Proceedings of the Linguistic And Cognitive Approaches To Dialog Agents Symposium, Rafal Rzepka (Ed.), at the AISB 2010 convention, 29 March – 1 April 2010, De Montfort University, Leicester, UK

Facial Expressions for Communicating User Feedback

Savandie Abeyratna[1], Galina Parmei[1], Hissam Tawfik[2] and Rentian Huang[2]

Abstract. The paper proposes a prototype for an *Affective Interface Feedback System* (AIFS) which aims to convert multi-criteria estimates of customers' satisfaction with a product or service into a non-verbal representation as virtual facial expressions (FEs), or *emoticons*. We focus on developing a system that can provide emotional content that can be unambiguously recognised by any users. A perception experiment was carried out to identify FE features that predominantly characterize the Satisfaction-Dissatisfaction emotion space. Future work is aimed at successfully learning these feature combinations and corresponding prediction factors in order to generate FEs that can convey levels of customer satisfaction to users through the *AIFS*. The proposed solution is intended to complement current feedback representation methods by adding a mode for more natural, 'at-a-glance' user specific data comprehension.

1 INTRODUCTION

Emotional facial expressions (FEs) are an efficient mode of human non-verbal communication accounting for 55% of interpersonal message conveyed during face to face interactions [1]. FEs can provide feedback in a concise pictorial form whose affective meanings are readily recognizable universally [2].The psychology behind how people are able to easily decode emotional FEs is still not fully understood. Yet this characteristic of human beings makes FEs a suitable interface candidate for applications aiming to communicate feedback information.

The domain of Customer Relationship Management (CRM) thrives on capturing and understanding customer feedback in order to improve an organisations performance by addressing customer satisfaction. Most commonly data are collected via self-reported surveys, formatted as *x*-point Likert scales, which aim to assess customers' level of satisfaction or dissatisfaction with a certain product or service [3]. Results obtained using the surveys are traditionally displayed numerically as absolute values or percentages and/or in a graphic form as bar or pie charts. However, in view of a large amount of data collected via surveys there is a need for more concise, means of communicating customers' feedback.

Advances in Affective Computing have given rise to new CRM solutions for measuring and displaying customer satisfaction. It is worth noting that current Affective CRM solutions focus predominantly on developing computer systems that recognize FEs – to reveal by this means the degree of customer's satisfaction with a product or service in question [4], i.e. an "input related affective research".

There is though a branch of Affective Computing that develops affective interfaces – by taking into account the communication power of FEs and of other non-verbal cues, i.e. an "output related affective research". In current CRM solutions, affective interfaces are mostly in the form of "smileys" with simplistic expressions [5] or cartoon anthropomorphic figures with various expressive postures. However, in all applications the relationship between the certain categories of numerical feedback data, on the one hand, and the smileys ascribed to these categories, on the other, is imposed by system developers. The choices of emotional FEs used in these affective interfaces are not buttressed by psychological research on the perception of the facial emotional content by different user groups, thus challenging the affective interfaces accuracy. In addition, these systems use smiley depictions only of basic emotions [2] while disregarding the continuous (dimensional) nature of FEs [cf. 6] and the relationship between the FE dimensions and the Satisfaction scale used in CRM surveys.

The main aim of the present study is twofold: i) to elaborate the procedure of compressing data using a survey and (ii) to develop an interface for unambiguously conveying feedback on Satisfaction—Dissatisfaction with a product or service in a form of comprehensible emotional facial expressions. Figure 1 illustrates the main research goals which spans from psychological experimentation and analysis to machine learning techniques.

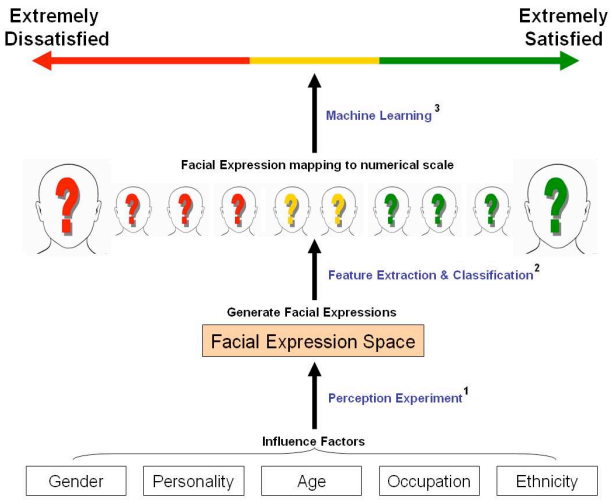

Figure 1. Underlying principles of the *Affective Interface Feedback System*.

[1] Faculty of Science and Social Sciences, Liverpool Hope University, UK
[2] Faculty of Business and Computer Science, Liverpool Hope University, UK
Email: {abeyras,parameg,tawfikh,huangr}@hope.ac.uk.

The main challenge for the project is ensuring that the information displayed in the FE is unambiguously legible and meaningful to any system user. Thus our vision is to develop an *Affective Interface Feedback System* that would contain individual or group user profiles which will determine the FEs generated to display satisfaction survey results. Psychological perception expreiments would provide insight into the influence of gender, personality, age, occupation and ethnicity on the perception of emotional facial expressions (Figure 1[2]),. Machine learning techniques could then be used to generate facial feature patterns depending on user profiles (Figure 1[3]),.

The focus of this paper is directed towards constructing an emotional FE space that represents the satisfaction – dissatisfaction dimensions for different individuals (Figure 1[1]), and evaluating simple features of the proposed *Affective Interface Feedback System*.

2 EXPERIMENT

Aim: Finding out which emoticons and facial features can consistently convey certain levels of customers' Satisfaction vs. Dissatisfaction with a product or service to different groups of individuals.

Participants: A total of 48 participants were recruited. Table 1 shows the breakdown of participants according to their ethnicity, gender and age.

Ethnicity	Total	Male	Female	Age			
				16-25	26-35	36-45	46+
European Caucasian	30	15	15	12	7	5	6
Asian+ Other	18	9	9	4	13	1	0
Total	**48**	**24**	**24**	**16**	**20**	**6**	**0**

Table 1. Distribution of experiment participants

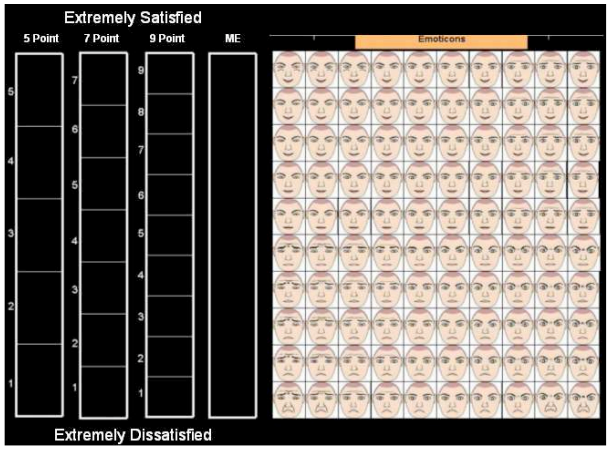

Figure 2. Experimental setup. *Left*: four response formats of the Satisfaction—Dissatisfaction scales, as 5-, 7-, 9-category or magnitude estimation (ME) scale. *Right*: the 10 x 10 emoticon set; Valence (positive, up, vs. negative, bottom) is represented by the vertical dimension; Activity (passive, left, vs. active, right) by the horizontal dimension).

Stimuli: Emoticons, outlined equivalents of Ekman and Friesen's FEs of basic emotions [2], as well as blends of these, with varying degree of the basic-emotion 'parent' pictures. An emoticon set (N=10 x 10) was adopted from [6]. The emoticons vary along two dimensions, **Valence** and **Activity** [7]. In the set, the degree of Valence is conveyed predominantly by the lip curvature and that of Activity by eye opening and eyebrow height.

Procedure: As shown in Figure 2, a Satisfaction—Dissatisfaction scale was presented to participants in four different response formats: 5-, 7- or 9-point category scale or magnitude estimation scale (ME; with positive and negative anchors). The participants were required to choose and drag emoticons from the emoticon set to corresponding divisions of the Likert scales or ten to the ME scale, with not necessarily equal spacing between the emoticon choices. The use of the four different types of response formats was intended for revealing the most informative type of the scale and of number of categories.

3 RESULTS and DISCUSSION

We first identified a set of emoticons representing the two anchors, *Extremely Satisfied* and *Extremely Dissatisfied*, as well as the Neutral value on the Satisfaction—Dissatisfaction scale.

The first finding is that for the *Extremely Satisfied* anchor and the *Neutral* position of the scale, all subjects across all four response formats chose very compact clusters of emoticons, with the **Happy** (high valence).and **Neutral** (medium valence).expressions respectively

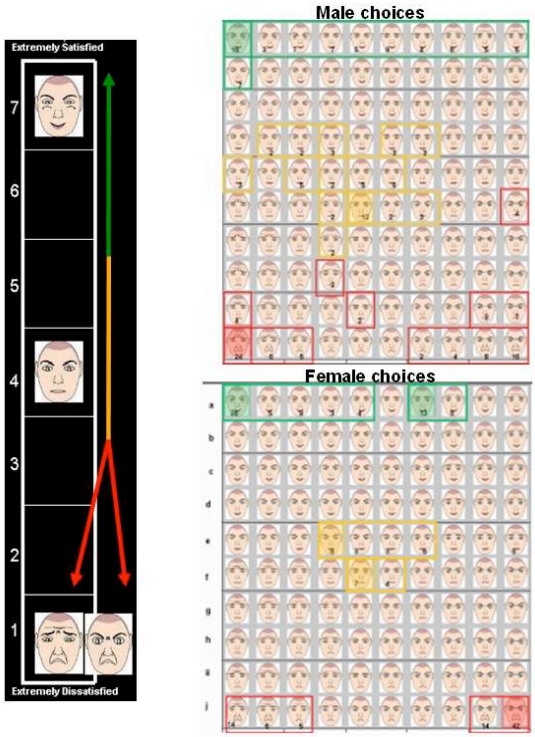

Figure 3. Male (top) and female (bottom) emoticon choices (across all response formats) for the *Extremely Satisfied* (green) and *Extremely Dissatisfied* (red) anchors as well as Neutral value (yellow) on the Satisfaction—Dissatisfaction Scale.

For the *Extremely Dissatisfied* anchor, however, across all response formats the chosen emoticons were split among two clusters of **Angry** (active) and **Sad** (passive) faces, i.e. along the Activity dimension. In addition, this split revealed significant gender difference: Females chose predominantly active **Angry** faces whereas males chose passive **Sad** faces as an expression for their highest level of dissatisfaction (Figure 3).

Such "bifurcation" of the emoticon choices was also observed for the *Extremely Satisfied* anchor but only when the number of emoticons selected (or categories used) was ≥ 7 (Figure 4). These results indicate that (1) users' Satisfaction—Dissatisfaction scale cannot be represented by emoticons using just one dimension. (2) At least at its negative pole, the Satisfaction—Dissatisfaction scale should reflect by corresponding emoticons two very different behavioural dispositions, active or passive. (3) To disentangle both positive, Satisfaction, and negative, Dissatisfaction, poles, an experimental design should be used that would implement a two-dimensional scheme of evaluation of a product or service. (4) A further experiment would shed light on the revealed gender difference in the emoticon choices. Occupation and/or socio-economic background of participants can also be taken into account for better understanding inter-individual differences in decoding facial expressions.

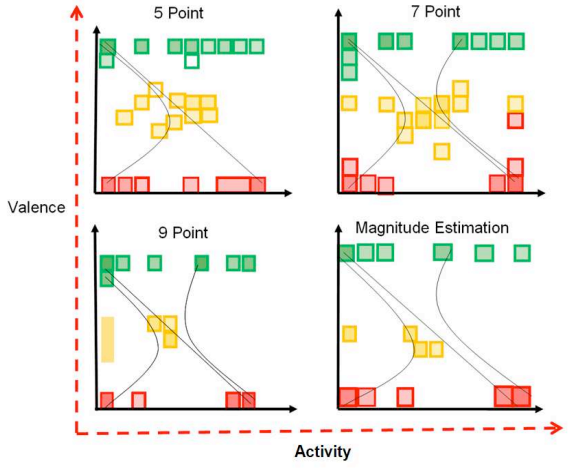

Figure 4. Distribution of selected emoticons for each of the four response formats. Colour coding is as above. The curves illustrate various combinations of the choices that may differ along the Valence - Activity dimensions according to different individuals.

4 PROPOSED SYSTEM

Here we propose a simple prototype for an *Affective Interface Feedback System* (AIFS), instigated by an "output related affective research" pioneered by Chernoff [8] and aiming at representing rich, multi-criteria information via FEs. In the current method virtual FEs, or *emoticons,* identified from the above experiment, are used as a means of communicating feedback between organisations and their customers [2] in order to demonstrate the concept of our research.

As is illustrated in Figure 2, the AIFS uses survey data obtained using *x*-point Likert scales with two poles as an input. The value of *x* may vary, thus resulting in a 5-, or 7- point etc.

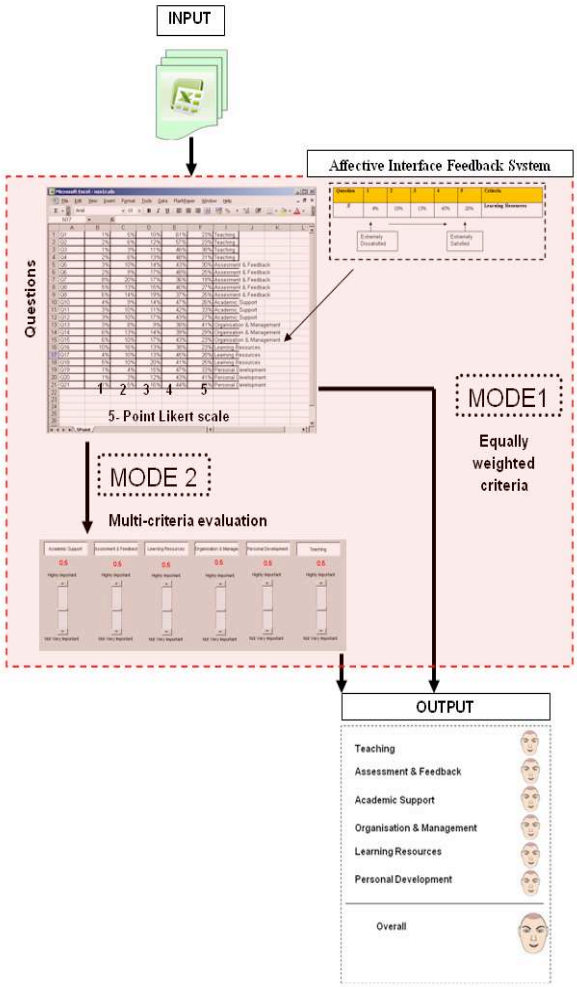

Figure 5. Architecture of the *Affective Interface Feedback System* exemplified by the National Student Survey with six evaluation criteria and showing two modes of multi-criteria data analysis: *Mode 1*: Equal weights; *Mode 2*: User-defined weights.

category scales. The number of evaluation criteria (of questions posed) regarding a product or service can also be varied – depending on the aspects of interest for the organisation. The National Student Survey used by us as an example (Figure 1) implements a 5-point Likert scale and contains 21 questions belonging to six evaluation criteria: Teaching; Assessment & Feedback; Academic Support; Organisation & Management; Learning Resources; Personal Development. Data for all questions is first pooled into these six criteria and represented numerically. Figure 1 indicates the AIFS's *usability*, *flexibility* and *adaptability*.

The *usability* of the system is addressed via features of the graphical user interface which allows easy navigation through it. The use of an Excel-format data as input adds to the *usability* of the system. The *flexibility* of the AIFS is achieved through variation of the Likert-scale formats: 5-, 7-, 9-point scales or magnitude estimation scale with positive and negative anchors.

Finally, the AIFS's *adaptability* is implemented as two modes of aggregating data in multi-criteria evaluation. For calculating an overall outcome, the AIFS provides two options for data aggregation – either by equally weighting each of the criteria (Mode 1), thus calculating the grand mean, or by allowing the user to define certain weights to indiviadual criteria (Mode 2), calculating the weighted mean.

At its current stage the AIFS converts the numerical data into a pictorial interface in the form of emoticons with a high selection frequency based on the above experiment. Next stages of development are aimed at ensuring the *efficiency* and *accuracy* of the AIFS by incoorperating user profile based FE generation based .

5 CONCLUSIONS & FUTURE WORK

In this paper we propose an affective interface which could serve as an add-on to current CRM solutions by communicating customers' feedback data in the form of facial expressions in a user specific manner. The proposed *Affective Interface Feedback System* presented in this paper is at its very early stages and only addresses the adaptability, flexibility and usability of the system. Future work is aimed at improving the efficiency and accuracy of the system. Further psychological experimentation will allow the identification of inter-individual and/or cross-cultural differences that affect individual decoding of emotional FEs. Facial feature extraction (Figure 1^2), will allow the classification of user specific feature patterns. Machine learning will be used to train the system to generate FEs depending on user profiles. Providing a user-specific FE as output would contribute to the emotional touch of current affective CRM applications.

6 AKNOWLEDGEMENTS

The project was supported by HEIF4 grant *E-voting Affective Interface* to HT and GP. We are grateful to Mei Yii Lim for providing us with the emoticon set and her valuable suggestions.

REFERENCES

[1] P.T. Kuo, I. Chung, J.E. Chen, and C.W. Wu, An emotional robot with facial expressions, *Chung Hua Journal of Science and Engineering*, 5, 9-13 (2007).

[2] P. Ekman and W.V. Friesen, *Unmasking the Face: A Guide to Recognizing Emotions From Facial Cues*. Prentice-Hall Englewood Cliffs, NJ (1975).

[3] W. Reinartz, M. Krafft, and W.D. Hoyer, The Customer Relationship Management Process: Its Measurement and Impact on Performance, *Journal of Marketing Research*, 41, 293–305 (2004).

[4] R. W. Picard, Perceptual user interfaces: affective perception, *Communications of the ACM,* 43: 50-51 (2000).

[5] D. Tetteroo, Communicating emotions in instant messaging, an overview. In *Proceedings of the 9th Twente Student Conference on IT, Enschede, The Netherlands, 23rd June* 2008 *http://referaat.cs.utwente.nl/new/paper.php?paperID=400*

[6] M.Y. Lim and R. Aylett, An emergent emotion model for an affective mobile guide with attitude, *Applied Artificial Intelligence Journal*, 23: 835-854 (2009).

[7] J.A. Russell, A circumplex model of affect. *Journal of Personality and Social Psychology*, 39: 1161–1178 (1980).

[8] H. Chernoff, The use of faces to represent points in *k*-dimensional space graphically, *Journal of the American Statistical Association,* 68: 361-368 (1973).