

## WEARABLE TECHNOLOGIES FOR EMOTION COMMUNICATION

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### INTRODUCTION

It is reasonable to argue that emotion is an important element of everyday social interaction. Inclusion and display of emotions are considered to be important to maintain an affective social communication. Emotion is what gives communication life (Planalp, 1999). The body is the main site for expression of emotions. People intentionally or unintentionally communicate their emotions with various facial expressions, gestures, vocal tones, and bodily movements. We communicate our emotions through our bodies (Planalp, 1999). The manifestations of our emotions occur not only with the observable bodily changes but also with unobservable reactions. Through the observable cues, while one reveals his or her emotions, others try to predict them and react accordingly. The display and comprehension of bodily reactions are used for building and communicating emotions non-verbally.

The expressive attributes of bodily reactions and gestures are also accompanied by clothes and accessories to build an affective communication. Besides the hard-to-control physiological responses, people also use controllable elements of appearance such as garments, jewellery, and accessories to express themselves. Self built physical appearance helps to express moods and emotions in a socially acceptable way. The symbolic power of appearances of things can be used not only to enrich the expression of the social self but also to manage how to communicate the self.

Clothing itself is a mode of communication. The clothes or the accessories people wear make statements and express something about themselves. That the clothes we wear make a statement is itself a statement that in an age of heightened self consciousness has virtually become a cliché (Davis, 1992). Clothing is not a universal visual language that conveys the same meanings with the same codes, but communicates various meanings both for the users and the viewers in all different cultures. People reveal their

choices and emphasize their identity and personality through the display of clothes. Likewise, they interpret the visual statements constructed by other people. We redefine our appearance with clothing and accessories, and increase the expressive abilities of our bodies.

### SELF EXPRESSION VIA WEARABLE TECHNOLOGIES

The message conveyed by clothing is derived from the visual composition of the garment, which is a combination of the cut, the drape, the texture, the silhouette and the volume of the garment. Despite the numerous permutations of clothing made up from different pieces of garments, the message conveyed by classical clothing is static. The expressive ability of clothing does not change unless the clothes worn are changed.

In today's fast paced, networked and wireless society, the dynamics of the society and the advanced communication technologies determine the ways of in which messages are transmitted and received. Also, user-centred design approaches, with increasing inclination towards customisation, participation and interactivity in product development, are being transferred to clothing design to create interactive systems that allow user definition of final appearance. In an age where identity is increasingly fluid and multifaceted, the static clothing and unresponsive materials we wear are often insufficient means of expression. Clothing designers want to create systems of clothing that react, collect information, and enrich our interactions with spaces and people (Galbraith, 2003). Besides the traditional ways of creating user defined clothes and accessories, the capabilities of advanced technology such as miniaturized electronic components and smart materials are finding application in the design of pervasive wearable technologies with better possibilities for self expression. Campbell et al. (2001), working on pervasive devices and digital jewellery, underline the need to acknowledge and even enhance users' abilities to address everyday personal and social needs in designing wearable technologies for everyday life. They believe that pervasive wearable devices will need to reflect our tastes and moods, and allow us to express our personalities, cultural beliefs, and values.

Wearable technologies increase the expressive abilities of clothing, with responsive and reconfigurable components that allow a better representation and expression of personal choices. Expressive components of clothing such as rhythm, physical movement or visual texture can be created through computation, and examples of new types of clothing based on computing could provide modes of expressions unachievable with traditional garment techniques (Co, 2000).

The combination of computation technology and smart materials afford new expressions and applications and invent new forms of information handling and presentation (Hallnäs, Melin and Redström, 2002). The advances in materials, electronics and computation technologies allow designers to develop expressive clothing with various multimedia capabilities. Computationally active non emissive textile displays (Post et al., 2000) or electroluminescent fibre embedded textiles, light emitting diode (LED) based textiles, sensors, microcontrollers, textile based controls, embedded ultra thin displays or speakers, all enable designers to create clothes that achieve previously unachievable expressive capabilities.

Wearable technologies provide novel ways of communication not only with reconfigurable components that augment self expression, but also by being actively involved in electronic networks. Wearable technologies can

collect information or transmit messages via electronic networks and also communicate with the wearer and the other users. Being networked via wearables allows users to communicate both in the visible public domain and in the invisible and non-physical personal and public domains.

### COMMUNICATION OF EMOTION VIA WEARABLE TECHNOLOGIES

It is challenging to communicate our emotions comprehensively in the absence of physical cues and communication channels. Face to face communication benefits from the expressiveness of facial or vocal cues and visual, auditory or olfactory channels of communication. However, for remote communication through electronic networks, comprehensible multimedia signs should be developed for affective communication. People use specially invented characters, the face shaped icons, the *smileys* (or emoticons), avatars, colours, and still or animated graphics, to enhance communication, and emotion communication in particular. It is becoming more common and thus more comprehensible to encode and decode personal messages with the use of these multimedia expressions. Information communication technologies define a new shift towards ascribing meanings to multimedia representations for communicating personal information. Discussing the possibilities of communicating emotions through wearable technologies is thus only meaningful after this shift. As we have evolved to recognize the emotions from visual cues, such as gestures and body movements, we are developing an ability to decode the emotions by evaluating the visual cues that are artificially created and represented to us with the evaluation of communication. As Gaver (1999) reminds us, technology may support emotional communication more directly than traditional media.

Affective and augmented communication of emotions can be provided by wearable technologies as they can display and broadcast the multimedia compositions of final appearances that are defined and decided by the user. Responsive clothing has the ability to refresh its appearance according to the input provided by the user, a network member, or the environment. Computational components embedded in clothes process any kind of input and produce an output that can be visual, auditory, tactile, or any such combination. The user can determine which kind of stimuli should be taken as input and how it should be processed.

As stated before, emotional appraisal is communicated through visual or vocal cues detectable by others. These cues are results of the bodily changes that occur when an emotional event acts as a trigger. Biometric data during an emotional appraisal can be used as input for creating an output for wearables. Sensors worn on the body can precisely detect physiological changes in the course of an emotional appraisal. Frijda defines the physiological changes experienced during emotional appraisal as the change in heart rate, blood pressure, blood flow, respiration, sweating, secretion, pupil dilation, trembling, brain waves and muscle tensions (Frijda, 1986 in Planalp, 1999). All of these changes can be used as sources of input to generate computational responses to represent emotions as multimedia compositions.

Sensatex Inc., a New York based textile company, has developed a wireless system that can detect and monitor changes during physical activities in the human body. 'SmartShirt', described as *the shirt that thinks*, allows the comfortable measuring and/or monitoring of an individual's biometric

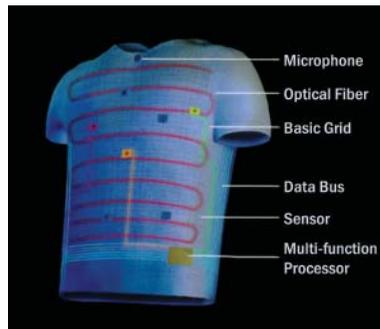


Figure 1. 'SmartShirt' (Sensatex, 2008).

data, such as heart rate, respiration rate, body temperature, calorific burn, and provides readouts via a wristwatch, PDA (personal digital assistant) or voice. Biometric information is wirelessly transmitted to a personal computer and ultimately through the Internet. Alongside other similar examples in the market, SmartShirt is a good example of how physiological changes can be measured and used for an enhanced awareness about the emotional changes occurring within the body (Figure 1).

Besides the physiological changes within the body, the detection of these changes in the environmental conditions related to the user can also be used as an input. Being more aware and more informed about what is going on in the environment helps the wearer to manage his/her emotional expressions socially. Detection of the changes within the personal interest sphere, detection of any other wearable user with particular importance to the user (whether the wearer tends to react positively or negatively to his or her presence), or detection of a new wearable user logged in to the same electronic network as the wearer, receiving a new e-mail, or the rise or fall of the stock exchange, can each be considered as a potential source for input. These various inputs can be processed and used to affect or augment the expression of aroused emotions, thereby increasing the wearer's control over emotion display.

### MANAGING EMOTIONAL RESPONSES VIA WEARABLE TECHNOLOGIES

The output produced via wearable technologies by the computational processes can reflect the changing emotional responses of the wearer, since the output can be programmed to be sensitive to the instantly changing patterns of the input. The interactive responses of the garment to the instantly changing stimuli can enhance the expression of emotion by acting as a virtual second face that reveals the emotions. Unlike the hard-to-control physiological responses to environmental or personal changes, the physical responses of the wearable technologies can be controlled and directed to express emotions in an intentional and desired manner.

Besides developing systems that visualise the physiological responses through the use of clothes and accessories as media, we can develop clothes that can dynamically produce emotional expressions by user command. These clothes are intended to enrich our emotional dialogues and help manage our social relations. The emotional response of the wearer to any occasion can i) be amplified by presenting noticeable, exaggerated visual compositions, such as changing colours or textures of garments; ii) be hidden by not showing any physical response (despite being expected from the wearer and his/her smart garments) when it is socially not appropriate; or iii) be speculated by expressing empowered emotional responses to a situation where the wearer has to react in that way socially. The interactive responses of clothing and accessories can be controlled, programmed, instantly changed, or reconfigured according to the wearer's intentions and they can also be used to enhance the expressive abilities of the wearer. The augmented emotional responses of users can be learned by smart clothes, as a means of further assistance in the management of social interactions.

### EXPERIMENTAL EXAMPLES OF WEARABLE TECHNOLOGIES

Most of the examples of wearable technologies we come across can be considered as experimental prototypes that have not yet been released for daily use. The commercialisation of wearable technologies and



Figure 2. 'Chimerical Garment' (Co, 2000).

making them a part of daily clothing is dependent on advances in related technologies and the development of broader user acceptance for ambient devices and environments. The following prototypes of wearables exemplify the use of technology for creating networked and interactive wearables that can alter emotion communication.

The 'Chimerical Garment' is one of the earliest examples of computational garments (Co, 2000). It explores the idea of technology and computation as expressive elements of fashion in relation to the human body and its movement. Through sensors embedded in an arm unit, the Chimerical Garment responds to body movements, breathing and temperature changes (Figure 2). It displays computationally-created three-dimensional graphics on the LCD embedded in the garment. As an early example of responsive fashion objects, Chimerical Garment elegantly exhibits how body information can be converted into abstract visual messages and can be worn on the body.

Another example is 'Halo', which is networked clothing: it is a system for implicitly-controllable, reconfigurable and programmable garments. Therefore, it is also an example of a multi-user garment. A series of interconnected Halo units, each with its own microcontroller and glowing light panel, receive power and rhythm input from the 'Mama' unit equipped with serial and infrared receivers for connectivity with a PC (wireless reception from Palm Pilot and other Halo devices). Halo can interact with other Halos and use this interactivity as an input to create a dynamic visual pattern. Besides networked interaction, the user can instantly provide input for Halo and can change its visual pattern. This input can easily be controlled and emotions can easily be converted into visual statements (Figure 3).

Philips Design has prototyped two garments that demonstrate how electronics can be incorporated into fabrics and clothes to express the emotions and personality of the wearer (Figure 4). The examples also show an ongoing interest of pioneering companies in creating new wearable forms specially designed for exchanging or communicating emotions. 'Buebelle', the blushing dress, is a two layered garment designed to monitor the emotions of its wearer. The inner layer consists of biometric sensors that detect the changes at the wearer's body. The outer layer is

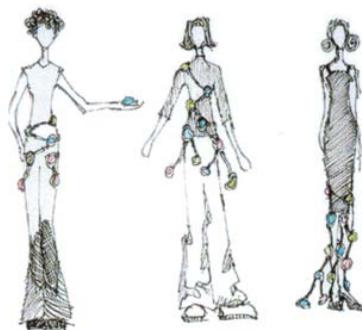
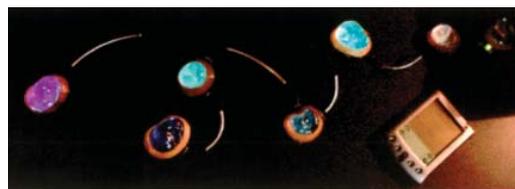


Figure 3. 'Halo' (Co, 2000).

Figure 4. 'Buebelle' (Philips Design, 2006).



Figure 5. 'Frison' (Philips Design, 2006)

used to monitor these changes with light emissions. The second example, 'Frison' is a body suit which also uses biometric sensing technology to sense changes on the skin and creates an LED visual output (Figure 5). Both garments show the potential of available technologies in creating new wearable forms for exchanging emotions.

A set of jewellery called 'Interactive Ornaments: Emotions in Motions' designed by Fusakul (2002), illustrates a good example of how accessories can be used for communicating emotions. The set includes three pieces of jewellery that react and respond to physiological changes, in order to enhance the emotional dialogue between people. The jewellery system can detect such changes and react accordingly to enrich the visual display of the wearer. Fusakul's jewellery pieces are intended to augment the expression of emotions and to make it easier for people to show how they feel, by using interactively changing compositions. 'Vein-2' is a fibre optic necklace that changes its colour according to the heartbeat of the user. It includes a heart-rate monitor strapped onto the user's chest, which sends radio signals to the necklace. Vein-2 becomes red when the heartbeat rate increases and turns to blue when the heartbeat slows down. 'Anemone' is a shoulder piece. It consists of lights pulsating according to the rhythm of the wearer's heart. It uses light as a direct representation of change of heartbeat during emotion appraisal. The third piece 'Aliform' consists of nine elliptical shapes cut from shape memory alloy film. The wings of the elliptical forms swell in sequence according to the changes in the heartbeat. The piece consists of a microchip that controls the sequence of the wings (Fusakul, 2002).

## CONCLUSION

Wearable technologies can be used as a multimedia display that reflects the emotional status of the wearer by ascribing meanings to the interactively changing compositions of expressive forms. Wearable technologies allow their wearers to refresh their appearance according to the changes in their emotional state. Computationally controlled garments and accessories can detect the need for expression and transmit messages appropriate for the context. This way, clothing becomes a complementary medium of communicating emotions and naturally enhances the expressive abilities of the self by broadening the channels of communication. Thus, wearables both enhance the expressive abilities of the self and enhance the usability of the clothes. Wearables define a new relation between wearers and garments, and propose new directions for fashion.

Wearables can display intimate data. If bodily changes are detected and used as input for generating a multimedia response for emotion communication, the output is a direct representation of intimate data. Different than other ambient devices used to communicate emotion, only wearables can provide a real communication of emotion appraisal. However, new channels of communication can be used to amplify, to hide or to fake emotions and provide a degree of control over the expression of emotions desired for management of social intercourses. Wearables generally also allow users to manage their displays of emotion. Managing emotion communication via wearables thus alters self expression and social communication.

Detection of bodily changes during an emotional appraisal, and automatically expressing the emotions through a wearable agent, augments the communicative capabilities of shy or socially less skilled people. More

importantly, the same approach can be used to enhance the communicative abilities of distinct user groups, such as the impaired, the autistic, and the elderly. Detection of an emotional appraisal becomes more comprehensible for other people when displayed via wearables. Networked wearables also allow people to monitor emotional changes from a distance. Wearables thus can be used as emotion expression aids for better social communication for special user groups.

Wearables increase the sociality of long distance communication. Wearables with the ability to connect to multiple electronic networks, whilst simultaneously providing localised expression, can also facilitate affective emotion communication between remote users. Intimate and direct information about users' moods, feelings, and bodily changes can be communicated across distances for a better emotional dialogue. Networked wearables not only facilitate one-to-one emotion communication but also allow the sharing of collective emotions and moods. Multiple remote users can express and share emotions through such networks.

Remote communication of emotion via wearable technologies also changes the real time nature of emotion communication. Wearables allow asynchronous communication of emotions during remote communication. Emotion is conventionally experienced for a limited period of time and cannot be stored. Wearables can store the emotional appraisal data and can communicate it asynchronously to a remote user as a multimedia representation when that user logs in to the network. Furthermore, networked wearables can express emotions to remote users at any given time or desired moment, augmenting the social abilities of the garment wearer. Wearables also create a networked physical self, who can be always online and can constantly broadcast personal information which can simulate the communication pattern of avatars and user profiles on the Internet. Wearables thus blur the border between physical and virtual domains, providing dual presence to the user by being represented in electronic networks whilst living and communicating in the physical world.

Wearables enhance the way we interact with our bodies, as they can be used to follow and monitor bodily changes, thus increasing self awareness about our body and its reactions. Wearables enhance the way we interact with other people, as they augment face-to-face and remote communication with interactively responding components. They enable users to wear rather than simply access social network functionalities and, in coordination with other networked users, provide the possibility of detecting, broadcasting and exchanging real time emotion data.

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**Anahtar Sözcükler:** giyilebilir teknolojiler; duyguların ifadesi; kişisel ifade; bilişsel tasarım.

## GİYİLEBİLİR TEKNOLOJİLER: DUYGULARIN İLETİŞİMİNDE YENİ OLANAKLAR

Bu çalışma duyguların iletiminde giyilebilir teknolojilerin kullanımı ve giyilebilir teknolojilerin kullanıcılarına sunduğu olanakları tartışmaktadır. Bu çalışmada 'giyilebilir teknolojiler' ve 'giyilebilirler' terimleri, akıllı teknolojiler yardımıyla üretilmiş, görselliği bilişsel işlemler yoluyla kullanıcısı tarafından değiştirilebilen etkileşimli kıyafet ve aksesuarları tanımlamak için kullanılmaktadır. İnsanlar duygularını yüz ifadeleri, jestler ve beden hareketleri gibi gözlemlenebilen bedensel tepkilerle ifade ederler. Duyguların görsel olarak ifadesinin gücü, bedenin duygu iletimi sırasında kullandığı fizyolojik ifadelerle kıyafetler ve aksesuarlar yardımıyla yapay görsel ifadeler ekleyerek artırılabilir. Giyilebilir Teknolojiler, görselliği etkileşimli olarak değişebilen dinamik bir kıyafet yapısı dolayısıyla kullanıcıları için yeni bir kıyafet deneyimi tanımlarlar. Bilişsel işlemlerle desteklenen ve kullanıcılar tarafından tanımlanabilen yeni etkileşimli görsellikleriyle giyilebilir teknolojiler, duyguların ifadesinde ve iletişimde kullanıcılarına yeni olanaklar sunmaktadırlar.

### ABSTRACT

This paper discusses the possibilities of exploring new ways of expressing emotions with wearable technologies. In the paper, the terms 'wearable technologies' and 'wearables' are used to refer to garments and accessories that have embedded smart technologies with the ability to connect to an electronic network and the ability to create customisable, dynamic and interactive responses. People mostly communicate their emotions by

observable bodily reactions such as facial expressions, gestures, and body movements. Visual expression of emotion can be augmented by adding artificial visual responses to the physiological visual responses of the body with garments and accessories. Wearable technologies define a new experience of clothing with the possibility to create interactively changing appearances. The dynamic visual compositions defined by the user, and provided by the computational processes, can enhance the abilities of the user for the expression of emotions.