Physiological Computing

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ABSTRACT
On the outer reaches of interactive systems research the physical barrier that has thus far defined so much of human-machine interaction is cautiously being breached. Human-computer interaction is evolving beyond interaction based around deliberate user interaction with electromechanical devices. Early results are exciting and serve to give a sense that the future is now and we only have to choose to attend to it.

KEYWORDS: Physiological computing, HCI evaluation, affective computing, biofeedback, brain-computer interaction.

INTRODUCTION
Increasingly interactive applications are taking advantage of advanced sensing capabilities in order to free users from the constraints imposed by individual physical machines. The field of ubiquitous computing is breaking the machine itself down and dispersing it into the fabric of the users' changing world, a world where work and leisure activities are no longer distinct.
Far from severing the ties between user and machine, the reduced physical presence of 'the computer' is actually forging a more intimate relationship between people and technology. One striking effect of this is the increasing exploration of specialized sensors for gathering more personal user data. Of particular interest are those sensors that allow us access to detectable human physiology - data relating heart and respiration rate, the changing level of tension in a subject's muscles, the level of excitation in the sweat glands as well as peripheral body temperature. We can even use these non-intrusive sensing technologies to listen to the gross electrical output of an individual's brain!

Work on direct brain-computer interaction (BCI), for example, is being carried out in dozens of labs across the globe. This work is carried out in a number of disciplines and for a variety of reasons and has as yet to be gathered together for scrutiny. Similarly

But that is a small step after all the exciting work that has already been carried out. Related, in technological terms, is the development of intelligent, affective computers. Researchers in affective computing hope to enrich the human-machine relationship by creating machines that interpret and respond to a user in an emotionally intelligent manner[2]. Physiological data gathered through specialized sensors provide important indications of arousal. When considered alongside other personal user data (vocal intonation, facial expression) this data can be used to ascertain the changing emotional state of a user.

WORKSHOP GOALS
The goal of this workshop is to bring together researchers and practitioners who are interested in the utility of physiology within the human-machine interface. The main goal of the workshop is to develop an understanding of how the availability of physiological information is going to affect the future of human-machine interaction.

RESEARCH ISSUES
In order to achieve our goal we need to gather knowledge and experience from a wide variety of experts in different fields of inquiry and applied use.

Physiological sensing technologies
The first area we need to establish an understanding of is the that of the sensing technologies underlying physiologically-based human-machine interaction. Such technologies are commercially available and in order to encourage their uptake by the HCI community the first thing we need to do is demystify the technology – what is it, how does it work and what quality of information may I expect to receive from such technologies ?

Development support for physiologically-enabled interactive applications
Commerical sensing devices are often developed with specific appllications I mind. This means that sotware available with these devices is most often closed to further development. In addition to promote the uptake of phsyiological detection equipment we need to develop and make available suitable tool support for those wishing to develop applications which utilise physiological information.

Physiology as a usability metric
As mentioned, detectable physiology has been used as a usability metric in the design of interactive systems since the mid 1980's. In order to make progress in this field,

we need to establish from practitioners the utility of the information source, its reliability and any problems we may need to overcome technically.

Affective computing
Affective computing is one of the emerging computing paradigms that has already found a role for physiology in the human-machine interface. How do the experiences of affective computing researchers compare with those of psychophysiological usability practitioners?

Bio-cybernetic or biofeedback systems
Biofeedback training, where a user's physiology is presented back to him/ her in real time in order that he/she may learn to exert conscious influences over his/her own physiology, is another old and established field. It has employed comparatively rudimentary technology for a very long time and could certainly benefit form the expertise of HCI experts as much as they could learn from biofeedback practitioners.

Healthcare applications
From critical monitoring of physiology through a plethora of clinical biofeedback applications, the phsiologically-enhanced computer is a workhorse within the medical field. The interactive concerns of these systems will be shared bythose researchers exploring brain-computer interaction as well as those who computer will one day respond in an affective manner.

What all of these applications have in common is the need to detect, process and suitably present human physiological information. Currently each filed covers the same evolutionary development ground in order to make advances in its respective filed. But there is enough in here for the HCI community that we could all benefit from a better understanding of the relationship between physiologically-enhanced computer systems and man.

ORGANIZERS' BACKGROUND

Jennifer Allanson
Dr Jennifer Allanson is a lecturer within the Computing Science Department at Lancaster University. She began work on Physiological Computing in 1998 as part of her doctoral studies and has publishing several key papers on this subject. Her doctoral work focussed on *electro*physiologically-interactive computer systems (EPICS). Work in this area has included the design and implementation of tools aimed at facilitating the prototyping and subsequent implementation of electrophysiologically-interactive computer systems. The toolkit that resulted from this work is arguably the first of its kind. Her doctoral work now forms the basis of a funded project to develop support for sentient systems. In addition she is part of an interdisciplinary team putting together a project to explore brain-computer biofeedback control interfaces.

Gillian M. Wilson
Gillian Wilson is a doctoral student in the department of Computer Science at University College London. She graduated in Psychology from York University (1998). She is conducting research in the area of multimedia quality assessment, where the application of interest is Multimedia Conferencing. As the number of networked multimedia applications increases constantly, users audio/video quality requirements need to be clearly specified. Subjective assessment is currently used to do this, however it has drawbacks. Gillian's research is utilising an objective method to assess the impact of media quality on users: physiological indicators of stress are being measured. Findings so far indicate that physiological responses to media quality degradations can be detected and that they do not always correlate with subjective results. Thus, to rely solely on subjective assessment is unwise. A three-tier approach to multimedia quality evaluation is proposed by this research, incorporating measures of task performance, user satisfaction and user cost.