Chapter 1
Bio–Interfaces:
Designing Wearable Devices to Organic Interactions

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ABSTRACT

The bio-interfaces are widening the notions of complexity, affectiveness, and naturalness to an organic scale, in which the physiological information of the users acts as data to configure an interaction that responds to their emotional state in order to match the state of their body at that particular moment. In this context, the chapter discusses the role of the bio-interfaces in building a differentiated condition of interaction governed by the biology of the users. For this, the chapter presents applications of bio-interfaces in the areas of design, art, and games, considering their use as wearable devices that provide an organic interaction between man and machine, which could, in turn, lead these systems to a co-evolutionary relationship.

INTRODUCTION

The research and development of bio-interfaces constitute a transdisciplinary problem involving different fields of knowledge, such as: neurobiology, psychology, design, engineering, mathematics, and computer science. Unquestionably, growth of this research area is driven by the growing knowledge of biological functions, the advent of the computer - as a powerful and low-cost tool, the growing perception of the needs and

potential of individuals with social and / or motor disabilities and, more specifically, the possibility of translating biological functions into numerical data that can be interpreted by computer systems that enable other channels of communication with the external world.

The context of bio-interfaces encompassed by this chapter includes the studies related to functional biometric interfaces as well as brain-computer interfaces, both focused on enabling communication processes between humans and machines and/or humans-machines-humans, based on a co-evolutionary relationship of bio-

logical and technological systems. In this sense, aspects that are intrinsic to the application of these bio-interfaces will be addressed from a scientific perspective, considering the contributions by Sutter (1992), Picard (1998), Chapin et al. (1999), Bayliss & Ballard (2000), Wolpaw et al. (2002), among others, as well as within the scope of creation in arts, design and games, focusing on the productions by Gabriel (Wilson, 2002); Gilchrist, Bradley and Joelson (1997); Zuanon and Lima Jr. (2008 and 2010); Pfurtscheller (Friedman et al., 2007). Reflections will be emphasized based on the design of wearable bio-interfaces, specifically the characteristics essential to their design of interaction, taking into account future perspectives for the development of interactive bio-interfaces.

BIO-INTERFACES BACKGROUND

For several years, electrophysiological and electroencephalographic activities, and other measures of brain functions, have been considered means to new non-muscular channels of communication for sending messages and commands to the external world. This possibility becomes reality with the development and application of functional biometric interfaces and brain-computer interfaces (BCI) responsible for actually enabling this communication process between human-machine or human-machine-human, through the acquisition and encryption of the user's biological information. In this section, we will address the main aspects related to this context, to provide an ample understanding of the operation spectrum for both interfaces.

Functional biometric interfaces, based on checking ANS (autonomous nervous system) variability, provide information about the physical state or the behavior of those who use them, continuously gathering physiological data, that is, without interrupting user activity. For such, bio-sensors are used as input channels for a functional biometry system, such as: galvanic skin response

sensor (GSR); blood volume pulse sensor (BVPS); breathing sensor (BS); and electromyogram sensor (EMG).

Galvanic Skin Response Sensor (GSR)

The GSR enables the possibility of measuring the parameters of electrical conductance from skin tissue through the application of two electrodes. This conductance is considered a function of the sweat gland activity, which is a part controlled by the sympathetic nervous system. Thus, when an individual suffers from anxiety or is frightened, a quick increase in skin conductance occurs due to the increase in sweat gland activity. This increase actually reflects the changes that are occurring at the stimulation level of the user's sympathetic nervous system as the result of an internal or external stimulus. The GSR then interprets these alterations and later they may be encrypted as actions in the environment external to the user's body, for example, the light of an environment that turns on after an increase in skin conductivity has been detected as a result of the person's apprehension in entering a dark room. It is important to underscore that an individual's skin conductance baseline is unique and it varies as a result of many parameters, such as: gender, food diet, skin type, social context, among others.

Blood Volume Pulse Sensor (BVPS)

The blood volume pulse sensor (BVPS) uses photoplethysmography to detect existing blood pressure at the extremities of the individual's body. This process consists of applying a light source and then measuring this light when it is reflected on the skin. With each contraction of the heart, the blood is forced through peripheral vessels, which causes their obstruction. In other words, what can be observed at this moment is an alteration in the amount of light that arrives at the photo sensor, thus allowing the reading of the user's blood pressure

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