IBM Global Services

Executive Tek Report

August 30, 2001

Affective computing: Knowing how you feel

Executive Summary - Building information systems that can detect, classify, organize and respond to human emotions can help make the user experience more efficient and friendly. There also are specific applications that can help people to better understand their own emotional lives and those of others. This class of systems and applications are termed "affective computing." It is also possible to use affective computing to increase safety (for instance, changing vehicle attributes or responses when driver inattention is detected) customizing experiences, optimizing computer-mediated learning and gathering feedback on user preferences. While affective computing is still in its early stages, advances in algorithms, miniaturization of systems, and the use of personalization are already coming together in ways that should lead to a near term leveraging of this technology.

The tour guide is talking you through a series of illustrations featuring late Hellenistic architecture. You thought this would be fascinating, but now find that it is quite tedious. Within a minute, the tour automatically switches to a wine making sequence and your interest increases as you view the new process — the growing of the grapes, the harvesting, the preparation for fermentation, and the variety of wines that can result. You are particularly interested in the aging of the wine and the different qualities of the grapes. As soon as the narration is finished, you're immediately given a behind-the-scenes look at these aspects of wine making and, in fact, are treated to a short chat with a vintner who is aware of your special interests. After a few more online tours like this one, a complete itinerary is created in anticipation of your actual trip to Greece.

How this happens

Frustration may be the most common emotion associated with computer use. While our information systems may not be able to detect our emotions, they certainly can evoke them. There are a number of reasons why either providing emotional data to computers or and having computers express emotions can be of value. There are also many technical road-blocks that must be cleared before even the most basic uses of affective computing can be implemented. However, advances in recent years could propel this technology out of the lab and into the marketplace.

For instance, the ability to detect the physical manifestation of emotion has become more sophisticated, and the devices used to detect emotion now include many that are not intrusive. We also face the prospect of having the means to detect emotions on an ongoing basis. Both wearable computers and pervasive computing can provide the longitudinal information that can support useful conclusions about our emotional states. In addition, information about context is becoming more available though environmental sensors and from personalization. Finally, there are hints that some mathematical tools, including those used to make speech recognition more effective, might help correctly determine peoples' emotional states.

The basics behind affective computing are fairly straightforward. First, you have to detect the emotion. Some things, like facial expressions, gestures and tone of voice are obvious to humans, but captured only as raw data by computers. The computer has an advantage in other modes, such as the ability to detect a change in the touch of a keyboard, the temperature of a hand on a mouse, or access to direct physiological measurements.

The next element in affective computing involves putting the information detected into context. This is something humans do all the time. When we know the person, we know what that smile means (or, at least, we *think* we do). Here, the computer has been at a severe disadvantage for years. Most studies of emotional response have been across masses of people rather than following specific individuals. This was because researchers believed that responses were universal (the startle response is particularly robust across a large portion of the population) and partly due to practical reasons. Given the size and awkwardness of sensing equipment and computers, it was impractical to have people spend their days in contact with the systems. However, today, this is practical since computers and sensors have become wearable.

According to Rosalind Picard, an MIT professor and expert in affective computing, we are now at a point in this discipline roughly analogous to where speech recognition was about a decade ago. It may be possible to create user-dependent affective computing by having users work with the system over many circumstances and over a long period of time. For people who don't want to walk around looking like computer geeks, user data can be captured by installing affective computing devices less obtrusively; for instance, in cars. There, users have numerous touch points, such as the steering wheel and the pedals, and the subject remains in a relatively fixed position, easily observed with tiny cameras. In fact, MIT has done just such a study, putting people through a set pattern of driving conditions and measuring their responses.

Once the emotional data is captured and put into context, it must be analyzed and interpreted. Pattern recognition and algorithms offer promise here. There is some indication that techniques used in speech recognition may be helpful, but this remains perhaps the most challenging part of turning affective computing into practical value.

Other aspects of affective computing are further down the road and their future economic value is far from clear. Any sophisticated attempts to get computers to appropriately express emotions and respond to very complex emotional situations will require breakthroughs. Even further away are any attempts to create "real" emotions within a computer, as many people believe this is a philosophical line that will not be crossed.

Currently, there is no significant commercial application of affective computing (although lie detectors and biofeedback devices are closely related). However, many areas of practical interest are being investigated. Education and training look to be among the most promising fields; using interaction with the user to manage frustration and pique interest. Public safety could drive the development and commercialization of affective computing if it can be demonstrated that by unobtrusively observing people in crowds and community settings, such as schools, violence might be curtailed; or if cars can be shown to detect and respond to rage, boredom and other potentially dangerous emotional states. Also, there are many potential medical applications, such as stress management and determining drug dosage, especially for attention- and mood-altering pharmaceuticals. One should not discount more popular applications that would be possible, such as using affective computing as an adjunct to online games or chats. Prototypes have already been built that help systems to automatically select music that complements the user's mood.

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What this means to you

Any technology that significantly increases the quality of the user's interaction and experience with the system is important. The interaction with the computer can be more intuitive, less uncomfortable and, hopefully, fun. In the case of affective computing, users could always benefit when systems are made to be more friendly and engaging, particularly for those people who are not comfortable with the technology. In the future, emotional data and emotional profiles could become as important as personalization is today.

Although affective computing applications currently remain in the lab, all the technical elements for practical success, with the exception of robust algorithms for rapid, accurate interpretation, are in place. This is not the same as saying the mathematical models are all that stands between researchers and the most far-reaching dreams of affective computing. In the future, using unprecedented processing power, advanced software and sophisticated algorithms, businesses will be able solve complex problems, and derive knowledge from vast amounts of data. While commercial value for affective computing may be near term, applications that seem to give computers human emotions are probably a long way off. Digital pets, gaming, training and safety applications are likely to provide the earliest opportunities.

A current foray into this space is an IBM project, under whose aegis can be found the emotion mouse (which detects temperature variations); algorithms for facial expressions; pupil finder (which detects where you're looking); and suitor (Simple User Interest Tracker). Companies who are exploring pervasive technology should look for synergies between their pervasive strategies and affective computing alternatives.

Nonetheless, social concerns are inevitable. Complete emotional profiles would make people particularly vulnerable to exploitation. Even when users would have complete control of their data, they would probably be wary about submitting to any significant manipulation by an IT device. Society as a whole will need to weigh and balance very difficult questions regarding the control and monitoring of emotions in community situations, military applications, the use of affective computing to coerce, control or condition people and the therapeutic use of this technology to support treatment of affective disorders.

Two industries: Government and manufacturing

In government, wearable computing is already of interest to military, making the move into affective computing somewhat easier, particularly in the case of pilots who are already wired for telemetry and biosensing. In addition, police forces may be interested in more sophisticated ways to manage prisioners, identify suspects and control crowds. Health care and education applications are also likely to be of some importance to government agencies.

For manufacturing, one of the toughest challenges is to get reliable and usable feedback from customers. One can easily imagine sensing the emotions of people — as they use tools, play with toys or work with software — discovering where things go smoothly and where they might be improved. On the manufacturing line, where safety might be of concern, the attention of workers could be continuously monitored.

Tek to watch
Sensors
Pattern recognition
Fuzzy logic
Personalization
Personal area networks
Algorithms
Pervasive computing

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Other sites of interest

MetaFace
http://www.metaface.computing.edu.au/

About this publication

Executive Tek Report is a monthly publication intended as a heads-up on emerging technologies and business ideas. All the technological initiatives covered in *Executive Tek Report* have been extensively analyzed using a proprietary IBM methodology. This involves not only rating the technologies based on their functions and maturity, but doing quantitative analysis of the social, user and business factors that are just as important to its ultimate adoption. From these data, the timing and importance of emerging technologies are determined. Barriers to adoption and hidden value are often revealed, and what is learned is viewed within the context of five technical themes that are driving change:

Knowledge Management: capturing a company's collective expertise wherever it resides -- databases on paper, in people's heads -- and distributing it to where it can produce the big payoffs
Pervasive Computing: combining communications technologies and an array of computing devices (including PDAs, laptops, pagers and servers) to allow users continual access to the data, communications and information services
Realtime: "a sense of ultracompressed time and foreshortened horizons, [a result of technology] compressing to zero the time it takes to get and use information, to learn, to make decisions, to initiate action, to deploy resources, to innovate" (Regis McKenna, *Real Time*, Harvard Business School Publishing, 1997.)
Ease-of-Use: using user-centric design to make the experience with IT intuitive, less painful and possibly fun
Deep Computing: using unprecedented processing power, advanced software and sophisticated algorithms to solve complex problems, and derive knowledge from vast amounts of data

This analysis is used to form the explanations, projections and discussions in each *Executive Tek Report* issue so that you not only find out *what* technologies are emerging, but *how* and *why* they'll make a difference to your business. If you would like to explore how IBM can help **you** take advantage of these new concepts and ideas, please contact us at **insights@us.ibm.com**. To browse through other resources for business executives, please visit: **ibm.com**/services/insights

Executive Tek Report is written by Peter Andrews, an IBM emerging technology analyst, and is published as a service of IBM Corporation.

G510-1638-00