Affective Jewellery:

towards a more affective human-computer interaction

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Abstract
The present essay aims at considering the process to develop affective-wear items. These, equipped with sensors and microchips, could safely and simultaneously monitor a series of biometric parameters, establishing an interactive relation between the user, technology and the environment. In order to apply the concept of affective wear, we developed an affective jewel, a bracelet composed of a sensor connected to a microchip able to recognize and measure electrodermal reactions. These reactions account for physiological phenomena of emotional character, such as memory, concentration, excitement, euphoria and tension.

Keywords: wearable computing, affective computing, affective jewel, emotion, body.

Nowadays, computer technologies, responsible for historical changes worldwide, are likely to leave their traditional and geometrical patterns behind towards a more natural adaptation to the environment and the human body. The growing trend to gather and integrate multiple technologies and human beings is a result not only from changes in digital technology, but also from the outcome of new materials with special features, mostly associated with computer systems. Scientific development in robotics, molecular and nanotechnology has led to stimulable, invisible and smart materials, among others. Hence, artists, engineers, designers and scientists have been working together to deliver cleverer and friendlier computers through both physical and digital interfaces (hardware and software) for a more natural interaction with the users.

Thus, Rosalind Picard (1998, 11), an MIT engineer, describes the affective computer science as any artificial system (either hardware or software) that deals with or deliberately exercises an influence upon human emotions — even in a simple way. This is also meant to seek an interaction with aspects of the reason-emotion equation, in order to create artificial systems that provide an enhancement of affective qualities in computational relations between humans and machines.

Such a device, when added to the wear (clothes, accessories, jewellery), becomes likely to amplify its affective computational possibilities through a direct contact with the body. In this way, physical and/or physiological stimuli, corresponding to psychological aspects of the user and associated with computer technology, can make affective qualities emerge as a result from the identification of emotional responses and of unfolding changes in the relationship between the user and the system, the user and the environment, or the user and him/herself.

According to António Damásio (1996), neurologist, emotions cause physiological reactions in a continuous process of influence of mind over body. This experience refers to the essence of feelings, always related to pain or pleasure, satisfaction or dissatisfaction, happiness or sadness, contentment or the lack there of it as a set of psychological phenomena named *affectivity*. In contact with the human body, a site of multiple occurrences, these affective items are intended to become active and integral part of it.

Based on the results referred to, the present essay aims at considering the process to develop affective-wear items. These, equipped with sensors and microchips, could safely and simultaneously monitor a series of biometric parameters, establishing an interactive relation between the user, technology and the environment.

The interdisciplinary character of the affective jewel led to a partnership between the Art Institute of the University of Brasília, the UnB's Department of Electrical Engineering and the TECBOR Project (sustainable rubber production in the Amazon), run by Lateq/UnB[1] (UnB's Laboratory for Chemistry Technology). Here, design is a vital aspect for concept development.

In this sense, the concept of a computational affective wear has been used to develop the affective jewel, a technology that can be worn and may also adorn and communicate with the body. However, its purpose was not to create devices sensitive to physiological signals, but rather pieces that make aesthetics and poetry emerge.

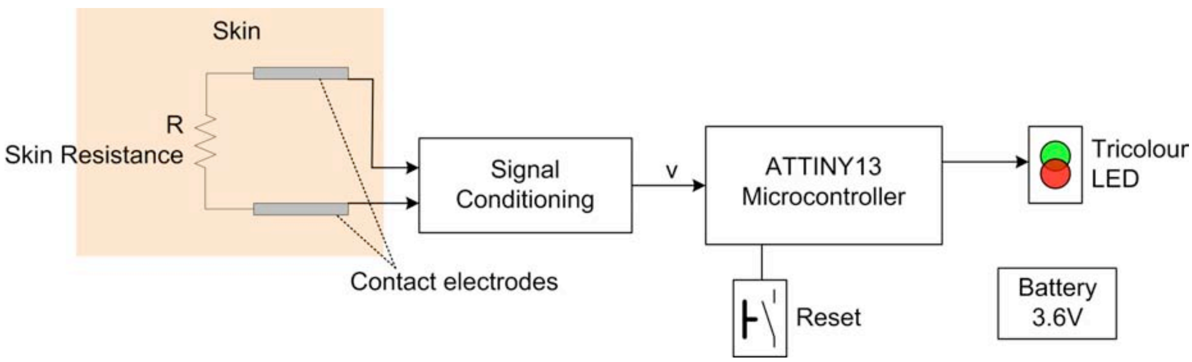
The sensitive bracelet: an affective jewel

In order to apply the concept of affective wear, we developed an affective jewel, a bracelet composed of a sensor connected to microchip able to recognize and measure electrodermal reactions; in other words, the variations on the skin electrical conductivity. These reactions account for physiological phenomena of emotional character, such as concentration, excitement, euphoria and tension. The system consists of a digital galvanometer (GSR - galvanic skin resistance), which is capable of reading sympathetic nervous states derived from internal or external stimuli.

The development of the jewel prototype was based on the

Galvactivator, a sensitive glove created at the MIT's Media Lab and equipped with a galvanometer. The glove detects the user's skin electrical conductivity and sends it to a light-emitting diode (LED), which shines more or less intensely, according to the stimuli triggered by an emotional state. Picard and Scheirer (2001) found out that a psychological excitement is likely to cause an increase on the skin conductivity, which, in its turn, leads to the intensification of the LED light.

The affective jewel electronic system



Picture 1. Diagram of the electronic system of the affective jewel.

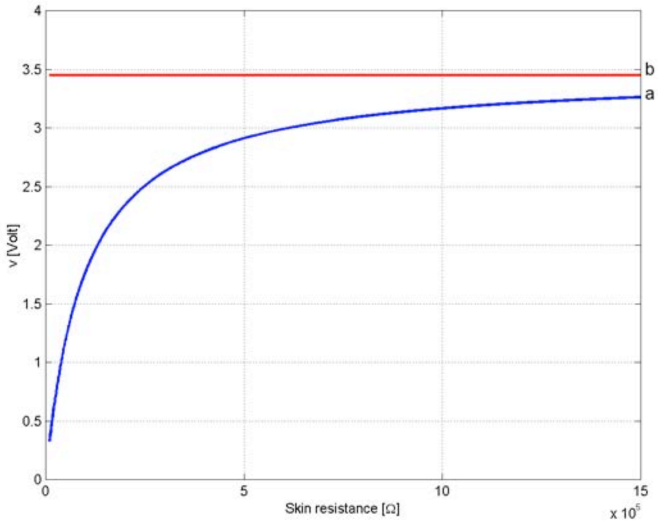
The affective jewel electronic system is based on a microcontroller. Microcontrollers are programmable microprocessors designed for specific purposes. A small, energy-saving and very-low-cost microcontroller to this project was chosen. Nonetheless, it is fast enough to meet the needs of the computational system in the affective jewel. Its electronic system is also composed of a pair of contact electrodes, a signal-conditioning circuit, a tricolour LED[2], a reset button and a 3.6-V-rechargeable battery, commonly used in mobile phones (Picture 1).

The contact electrodes are primary devices used to measure the skin resistance. Indeed, they consist of two conductors to be attached to the skin in different points. It is recommended that the maximum distance between them be 5 cm. The direct contact with the skin causes the resistance between both pieces — which means: the resistance *R* of the skin — to alter the signal conditioning system. This variation is detected through the electric tension *v* measured by the microcontroller. The measured tension *v* and the skin resistance *R* relate to each other, as follows:

$$v = \frac{2{,}7R}{2{,}8R + 2{,}7 \cdot 10^5} \cdot 3{,}6$$

In the formula, *R* is measured in Ohms (Ω) and *v*, in volts. As verified in previous experiments, *R* ranges from some dozens of thousands of Ohms until one million ohms. When no contact is established, *R* becomes unlimited and *v* intensity approaches 3.6V. If such occurs, the microcontroller can detect the anomaly and interpret it as electrodes being detached from the skin and turn off the LED. The detection process is very simple: if *v* is greater than the minimum detectable tension, it means *R* is very intense, due to both electrodes not being in touch with the skin. The picture 2 shows the tension curve *v* with respect to skin resistance *R*, as well as the non-contact minimum detectable tension. Therefore, the measurement of the skin resistance is represented by the tension *v*.

The microcontroller used is the model ATTINY13 made by Atmel Corporation. A reset button and a tricolour LED are attached to it and whose functionality is described in the following section.



Picture 2. Tension curve v with respect to skin resistance R (blue) and the non-cantact minimum detectable tension (red).

Circuit behaviour

The program stored in the microcontroller determines the system features as follows :

Adaptation: since each person belongs to a particular skin resistance variation band, the system proposed is able to establish its limits by means of storing its minimum and maximum values — measured by the tension *v* — in the program memory. These data are referred to as v_{min} and v_{max}, respectively;

Skin resistance indication: as mentioned above, the variable *v* is related to skin resistance: the higher the skin resistance, the higher v will be. The system measures the tension *v* every 100 ms. This will determine the intensity of LED's red and green light emissions, as seen in the formula below:

$$I_{VD} = \frac{v - v_{\min}}{v_{\max} - v_{\min}},$$

$$I_{VM} = 1 - I_{VD}.$$

According to these formulae, the higher the skin resistance is, the greater the green light emission I_{VD}. On the other hand, the stronger the emission of red light I_{VM}, the lower the resistance on the skin. For the LED is tricoloured, the intensities of green and red combine to form a third-colour tone. It should be observed that the values for the light intensity parameters range from 0 (no light emission) to 1 (a single-light emission);

Reusability: in the event that the affective jewel be used by another person, the v_{min} and v_{max} parameters should be adjusted to the new user. By pressing the reset button, the system detects the new v_{min} and v_{max} and determines the respective *v*-band limits;

Non-volatile memory: when the system is turned off, due to battery removal or recharge, the user's data (v_{min} and v_{max}) are kept in an internal non-volatile memory. When the system is turned on, the stored parameters are recovered. In this sense, the equipment is able to perform a non-stop operation;

Low energy consumption and use of rechargeable batteries: the battery used is the same type of batteries loaded into mobile phones. It enables battery recharge through conventional chargers. Since the energy consumption by the system is considerably low, it is expected that the battery work non-stop for a week without being recharged. In addition, when the system detects that the bracelet was removed, it enters a highly efficient energy-saving mode and the LED does not light.

According to the description, whereas serenity and relaxation lead to a high skin resistance expressed in green light emissions, anxiety and euphoria are responsible for low resistance levels identified through red light emissions.

In intermediate states, light emissions vary from yellow — when closer to green — to pink or orange — when closer to red. In addition, the microcontroller software adapts to the user, seeking to establish the skin resistance variation band. Data on the electric variation are stored every twenty minutes in a medium-term memory. It enables the affective jewel to be used by different people and match the parameters of the new user in less than 24h after being restarted.

Considerations

The use of technology to wear, adorn and expand body possibilities becomes a matter of symbolic relevance for individual and social identity. In this sense, computational affective wear seem to indicate the future of fashion, showing the possibility of integration of special materials and computational systems into clever, sensitive objects and clothes. These, beside their aesthetic appeal as a feature of fashion products, will be able to accomplish different tasks, such as monitoring body functions and paving the way towards new means of communication. Unleashing new forms of expression and integration with the environment, the computational affective wear may lead us to other imaginable possibilities in which objects connected to human senses and feelings will establish affective relations with whom wears them.

This affective jewel, for instance, may turn into a very sensitive bracelet by simply reprogramming its microchip to recognise different variables, such as skin temperature and moisture level, identification of sounds in an environment and the interruption or continuity in the movement of body parts. There will naturally be a need for further implementation of devices — LEDs, sounds or internet-integrated systems — capable of interpreting such stimuli. In this context, affective jewellery could be useful in performances of dancers and artists, as a means to collect and translate the information from assorted variables.

Besides, the affective bracelet could help achieve self-knowledge by monitoring the user's reaction to different situations and his/her respective answers to them. Moreover, the data stored in the microchip could be passed on to a computer and translated into graphs for psychological analyses and studies.

Through a much closer interaction with the body, mind and the environment, an affective computer science will be able to enhance the psychological effects from the advent of technology, turning the role of clothes and wearing objects into an extension of the human body, seeking a balance between technological advancement and nature. Affective clothes and objects are, therefore, intended to receive, interpret and express events occurring in the human body, making visible what was once invisible, causing unconscious processes to emerge, providing the interactor with a greater knowledge of his own.

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Short Biographical Profile

Flavia Amadeu is a Brazilian Designer. She holds a degree in Industrial Design from the University of Brasília, Brazil, and is currently a MA candidate in Art and Technology at the same institution, researching wearable and affective computing devices. Her empirical and theoretical perspective encompasses the interdisciplinary zone involving the art-science-technology trinity, with Professor Dr. Tania Fraga as tutor and Professor Dr. Geovany A. Borges as collaborator. In addition, she holds a teaching position in the Fashion Design course of the Euroamericana University of Brasília.

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Dr. Tania Fraga is a Brazilian architect and artist. She has completed her PhD at the Communication and Semiotics Program at the Catholic University of São Paulo. She developed a Post Doctoral research at CAiiA-STAR, UK, 1999, with a research grant from CAPES (Brazilian Agency for the Improvement of Higher Education Personnel). In 2003 she was member of the Advisory Research Committee of the Banff New Media Centre. She was Visiting Scholar at the Computer Science Department at The George Washington University, 1991/1992 and Artist-in-Residence at The Bemis Foundation, USA, 1986, with a grant from the Fulbright Commission.

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[1] The TECBOR Project (Tecnologia da Borracha da Amazônia — Rubber Technology in the Amazon) was developed in the Laboratory for Chemistry Technology of the University of Brasília (Lateq/UnB) and run by Professor Floriano Pastore. Its research aims at alternative solutions for production of rubber in the Amazon, approaching social, economic and environmental aspects to and offering perspectives of sustainable growth to rubber-tapping communities within the region.

[2] The 3-mm-tricolour LED is meant to light up in green or red. Nonetheless, when these two colours are connected to a conventional cathode, it enables the lighting of a third colour, as a result from the combination of the two others. The shades of the resulting colour range from yellow to pink;