Aura: an intimate remote awareness system based on sleep patterns

Aoife Ní Mhóráin, Stefan Agamanolis
Human Connectedness group
Media Lab Europe, Sugar House Lane, Bellevue, Dublin 8, Ireland
aoife.nimhorain@medialabeurope.org, stefan@media.mit.edu

ABSTRACT
When partners are separated by distance they are often aware that the quality of their attachment is impaired due to a lack of emotional contact. Aura is a project that aims to create a sense of presence between two people who are separated by space and in some cases, time. The means by which we proposed to do this was by exploring the possibilities of physiological monitors as a way of determining emotional state. An augmented sleeping mask monitors sleeping patterns and transmits them to the remote location, where they are mapped to sound and musical selections in a personal keepsake "music box" that represents the remote partner. The project has highlighted a number of difficulties in designing remote awareness systems, especially those that use physiological measurements as a basis for capturing emotion.

Author Keywords
Human connectedness, affective computing, remote awareness, biometric, sleep, electrooculargram, presence, rapid eye movement.

INTRODUCTION
While in a relationship there are many ways by which a couple can communicate. The most subtle form of communication is perhaps the unspoken awareness of another's emotional state. Being able to 'read' or intuitively understand your partner is a valued part of the closeness in a relationship [8]. However, in our modern world, many couples find themselves separated yet capable of continuing the relationship. Aura aims to investigate the possibilities of reinstating this subtle awareness irrespective of separation. We consider this subtle awareness to be a visceral awareness or "gut feeling", where people feel and understand the other's emotion intuitively.

Cacioppo et al. have considered the use of biometric measurement as a means of discovering and understanding emotion [4]. When our emotional state changes our body reacts accordingly: we sweat when we are stressed, our heart beats faster if we are excited. Research into affective systems has been exploring the use of biometric data collection as a way of understanding an individual's emotional state. Projects such as the *Affective Learning Companion* use different sensing methods to understand the emotional state of the user and thus enable a more understanding learning environment [1]. There are projects that make use of biometric monitors to affect games and are used to help people learn about their own emotions. *Relax To Win* uses a measurement of galvanic skin response to manipulate the movement of characters in a virtual world [10]. Brain Ball also uses biometric information to control the movement of a physical ball across a table [12]. The project *Mobile Feelings* suggests the exchange of emotion or feelings using mobile telephones [11]. Aura is another project that addresses this area.

During the development of our project it became evident that the complexity of emotion that we wanted to convey was not something we could assess using physiological measurement alone. We realized that context is critical; in order to fully comprehend each emotive state that occurs as a person goes about their daily life, it is necessary to know about the context of the person's activities.

Additional complications arose when attempting to map these emotions to meaningful outputs at the remote location. The need for a visceral method of conveying emotions was central to our goals. We felt the remote user should intuitively understand an emotion without the need to interpret a mapping in a higher-level cognitive way. However, we also considered that this might prove difficult with complex emotions, thus requiring a more specific metaphor.

Many projects, such as *Dangling String,* explore tangible possibilities for intangible concepts [15]. Given that one can connect almost any input to almost any output, the variety of possible mappings in awareness systems is infinite, and a chosen mapping may not have any meaning

Figure 1. Aura sleeping mask.

except perhaps to its creator. For example, in the *InTouch* project [14], the choice of connecting cylindrical rollers mounted on two remote bases seems arbitrary. However, users somewhat bypass this higher-level metaphor and can convey movements on the rollers that carry an intuitive emotional quality (fast jerky movements to express anger or excitement, slow smooth movements to express sadness or calmness, and so on).

In order to provide more meaningful cognitive metaphors that work for a wide spectrum of people, some have tapped into models recognized throughout a society or culture, such as colour. The Ambient Orb is one such product [2]. This product uses change in the colour of a light to communicate information. The use of colour here is so general that the Orb can be used as a visualization of many kinds of information, usually data such as the weather forecast or stock prices.

The background to the Aura project lies in an earlier project from our lab named Habitat. This project shares daily activities or rhythms between two households by using connected furniture as both capture and display mechanisms [7]. Aura progresses from this by investigating biorhythms and sharing them between two people.

DESCRIPTION

While investigating which biological changes we could measure it became apparent to us that it would be difficult to find a method of recording that was unobtrusive. We found it inappropriate to suggest that a user would be required to be directly connected to bulky hardware during their everyday activities. The product developed by Sensatex, *SmartShirt,* has embedded sensors that monitor biometric information in a shirt worn like a vest [13]. This product provided some inspiration for our approach.

Another matter for consideration was that of context. While measuring changes in the body it is impossible to understand them appropriately without knowing the activity that the person is carrying out while the recording is taking place. For example after recording a heartbeat, understanding a meaning from that measurement is difficult. The heart beating faster could mean a lot of different things: a person running, a person being attacked, a person excited because they are enjoying something. The information is without much use without the context. In his conclusion Cacioppo concedes this by saying that although the science is provocative he was unsure that existing methods of measurement would provide the results required [4]. In order to partially overcome this problem we fixed the time of recording down to sleep.

Choosing sleep addresses both issues of providing an unobtrusive method of recording as the user remains relatively still and it also provides us with a fixed context. We designed an augmented mask that monitors sleeping patterns (figure 1). Aura is a connection between two people that uses REM (Rapid Eye Movement) detection to gauge a good night's sleep. This is done using an electrooculargram (EOG) to detect a specific type of movement in the eyes that is typical of REM sleep. REM sleep is a lighter sleep state that correlates highly with dreaming. During a night of sleep a person typically goes through a number of sleep cycles, REM being one of the steps. By measuring the number of times a person goes through the REM cycle in a night we can make a guess about whether a good night's sleep was achieved and thus if the person is in a good mood during the following day. This information would then be mapped to a relevant visualization or physical output, to let the remote person know what is going on. It is important to emphasize that this measurement method is totally unverified and carries with it several assumptions of debatable accuracy. If it works at all, it would probably achieve only a gross estimation of emotional state at best.

In order to display the collected information in a way that allows the remote person to intuitively understand or get a feeling for the other's emotional state, we felt the output of the mapping had to be emotive itself. In other words, graphs or graphics that act as semantic representations or code for each emotion are inappropriate, as they do not affect us but only describe emotion. Graphics act as signals for us to react to but do not affect us directly. In the same way mapping this information to an object as an accurate affective symbol of an emotion is difficult. Symbols that relate to personal and emotional situations are entirely subjective and particular to each individual. The designer could pick a scenario that was totally accurate and intuitive to him/her but might mean nothing to a user. An anecdotal example might help to clarify this point:

> "My mind was fixed entirely on my new nephew. When Granny was carving the leg of mutton, I said:… 'How big is he?' Grannie (sic) considered, stopped carving, and measured off a distance on the carving knife…the

> announcement made such an impression on me that I am sure if I were being asked an associative question by a psychiatrist and he gave me the key-word 'baby' I would immediately respond with 'carving knife'. [5]"

We wanted to affect the person in the other location in the same way that they would be affected if they were in the physical presence of someone in a certain mood. One way of achieving this is by using phenomena that appeal to our basic nature like music or smell. We intuitively know a good smell or can feel happy while listening to an up-beat piece of music. We chose to concentrate on music as we felt it had the appropriate emotive affect.

We proposed that the music would be composed by the data that is collected about a person's sleeping rhythms. A precious box that takes associations from jewellery boxes contains a speaker. By opening the box the user can listen to the music that is composed from their loved ones previous night's sleep. It is the intention that the music box creates the impression that the user is listening to their loved one's emotion.

CONCLUSIONS

The use of biometric monitoring to gain knowledge of a person's emotional state is seductive as on the surface it seems logical and straightforward. However, in practice there are many areas still to be investigated before it will be viable. We still do not know enough about the nature of emotions, their psychology and how the body reacts, to be able to give a definitive model of use in relation to the conveyance of complex emotions. Simple measurement of physical arousal do not give us a sense of a person's emotional state; it suggests a number of different states that can sometimes be conflicting.

Practically, it is our finding as designers that it is very difficult to design an unobtrusive system or object that records the biometric data. Having users walking about with something that resembles the instruments found in an intensive care unit seems undesirable, if not implausible to us in a real life scenario. We must work on finding different ways of measuring the body if this is ever to come to fruition. The Smart Shirt as mentioned above is a good starting point for this [13].

We encountered a lot of problems while trying to find the appropriate mappings for emotions. The problem of over simplifying something that is intrinsically complicated and/or creating inappropriate associations caused us to hit against many a brick wall. There are too many cultural and personal associations for us to design such a universal system as we set out to design. A constructive, lower level approach where the user has access to and can manipulate the elements of the system may be more appropriate [9, 3].

The project is interesting as a design proposal that suggests a possible communicative product. It raises questions about our current means of communication: are they good enough

Figure 2. Aura music box.

for what we use them for? Aura also addresses the small sacrifices partners make for each other, or don't make as the case may be. A person can express their interest in the other by their willingness to participate in an extra and perhaps somewhat awkward ritual as they go to bed.

Aura also challenges assumptions about the possibilities opened to us by computing. Instead of trying to recreate traditional forms of human interaction using technology, should we not be imagining and designing completely new modes of communication that go "beyond" these traditional forms. This topic is discussed by Hollan and Stornetta in the context of video-mediated communication [6].

ACKNOWLEDGMENTS

We would like to thank Dipak Patel. This research has been supported by partners of Media Lab Europe.

REFERENCES

1. Affective Computing Group, http://affect.media.mit.edu/
2. Ambient Devices http://www.ambientdevices.com
3. Beakmann et al, Some Assembly Required: Supporting End-User Sensor Installation in Domestic Ubiquitous Computing Environments, *in Proc. UbiComp 2004*, Ubiquitous Computing, Springer-Verlag , Germany, 2004, pp107 – 124.
4. Cacioppo, J.T., Klein, D.J., Berntson, G. G., Hatfield, E., The psychophysysiology of emotion, in Lewis, M., Haviland, J.M. (Eds). *Handbook of Emotions*, Guilford, New York, 1993.
5. Christie, A, An Autobiography, William Collins Sons & co, Great Brittan, 1977, pp 127 – 128.
6. Hollan, J, Stornetta, S, Beyond Being There, *in Proc Chi 1992*.

7. Human Connectedness Group
http://www.medialabeurope.org/hc/projects/habitat/
8. Lewis, T., Amini, F., Lannon, R., A general theory of love, Vintage Books USA, 2001.
9. Life Long Kindergarden
http://llk.media.mit.edu/projects/bbb
10. MindGames Group
http://mindgames.medialabeurope.org/
11. Sommerer, C., Mignonneau, L., Mobile Feelings, in CODE – The Language of our time, Ars Electronica 2003, Hantje Cantz Verlag, pp. 258-261.
12. Smart Studio
http://smart.tii.se/smart/index_en.ph
13. Sensatex
http://www.sensatex.com
14. Tangable Media Group
http://tangible.media.mit.edu/projects/inTouch/inTouch.html
15. Weiser, M., Brown, J. S., Designing Calm Technology, Xerox PARC, 1995.