emotional connections between consumers and products. In short, realizing consumers' emotions for cultural goods can be highly beneficial. This paper discusses the possibilities of facial recognition in evaluating consumer attitudes toward different types of cultural images. The purposes of this research are as follows:

- (1) To review related theories on cultural goods and facial recognition.
- (2) To demonstrate the usability of FACS in evaluating consumer's interests in cultural goods.
- (3) To provide suggestions for using facial recognition to evaluate consumer attitudes in cultural goods.
- (4) To discuss the possibilities of applying facial recognition to the design of cultural goods.

2. Literature Review

2.1. Cultural Goods

The main difference between cultural goods and regular products is that cultural goods are full of emotions and narratives in cultural aspects while regular products only focus on practicalities. Cultural goods tend to be considered as specialty goods and are defined by three dimensions: referential, technical and circumstantial. The referential dimension describes the possibility of the consumer to compare products according to different references - some showed by the same artist, others showed in the same museum, etc. The technical dimension refers to the material and technical components of the product: the cultural product is very complex and often requires a previous knowledge to be consumed correctly. The circumstantial dimension refers to the temporary circumstances in which the product is consumed [3]. Perceived value and quality of service is important to the consumer alongside the cultural goods themselves. The price people are willing to pay to maintain or grow cultural goods or services can be seen as a measure of value placed on cultural goods themselves [16]. In cultural marketing, designers have to focus on the references, forms and functions of the cultural goods, as well as realizing the needs from consumers, in order to create emotional connection between consumers and products [11].

2.2. Consumer Attitudes

"Attitude" is a person's overall evaluation of a concept. Evaluations are affective responses, and are usually at relatively low levels of intensity and arousal. These evaluations can be created by both the affective and the cognitive systems [13]. Consumer attitudes can be defined as a function of the existence or absence of beliefs regarding a specific service or product [9]. It was expanded to assert that attitudes of affect for or against a service or product would determine the consumer's future behavior toward the service or product [1]. It is useful to consider attitudes as having three components: cognitive (beliefs), affective (feelings), and behavioral (response tendencies). Each of these attitude components is discussed in more detail below [10].

- (1) Cognitive component: The cognitive component consists of a consumer's belief about an object. For most attitude objects, people have a number of beliefs. Beliefs can be about the emotional benefits of owning or using a product as well as about objective features.
- (2) Affective component: Feelings or emotional reactions to an object represent the affective component of an attitude. This overall evaluation may be simply a vague, general feeling developed without cognitive

information or belief about the product. Or it may be the result of several evaluations of the product's performance on each of the several attributes.

- (3) Behavioral component: The behavioral component of an attitude is one's tendency to respond in a certain manner toward an object or activity. The behavioral component provides response tendencies or behavioral intentions. Actual behaviors reflect these intentions as they are modified by the situation in which the behavior will occur.

The three components mentioned above are complementary to each other. If one of the components changes, the other two will change accordingly. However, the intention of a reaction cannot represent the actual purchasing behavior.

2.3. Facial Recognition

Most psychical movements produce emotions, and most emotional reactions are non-verbal. During communication, people send emotional signals. In fact, 55% of human communications rely on facial expressions, while 38% on tones of speaking, and only 7% on verbal language [11]. The expressions of facial emotions rely on the movement of facial muscles [5], therefore, emotions can be recognized by facial muscle movements. Emotions can provide social information [14]. In short, facial expressions are the most important information resources in human communications. There are seven types of universal human emotions: sadness, anger, surprise, fear, disgust, contempt and happy [4].

There are over 10,000 of facial expressions a human face can make [4]. The Face Action Coding System (FACS) is used for measuring the facial movement [6,7]. Researchers discussed facial muscles separately and using the term "Action Unit (AU)", which can combine with each other (AUs), to describe facial movements produced by one or several different muscles [6,7]. There are 41 AUs defined as table 1.

Table 1. Single Action Unites (AU) [6,7]

AU Number	FACS Name	AU Number	FACS Name
1	Inner Brow Raiser	23	Lip Tightener
2	Outer Brow Raiser	24	Lip Pressor
4	Brow Lowerer	25	Lips Part
5	Upper Lid Raiser	26	Jaw Drop
6	Cheek Raiser	27	Mouth Stretch
7	Lid Tightener	28	Lip Suck
8	Lips Toward Each Other	29	Jaw Thrust
9	Nose Wrinkler	30	Jaw Sideways
10	Upper Lip Raiser	31	Jaw Clencher
11	Nasolabial Furrow	32	Lip Bite
	Deepener		
12	Lip Corner Puller	33	Cheek Blow
13	Sharp Lip Puller	34	Cheek Puff
14	Dimpler	35	Cheek Suck
15	Lip Corner Depressor	36	Tongue Bulge
16	Lower Lip Depressor	37	Lip Wipe
17	Chin Raiser	38	Nostril Dilator
18	Lip Pucker	39	Nostril Compressor
19	Tongue Out	43	Eyes Closed (<i>Optional</i>)
20	Lip Stretcher	45	Blink (<i>Optional</i>)
21	Neck Tightener	46	Wink (<i>Optional</i>)
22	Lip Funneler		

The FACS analyzes emotions by distinguishing AU movements. Nowadays, most the facial recognition systems and facial expression database around the world are FACS-oriented, focusing on how to make measurement automatically and reduce processing time [8]. In this paper, the FACS is used as a reference to score facial expressions, to discuss the possibilities that facial recognition can be applied as a research method to understand consumer attitudes toward cultural images in different designs.

3. Methodology

3.1. Experimental Design

After understanding the development and category of the use of facial recognition, the platform for the application of facial recognition to the design of cultural goods was conducted. The main purpose of this research is to obtain consumer attitudes toward cultural goods successfully by the experimental platform, and to adjust or fix lacking articulation if necessary. The experimental environment needed to be quiet, so the subjects were not distracted to afflict experimental validity. During the experiment, the subjects sat with comfort and face the screen. The position of the center of the screen was adjusted in the subjects' sight around 10~20 degree, and about 50~60cm from the subjects. There was clapboard between the subjects and the researcher so the subjects could take the experiment alone, while the researcher observed and controlled the process. The whole experiment was recorded by video and audio for analysis. Considering the convenience of organizing and analyzing files, the video size was set as 640x480 pixels. The experimental platform is as figure 1.

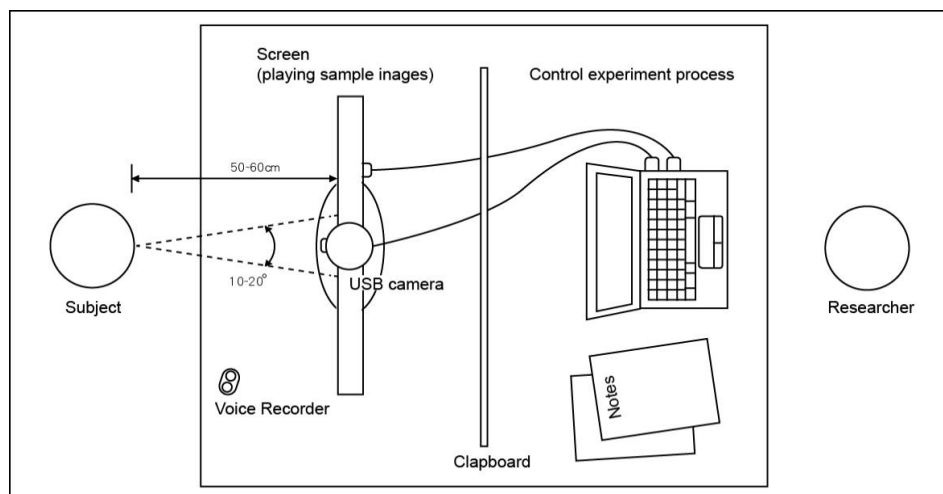


Figure 1. Experimental platform

3.2. Samples for the Experiment

The researcher took Chinese dragon graphics from Chinese Zodiac as experiment samples, the reasons is as follows: (1) Chinese Zodiac is the chronology well-known by Asians, its related cultural beliefs and stories are also familiar to Taiwanese people. (2) "Dragon" is the only virtual animal in Chinese Zodiac and provides more flexibility in design compared to other Zodiac animals. In order to overcome all possibilities that lead to emotions, sample images were categorized by different designs as variables. The researcher collected 204 dragon graphic images mainly from books and online database and filed them by numbers. In case of image backgrounds might influence the subjects' feelings for the image, the backgrounds were unified during the sampling process.

Table 2. Focus group members

Member	Current occupation	Years	Member	Current occupation	Years
A	Project manager	3	E	Graphic designer	4
B	Graphic designer	5	F	Artist	5
C	Visual designer	3	G	Graphic designer	5
D	Art director	2			

Table 3. Sample images

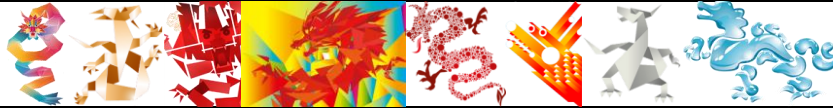
1. Ink paintings



2. Calligrams



3. Geometric figures



4. Paper-cuttings



5. Caricatures



6. Color blocks



7. Realistic drawings



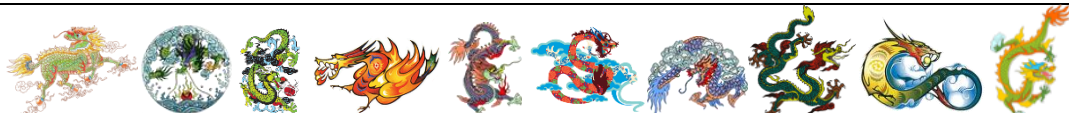
8. Line drawings



9. Stereoscopies



10. Color paintings



After filing images, a focus group was assembled to categorize all images. Focus group is a form of qualitative research in which a small group (6-12) of members discuss and share their opinions on certain issues. And the researcher can generate useful information during the discussion [15]. In this research, seven people were invited into the focus group, and each of them was specialized in the design field with more than two years of working experiences (see table 2).

The focus group used the KJ (Kawakita Jiro) method to categorize images and chose final version of sample images used in the experiment. The methods were as follows.

- (1) Each image was printed on a 10x15 card and was labeled with a number.
- (2) The focus group categorized images based on visual similarities, and named each category according to their characteristics.
- (3) Up to 10 representative images were chosen from each category by the focus group.

Finally, 10 types of images were presented for the experiment. They were: (1) ink paintings, (2) calligrams (3) geometric figures, (4) paper-cuttings, (5) caricatures, (6) color blocks, (7) realistic drawings, (8) line drawings, (9) stereoscopies, and (10) color paintings (see table 3).

3.3. Research Subjects

The subjects were 120 university students, with vision 0.8 or above after visual correction, and had no color blindness or visual dysfunction.

3.4. Experiment Procedures

The experimental platform was set by a USB camera connecting a computer, recording the subjects' facial expressions. One of the main challenges of the experiment was how to make the subjects show their emotions by facial movements. Though most facial movements were non-spontaneous, the pretest showed that the subjects' facial movements were not significant while watching sample images, which could increase the difficulties of facial recognition. By considering the subjects' feedback and repeating several pretests after adjusting the experiment methods, the experiment procedures were conducted as follows.

- (1) The subjects viewed the introduction video.
- (2) The subjects viewed all types of sample images displayed by Latin square designs to avoid continuous effect.
- (3) The subjects were instructed to verbalize their feelings after each type of samples was shown.

The subjects' facial expressions were recorded during the experiment, and were analyzed by the researcher to understand the subjects' emotions by using the FACS (Facial Action Coding System) as a reference.

4. The Procedures of Facial Recognition and Findings

In this paper, the FACS was used as a reference to analyze the subjects' emotions to discuss the possibilities of using facial recognition in the design field of cultural goods. By considering the subjects' facial actions as sign language, the researcher could get the subjects' attitudes toward different types of cultural images. The FACS is a descriptive system and is very detailed for applying in different aspects. To simplify the process of scoring AU, and to focus on the seven universal emotions, the researcher extruded optional scoring AUs and intensity; to organize 20 possible AUs when seven emotions occurred, for comparing with the subjects' videos (see table 4). The seven emotions with possible AUs are summarized as table 5.

Table 4. Possible AUs with seven universal emotions, summarized by this research [6,7]

AU No.	FACS Name	AU No.	FACS Name
1	Inner Brow Raiser	15	Lip Corner Depressor
2	Outer Brow Raiser	16	Lower Lip Depressor (Usually occurs with AU 25)
4	Brow Lowerer	17	Chin Raiser (May cause wrinkle on the chin boss)
5	Upper Lid Raiser	20	Lip Stretcher (Elongates the mouth)
6	Cheek Raiser	22	Lip Funneler (Usually occurs with AU 25)
7	Lid Tightener	23	Lip Tightener
9	Nose Wrinkler	24	Lip Pressor
10	Upper Lip Raiser (Produces nasolabial furrow)	25	Lips Part
11	Nasolabial Furrow Deepener	26	Jaw Drop (The mandible is lower by relaxation)
12	Lip Corner Puller (Recognized as smile)	27	Mouth Stretch

Table 5. Seven emotions with possible AUs, summarized by this research [6,7]

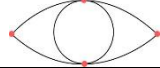
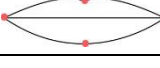




Emotion	Main AU	Facial Expression	Comparison AU	Possible AU combination
Sadness	1+4+11(+54+64) 1+4+15B(+54+64) 1+4+15B+17(+54+64) 11+15B(+54+64) 11+17	Jaw drop with mouth open	25+26	1+4+11+15B (+54+64) 1+4+15 (+54+64) 6+15 (+54+64)
		Lip corners pull down	15	
		Lower lip/chin push up	17	
		Lip corners pull down with raising cheeks	6+15	
		Deepen nasolabial furrow	11	
		Inner brows raise	1	
		Inner brows pull down then raise	1+4	
		Eyes look down	64	
		Upper lids drop	43	
		Eyes look down with upper lids drop	43+64	
Anger	Must including: 4, 5, 7 or 10	Brows pull down	4	4+5+7+10+22+23+2
		Eyes open wild, upper lids push up with brows pull down	4+5	5,26
		Lips close tight	24	4+5+7+10+23+25,26
		Upper and lower lids tighten	7	4+5+7+23+25, 26
				4+5+7+17+23
Surprise	1+2+5B 1+2+26 1+2+27 5B+26 5B+27	Brows raise with upper lids push up	1+2+5	4+5+7+17+24
		Mouth open	26 or 27	4+5+7+23
				4+5+7+24
Fear	1+2+4+5+L or R20+25, 26, or 27 1+2+4+5 1+2+5Z(+25, 26, 27) 5+20 (+25, 26, 27)	Higher upper eyelids (possible with lower eyelids tighten)	5(+7)	1+2+4+5+20+25, 26, or 27
		Jaw drop	26(+25)	1+2+4+5+25, 26, or 27
		Lips stretch	20	
		Brows pull down then raise	1+2+4	
Disgust	N/A	Upper lip raise (possible asymmetry)	10 (R/L)	9
		Lip corners tighten	14	9+16+15, 26
		Nose wrinkle	9	9+17
		Chin raise	17	10
Contempt	N/A	Brows pull down with cheeks raise	4+6	10+16+25, 26
				10+17
Happy	N/A	Cheeks raise	6	6+12
		Mouth corners raise	12	12C/D

Note: 25 or 26 may occur with all prototypes or major variants.

According to the emotional related theories [4], most emotional expression will last from 0.5 to 4 seconds. For obtaining detail information from the subjects, this research analyzed videos at a rate of 1/3 second, to find if there was any recognizable facial expression from the subjects during the experiment. The researcher referred extant research methods on facial recognition, to conduct the procedures as follows. [2,8,11]:

- (1) Standardize the videos as series of continuous images at a rate of 1/3 second.
- (2) Marked facial features. There were permanent features and transient features on the face, and transient features were marked only when they occurred (see table 6).
- (3) Compared facial features for each picture. If there was any changing facial feature, recorded the movement and collated corresponding AUs (see figure 2).
- (4) Scored corresponding AU combinations, and found possible suggesting emotions from table 5. The results are shown in table 7.

Table 6. Facial feature marks, summarized by this research [2]

	Element	Description	Mark
Permanent Features	Eye	The inside and outside corner of the eye. The upper and lower edge of the eye.	
	Lip	Lip corners. The upper and lower edge of lips.	
	Brow	The upper edge of brow. The inside and outside endpoints of brow.	
	Chin	The endpoint of chin.	
Transient Features	Furrow	The dark lines of nose on both sides.	
	Furrow	The dark lines of chin on both sides produced by open jaw	

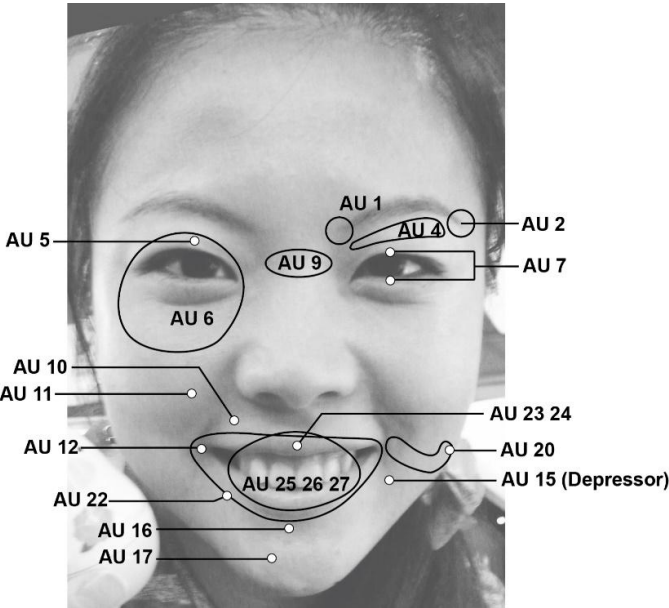
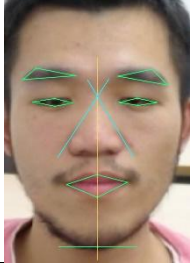
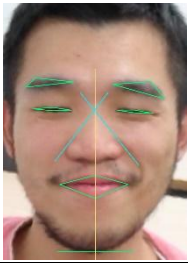
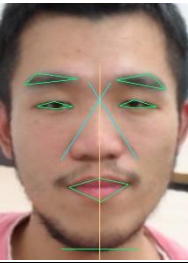
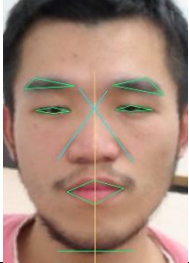
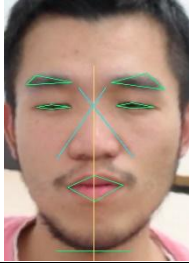




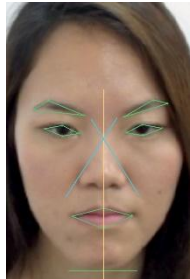
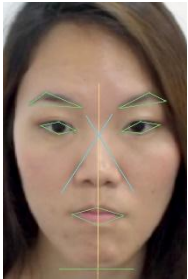
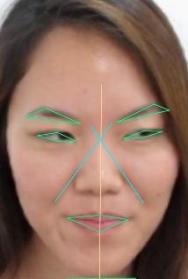
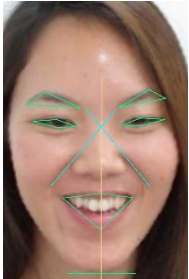
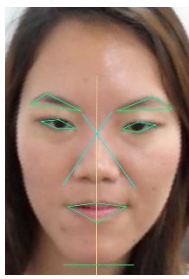


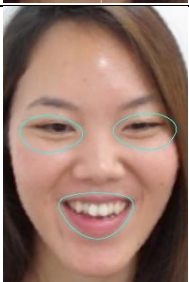



Figure 2. AU numbers and locations of facial areas and parts from table 4, summarized by this research [6,7]

Table 7. The result samples of facial recognition.

Time	N/A	0:20	1:13	1:36	3:50
Sample type	N/A	Caricatures	Caricatures (verbalizing feelings)	Color blocks	Line drawings (verbalizing feelings)
Facial features					
Moving areas	N/A				
AU	None	6, 12	5(L), 26	1, 2, 7, 11(L)	7, 11(L)
Possible emotion	Neutral	Happy	Surprised	N/A	N/A

Time	N/A	0:13	01:04	3:30	8:56
Sample type	N/A	Realistic drawings	Realistic drawings (verbalizing feelings)	Stereoscopies (verbalizing feelings)	Paper-cuttings (verbalizing feelings)
Facial features					
Moving areas	N/A				
AU number	None	1, 2, 5, 24, 26	4(L), 6, 7, 11, 24	6, 12	4(L), 14, 24
Possible emotion	Neutral	Surprised	Disgusted / contemptuous	Happy	Angry

According to the result, the experimental design conducted by this research could lead to the subjects' emotional expressions and could be recognized by the researcher using the FACS as a reference. And it is found that the subjects were more willing to express their emotions during verbalizing feelings rather than in the stage of

watching sample images. It is a tool for human communication, and is consistent with the theory of emotional expressions during verbalizing feelings, so people were willing to present themselves during the process of communication more than when they only received information. Moreover, the subjects were instructed to speak to a camera instead of human beings, which could avoid the situation that the researcher could affect the subjects' emotions in many possible circumstances.

5. Conclusions

Based on culture, with creativity to add its value, the cultural and creative industry has become one of the most important industries in many developed countries. It is important for cultural goods to catch consumers' attention, and to build emotional connection with them. The FACS was used to measure the subjects' emotions as non-verbal languages, and to understand their subconscious reactions. Besides applying in the field of psychology, FACS-oriented research methods were used in the commercial field to understand consumers' preferences. The purpose research method, including experimental design and analyzing procedure, was developed for recognizing consumer attitudes toward different types of cultural images. By AUs comparison and analysis, it was proved that the experimental design in this research could lead to the subjects' emotions and associated facial expressions for after viewing sample images. Meanwhile, it indicated that measuring facial expressions could be applied for the design of cultural goods. By collecting and measuring the consumers' emotional signals, the researcher could understand the consumers' true feelings on products, which could affect consuming behavior. And it will help designers to improve the communication with consumers and to link the design of cultural goods with consumer interests.

Although FACS has described facial movements with details and has suggested the possible AU combinations for seven universal emotions, human emotions can be very complex and it is hard to determine that all facial expressions are suggesting certain emotions only by AU combination recognition. Therefore, FACS is an incomplete system on emotional recognition [4], and a complete usability evaluation has not yet been conducted. Furthermore, the process of artificial comparison of each subject is time-consuming and controversial since the accuracy could be reduced by human errors, which is not suitable for quantitative analysis. In other words, for numerous collections and understanding of the consumer's general feelings for cultural goods, an automated facial recognition system with a large number of facial expression databases is needed. This paper has provided the possibilities of applying facial recognition on understanding consumer attitudes for the design of cultural goods. Future research will focus on analyzing consumer attitudes toward cultural goods by facial expression recognition, compared with the context of interviews, to understand the reasons that support emotions. By comprehending consumers' emotional reactions, designers will know how to increase consumers' affective components from design aspects, to motivate consuming behavior, for the purpose of continuing progress of the cultural and creative industry.

6. References

- [1] Ajzen, I. and Fishbein, M. (1980) *Understanding Attitudes and Predicting Social Behavior*, Prentice Hall, Englewood Cliffs, NJ.
- [2] Chen, H. M. (2003) *A FACS-Oriented Facial Expression Analysis System*, unpublished master thesis, National Taiwan University, Taipei.

- [3] Colbert, F., Nantel, J., Bilodeau, S., Rich, J. D. and Poole, W. (2001) *Marketing Culture and the Arts*, HEC, Montréal, Quebec.
- [4] Ekman, P. (2003) *Emotions Revealed - Recognizing Faces and Feelings to Improve Communication and Emotional life*, Times Books, New York.
- [5] Ekman, P. and Friesen, W. V. (1978) *Facial Action Coding System: A Technique for the Measurement of Facial Movement*, Consulting Psychologists Press, Palo Alto, CA.
- [6] Ekman, P., Friesen, W. V. and Hager, J. C. (2002) *Facial Action Coding System- Investigator's Guide*, Research Nexus, Salt Lake City, UT.
- [7] Ekman, P., Friesen, W. V. and Hager, J. C. (2002) *Facial Action Coding System- The Manual*, Research Nexus, Salt Lake City, UT.
- [8] Essa, I. A. and Pentland, A. P. (1997) *Coding, Analysis, Interpretation, and Recognition of Facial Expressions*, IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 19, no. 7, pp 757-763.
- [9] Fishbein, M. and Ajzen, I. (1975) *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*, Addison-Wesley, Reading, MA.
- [10] Hawkins, D. I. and Mothersbaugh, D. L. (2010) *Consumer Behavior: Building Marketing Strategy*, 11th Ed., McGraw-Hill, New York.
- [11] Hill, D. (2010) *Emotionomics: Leveraging Emotions for Business Success*, 2nd Ed., Kogan Page, London.
- [12] Mehrabian, A. (1968) *Communication Without Words*, Psychology Today, vol. 2, no. 4, pp53-56.
- [13] Peter, J. P. and Olson, J. C. (2010) *Consumer Behavior and Marketing Strategy*, 9th Ed., McGraw-Hill, New York.
- [14] Pollak, S. D., Messner, M., Kistler, D. J. and Cohn, J. F. (2009) *Development of Perceptual Expertise in Emotion recognition*. Cognition, vol. 110, no. 2, pp 242-247.
- [15] Stewart, D. W. and Shamdasani, P. N. (1990) *Focus Groups: Theory and Practice*, Sage, Newbury Park, CA.
- [16] Throsby, D. (2003) *Determining the Value of Cultural Goods: How Much (or How Little) does Contingent Valuation Tell Us?* Journal of Cultural Economics, vol. 27, no. 3, pp 275-285.