First Design of a Ubiquitous System for Affective Bonding and Support with Family and Friends

Sébastien Duval and Hiromichi Hashizume

National Institute of Informatics
Hitotsubashi 2-1-2, Chiyoda-ku, Tokyo 101-8430, Japan
{duval,has}@nii.ac.jp

Abstract. We consider the design of a ubiquitous system whose objective is to strengthen affective bonding and allow affective support, especially for distant relationships with the family and friends. It is based on wearable computers that evaluate emotions, transmit information to authorized persons, and enable interactions. Our most significant contribution is the provision of the design for a complete system usable in everyday life, based on emotional design and on multi-cultural feedback.

Keywords: Cultures, Emotional design, Emotions, Family, Friends, HCI, Ubiquity, Wearable.

1 Introduction

Ubiquitous systems can improve our quality of life by satisfying fundamental needs [1] and gratifying wishes. Here we consider relationships, and more particularly with the family and friends. The aim is to complement existing technologies and services, which are mainly based on voluntary linguistic input: e-mails, chat, voice over IP, etc. For this we propose, like others before us [2], to share information about emotions. Combining language and physiology in real-time is a promising strategy that allies continuous to occasional, conscious to unconscious, and explicit to implicit input. Leaving aside technological and algorithmic obstacles for a moment, we have to acknowledge the criticality of human needs for the proper design of everyday things:

> "[…] the emotional side of design may be more critical to a product's success than its practical elements", Norman [3, p5].

Our prior investigations confirmed the priority of psychological expectations over potential gains from emotional displays [4]. Social distance appeared decisive, with services dedicated to families and friends emerging as most propitious, leading to the current project. Our strategy is based on these results, on emotional design [3] to create desirable systems, and on feedback of potential users from multiple cultures to allow smart variations.

We first describe the system as a whole, then detail the user interfaces, and finally discuss emotional design with feedback from potential users.

D. Schuler (Ed.): Online Communities and Social Comput., HCII 2007, LNCS 4564, pp. 70–79, 2007.

2 Overview of the System

We first present scenarios to identify significant features then provide a global view of the system, and finally describe its components.

2.1 Scenarios and Critical Features

To clarify functional requirements and illustrate useful applications, we propose three scenarios: (1) *Hospitalized child*, (2) *Friends' holidays*, and (3) *Lonely grand-parents*. We then extract from them critical features.

Scenario 1. A 10-year old French boy is hospitalized for several months. His parents have difficulties visiting him regularly because of their work and of the distance. The boy continuously wears a bracelet that monitors his heartbeats and skin conductivity. A server processes the information to evaluate his emotional state. When high arousal is detected, the server sends an e-mail to his parents' cell-phone.

Scenario 2. A group of Korean students visits various countries during the summer. Each of them wears a networked watch that monitors physiological states and displays graphics. When they send e-mails from Internet cafés, a server extracts smileys and keywords. Combining physiological and textual information, it tracks the evolution of users' emotional state. This information is regularly sent to registered friends' watches and displayed using a customized visual metaphor. When one appears joyful, the others send simple messages using the watch interface to e.g. ask what happens.

Scenario 3. Two old Japanese live far from their family. They dislike wearables and refuse *monitoring watches* for both medical and affective purposes. However they enjoy e-mails to organize their activities and keep in touch with friends. When they send e-mails, a server processes the text to evaluate their state. Every Friday, their son logs on a secured web site that displays a summary of their emotions. When it highlights sadness, he visits his parents during the week-end.

According to the scenarios the system should evaluate emotions from physiological signals and/or content of outgoing e-mails. The analysis of e-mails implicitly requires algorithms adapted to different languages (sets of characters, grammar) and cultures.

For practical uses, visualization and interaction should be possible with standard *and* dedicated technologies; for instance the Web, cellular phones and wearable computers. A proper visual metaphor is required to check in a glance the state of family members and friends. Interactions should at least include the transmission of predefined messages.

Finally, when dedicated equipment is provided, it should be accessible to children, adults, and seniors. The location of sensors needs to be determined; the wrist may not be the most reliable place to monitor heartbeats and skin conductivity in an everyday setting.

2.2 Global View

To support affective communication with family members and friends, we propose to acquire emotion-related data from each user, process it on a server, and transmit personalized information to acquaintances (figure 1). Emotion-related data is acquired from physiological sensors embedded in a personal wearable, and from copies of e-mails received by the server from registered e-mail addresses. After processing the data, the server checks which users should get updates and accordingly creates updates based on the originator's and recipients' preferences.

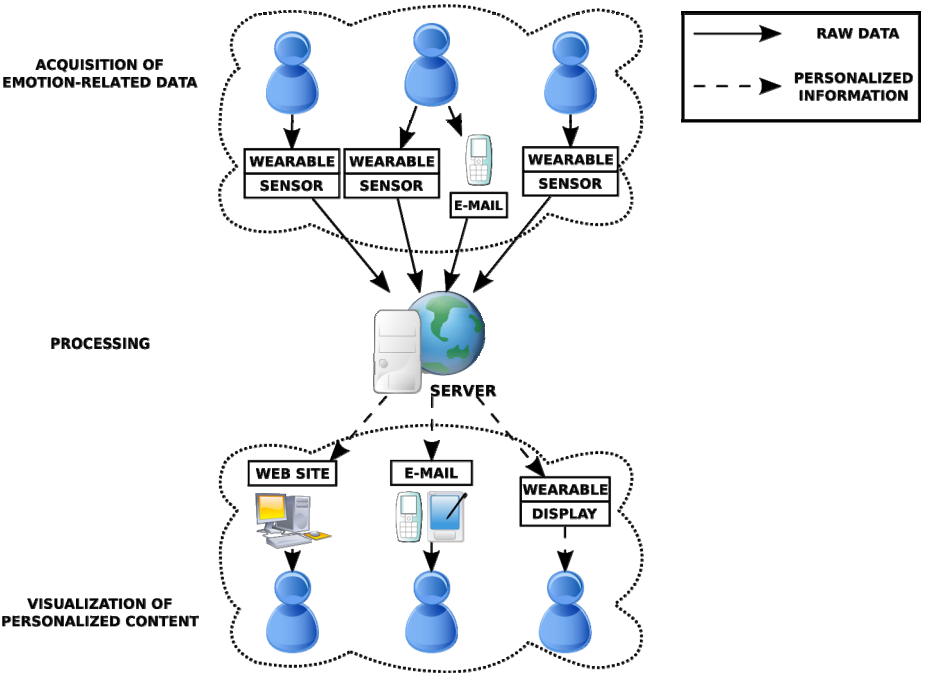

Fig. 1. Flow of data from the acquisition of emotion-related data to the visualization

The core of the system runs on a server, which stores the personalization and privacy information. Because of its sensitivity, the data should be protected; we suggest applying encryption and a storage retention policy. We currently evaluate benefits and drawbacks of pushing the raw data into versus pulling it from the server. Processing and networking should be limited due to the limitations in energy of wearables.

2.3 Description of Components

The main components deal with the management of personal information, processing of emotion-related information, encryption/decryption, management of messages, and visualization. Figure 2 details elements of the three first components.

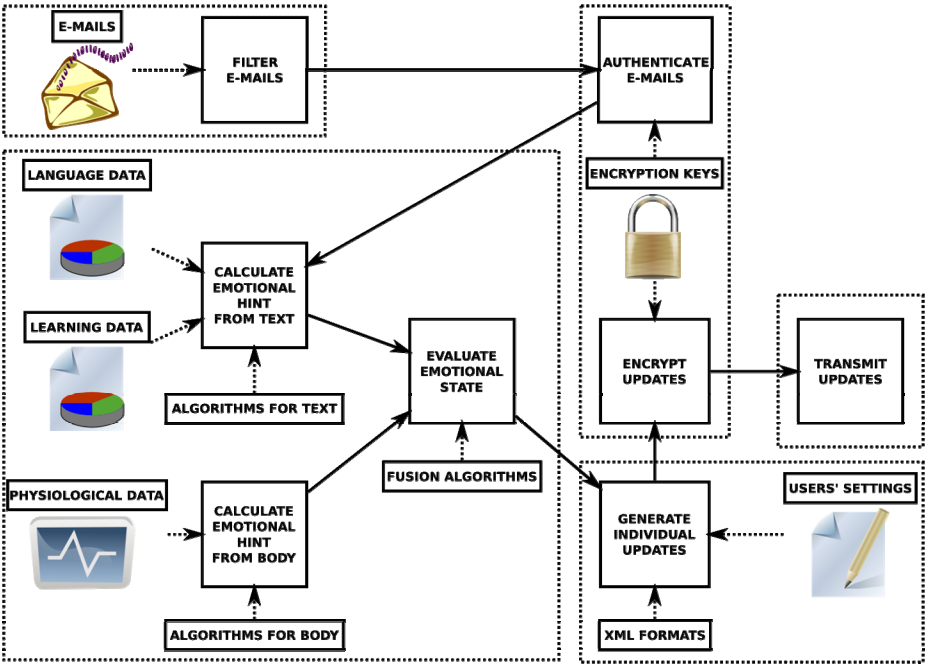

Fig. 2. Components involved in the evaluation of emotions on the server, and transmission

Emotional Information Management. This component evaluates emotions from data provided by physiological sensors embedded in the wearable computer, and text from outgoing e-mails. Because focus is on global design rather than precise evaluation, we can use simple algorithms. The intensity of emotions can be inferred from the speed of heartbeats or increases in skin conductivity, and the type (e.g. joy, anger [5]) from words compared to language-specific databases. Results are then fused.

Personal Information Management. This component lists information to provide to acquaintances. It checks the originator's preferences, identifies recipients, and the accuracy/frequency authorized by the originator and requested by each recipient. It then generates updates in appropriate formats from XML descriptions.

Encryption/Decryption. We propose to use GPG to authentify the origin of e-mails received by the server, and to encrypt updates sent by the server. We still have to find a satisfactory method to protect the transmission of physiological data.

Message Management. The manager possesses a list of predefined messages that can be sent and received through the interface. It deals with eventual translations.

Visualization. This component displays the state of family members, and eventual messages, on the screen. The default style, *bubbles*, is presented hereafter.

3 User Interfaces

We discuss the evaluation of users' emotions, their visualization, and the interactions via three types of interface. The first one is based on the Web, the second on e-mails, and the third on an extended version of the wearable computer.

3.1 Evaluation of Emotions

The emotional state of a user is evaluated in two ways. First, physiological sensors monitor heartbeats and skin conductivity. Second, an e-mail agent extracts keywords and smileys from sent e-mails. The sensors require calibration, and the agent benefits from a learning system.

The physiological sensors can be embedded in the user's accessories or garments that are directly in contact with the skin. Our choice is to place the sensors in bracelets or watches, because they can be used every day (which is not the case of enhanced garments) and are easily removed to recharge the batteries. Besides, wrist-located devices can be conveniently extended to view information and interact. Finally, acceptance shall increase thanks to the public's familiarity with these form-factors.

With the current design, the e-mail agent runs on a server. To benefit from the agent, the user must send a copy of his e-mails to a specified e-mail address. This task can be automated with standard e-mail software. We recommend users to set the copy as Blind Carbon Copy (BCC) to avoid misunderstandings with targeted recipients. On reception, the agent processes the e-mail to acquire hints about the user's emotional state. A summary is conserved for a week, and the user can access it with the web interface to provide feedback for the learning process.

Discussions with potential users, based on sketches, suggest that a simple interface could satisfy English speakers. This interface would show e-mails one by one, the aspect of words varying to reflect emotions. Using colors for kinds (happy, angry) and font sizes for intensities appears natural. It is unclear whether this method could be successfully employed with languages based on ideograms, such as Japanese.

3.2 Display of Emotions

After evaluating the emotional state, the server relays the information to authorized family members and friends. The information is then either pulled or pushed. First, users can access a graphical representation on a web site (pull), after identification. Second, they can receive e-mail alerts (push). Third, the information can be continuously updated on a wearable display (push). These methods provide flexibility for various life-styles, contexts, wishes, and needs.

The web interface lets users visualize in detail the state of acquaintances and check their own evaluated status. The state of family members and friends is displayed using a *soap bubble* metaphor (figure 3) in which the background color represents the state of the group, and colored bubbles the state of individuals. The speed of the upward flow reflects the speed of variations. Three views are possible: “current”, “day” and “week”.

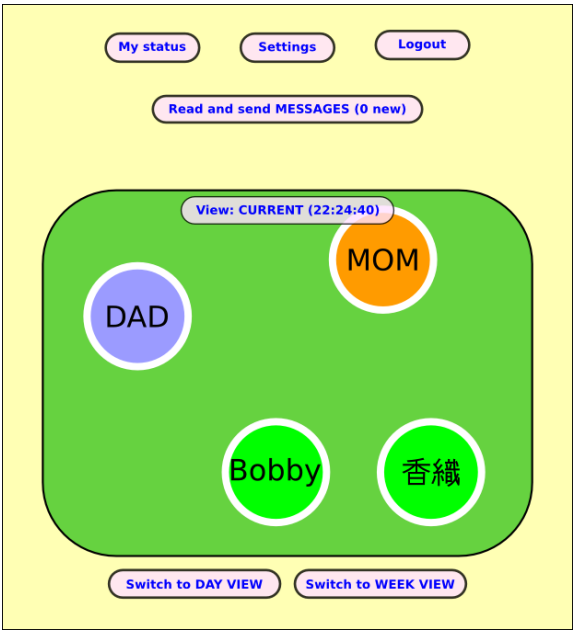

Fig. 3. Example of view for acquaintances' current state with the Web interface

With the e-mail interface, users receive e-mail alerts that summarize the states of acquaintances at specific moments, or indicate important changes (figure 4).

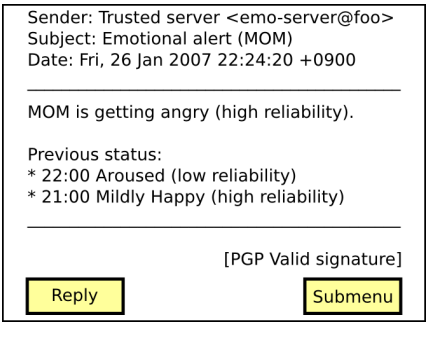

Fig. 4. Example of e-mail alert about a family member

The wearable interface (figure 5) is similar to the web interface. Acquaintances' state is displayed using the *soap bubble* metaphor but the options (e.g. switching from the "day" to "week" view) are not visible. A frame indicates the current view, and a click allows users to change it. This GUI works with a touch-sensitive display embedded in a watch, or with semi-transparent glasses combined to mobile input devices.

Visualization with wrist-located wearables poses several problems; notably that bystanders can see the display. The color scheme provides a first way to hide

meaning. A polarized film placed on the screen is also an efficient low-tech solution. Besides, to preserve privacy and save energy, information is only displayed for a short time when the user does not interact with the device. As for semi-transparent glasses, privacy is not a concern because only the wearer sees the information. However eye contact is hampered, which can have a negative impact on social interactions.

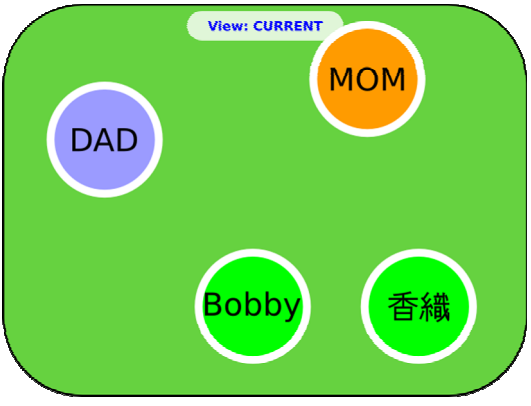

Fig. 5. Example of view for acquaintances' current state with the wearable interface

Several potential users requested the addition of a function to visualize their own evaluated status. They felt it is important in order to feel comfortable with the system, to monitor correctness, and to disable the system if it sends incorrect or embarrassing information. We consider several implementations such as letting users view their state among acquaintances as a ghost bubble. In the case of e-mail alerts, a descriptive line can be appended at the end of each e-mail.

3.3 Interactions

Users can send predefined messages to an acquaintance at any moment, get details about their state, provide feedback used for learning, and personalize their interface. To favor good emotional design, we ensure users get immediate and useful feedback about their actions. We plan to provide interfaces that fully support French, English and Japanese languages.

The web interface lets users visualize and send messages through a "Messages" screen. Recent messages are showed first. When a message is received through the system, the user can comment it and save it, reply to it, or delete it. Users can also check their status with the "My status" screen. It provides the current evaluated state, as well as a description of its evolution over the day and week. Feedback exploited by the learning component is provided here. The "Settings" screen is used to register new acquaintances and set the accuracy/frequency of information to transmit, on an individual basis. It is also used to register personal e-mail addresses and to set the e-mail address on which alerts are sent.

When receiving an e-mail alert, the user can send a message to the person concerned. The message goes through the server, where it is processed. If specific keywords

are found at the top, predefined messages take their place. For example a simple message "help?" would be replaced by "Do you need any help?". In the absence of keywords, the message is transmitted without modification to the recipient. The message is sent with an indication about the context such as the sender's evaluated state.

The wearable interface lets users visualize and send messages through a "Messages" screen. This interface does not currently allow text input so, when a message is received through the system, the user can just save it, reply to it with predefined messages through icons, or delete it. To send a message, the user clicks on the bubble corresponding to the receiver.

To support privacy, we also propose personalization functions. These include the selection of the type of information gathered and transmitted; for example, restrict the system to indicate only three states: "positive", "neutral" and "negative" rather than detailed emotional states such as "happy" or "angry". A second element of personalization is rendering: colors can be chosen by users. Color theory should guide the default settings. Changes in colors can increase comfort and prevent bystanders from understanding displayed information. Finally, one can request automatic notifications about states at regular intervals.

4 Emotional Design with Feedback from Potential Users

Emotional design is based on visceral, behavioral, and reflective dimensions, which influence any design [3]. We discuss them in the frame of our current design and of comments from six potential users (25-37 year old): two Japanese mothers, a French couple, a German male, and a Japanese male.

4.1 Visceral Dimension

Visceral design deals with shapes, physical feel, textures of materials, and weight. Its bases are valid for everybody:

> "The principles underlying visceral design are wired in, consistent across people and cultures. If you design according to these rules, your design will always be attractive, even if somewhat simple", Norman [3, p67].

Although this paper mainly describes the system and graphical elements, the aspect of the device itself should not be neglected. Wearables containing sensors can be created with various materials, shapes and colors, notably influenced by fashion. We recommend starting with bright colors, warm and soft materials.

To induce a positive affect, we use a bright/warm (yellow) background for the graphical user interface, round shapes, and the *soap bubbles* metaphor. Round shapes are applied to buttons, frames, and to the screen itself. We also suggest the display of sans serif fonts. The bubble representation can induce positive reactions because of slow motions, round and symmetric shapes with a bright (white) contour, and because soap bubbles tend to evoke fond memories of childhood.

Other senses could have a similar influence, such as simple soothing sounds played as feedback about actions. The French male suggested sending supportive messages by caressing a part of the device, with tactile stimulation on reception. One of the two Japanese mothers similarly suggested cold/heat stimulations under the bracelet.

4.2 Behavioral Dimension

Behavioral design deals with performance. This includes the provision of appropriate functions as well as understandable and usable implementations.

Because we propose an innovative system, it is difficult to know how people will use it and what functions are required; tests in real environments and revisions will be necessary. In this paper, we focus on a minimal set of functions and on clear feedback. The design respects the activities of users, avoiding interruptions (no beeps, no vibrations), except in the case of e-mail alerts, which depends on equipment used: cellular phone, laptop, etc. In the successive implementations and improvements of the design, we will consider how to notify users while preserving this important feature:

> "We need technologies that provide the rich power of [human] interaction without the disruption: we need to regain control over our lives.", Norman [3, p159].

The *bubble* metaphor was selected for its visceral, behavioral and reflective characteristics. It provides a good understanding of the data because it shows data as volatile (bubbles burst and vanish, data is retained for short periods only), because it reflects the passing of time with an upward flow, and because each bubble is independent but from the same source (individuals are from the same family or group of friends). Finally, this metaphor is appropriate to convey feelings related to the *family*, because soap bubbles are usually made with one's parents, siblings, or children.

4.3 Reflective Dimension

Reflective design deals with self-image, personal satisfaction, and memories. The quality of the experience cannot be assessed without tests in real world environments. However, we considered the heightening of the quality of the experience, and added the possibility to save and comment messages to *create memories*.

4.4 General Comments

Some of the comments gathered from the potential users concerned the acceptance and usability of the system.

The Japanese mothers looked most interested in the system, especially to know what happens during babysitting. The three Europeans objected to having their typed thoughts (e-mails) being monitored, and similarly rejected the idea of acquire and process voice with the wearable or cellular phones. Local processing, with the e-mail agent serving as proxy before transmitting e-mails, appears more acceptable to them. The presence of a function switching transmissions on and off was much appreciated, as well as the attention paid to security and privacy issues.

The proposed form-factors may be inappropriate for children and seniors. In the case of children, weight and screen size can pose problems. In the case of seniors, reading watch-size screens may be difficult due to reduced sight. Also, Parkinson's disease may prevent the fine manipulations required to interact with touch screens. Finally, equipment placed at the tip of sleeves or in bracelets can be inconvenient–or at risk–for wearers doing house tasks or taking care of babies.

The *soap bubble* representation is considered easy to understand however it raises predictable problems for large groups of friends, and for people that keep contact with their extended family. Similarly e-mail alerts can become unwieldy when used with large groups and very sensitive persons.

5 Future Works

Our future works are to improve the design of the system, evaluate its usability, and study its psychological and social impact.

First, we need to improve our equipment. The cheap sensors provided with the game *Wild Divine* and *Shimadzu*'s semi-transparent glasses *Data Glass 2* are inappropriate for everyday uses by laymen. To favor long-term use, we will consider ways to make the system more fun while carrying out tests and implementing improvements.

Usability will be evaluated in a mobile environment, including visual performance and comfort while walking on a treadmill and in the street, while sitting in a car, train, or coffee shop. We will consider movements, noise, light, and weather.

The psycho-social impact will be studied with French and Japanese families. We expect them to reveal cultural variations in reactions to the service, leading to a better understanding of the creation of ubiquitous systems. We also expect the system to act as a social facilitator and to increase social presence.

Acknowledgments

Thanks to Nadine Richard (NII, Japan) for comments on earlier versions of this publication.

References

1. Maslow, A.: Motivation and personality (1987)
2. Picard, R.: Affective Computing (1997)
3. Norman, D.: Emotional Design – Why we love (or hate) everyday things (2004)
4. Duval, S., Hashizume, H., Andrès, F.: First evaluation of Enhanced Jackets' Potential to Support First Encounters with Photo Slideshows and Emotional Displays. 8th Virtual Reality International Conference, pp. 75–84 (2006)
5. Ekman, P., Davidson, R.: The nature of emotions – Fundamental questions (1994)