AFFECTIVE COMPUTING: KNOWING HOW YOU FEEL

Mohd Hafiz Mohd Hassin, Azizi Ab. Aziz and Norita Md. Norwawi
Artificial Intelligence Special Interest Group
Department of Computer Science, Faculty of Information Technology
Universiti Utara Malaysia, 06010 Sintok, Kedah
alhafiz98@yahoo.com, aziziaziz@uum.edu.my, rita@uum.edu.my

Abstract: Current state of the art in computer science is an attempt to build a system that understands us. Affective computing is one of the attempts made to build an information system that can detect, classify, and respond to human emotion. Affective computing is a combination of artificial intelligence and cognitive science that inspired researcher to build a computer system or robot that similar to Commander Data in Star Trek fiction movie. This paper discusses the general architecture and applications of affective computing.

Keywords: Affective Computing, Artificial Intelligence, Cognitive Science, Emotion Detection and Human Emotion.

INTRODUCTION

Computer history begins from 3000 B.C where the first computer, abacus was invented. Abacus was used as a calculating device. In 1800 first punch cards for storing data were invented by Joseph-Marie Jacquard. Punch cards were used by the first electronic computers in the 1940's and onward until the development of more reliable data storage. In 1936, John Dvorak introduce keyboard as an easy to use input device with the least used keys on the outside corners, and the most often used keys within easy reach of the user's fingers. This is followed by the computer mouse, invented by Douglas Englebart in 1963. In 1969, AT&T Bell Laboratories develop UNIX which used command prompt to operate computer. In 1981, Microsoft and IBM also develop operating system using command prompt, named MS-DOS. The new era of human computer interaction (HCI) was paved by Apple Computer, Inc., using Macintosh operating system using graphical user interface (GUI) and followed by Microsoft in 1995. Within four days the software sells more then 1 million copies. And now Microsoft is the leader of graphical interface witch have realest Windows 98, ME, 2000 and the letters is Windows XP. Now with the increasing of the technology, HCI is moving from the GUI operating system to computer that can understand to the user emotion, called Affective Computing. Figure 1 shows the timeline for evaluation of computer and HCI.

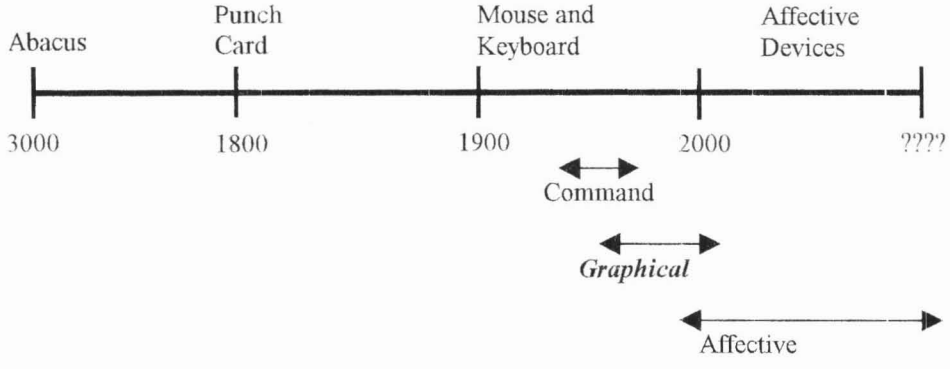

Figure 1: Timeline of Human- Computer Interaction Evolution

Affective Computing can be defined as "computing that relate to, arises from or deliberately influence of emotion" [8]. Affective computing is a new way to communicate between human and computer. The affective computing computer will be able to recognize human emotion and computer will responds to it. With the increasing capability of computer, now day computer can be able to recognize human emotion via various devices as camera, microphone or sensor. The first technology talk about affective

computing was discussed in the MIT's Media Laboratory Perceptual Computing Section Technical Report in 1995 by Rosalind Picard. From that day it sparks great interest to build such system that capable to understand how we feel.

Emotion

Emotion is a necessary part of life, related to how we feel, how we behave and think. Indeed, emotion makes us smart. Sure, utility and usability are important, but without fun and pleasure, joy and excitement, anxiety and anger, fear and rage, our lives would be incomplete [6]. Emotion not only of a single state such as anger, joy or sad, but also of a complex mix internal signals mechanisms that involved both the body and mind, helping us to function in a reasonable, balance and healthy way [8]. Emotion not only seen signals such facial expression, but also unseen signal such heart rate pulse or hormone changes in our body. This entire signal guides human motivation, planning, decision-making, learning and memory retrieval.

For a long time, psychologist and computer scientist have work together to make computer more reliable like developing machines that can comprehend the mystery of how human feel. Now a days with the advancement of technology and theory of cognitive science, devices can identify hundreds of facial features showing joy, anger, sadness and other emotions. The computers, which operate by recognizing patterns learned from a multitude of images, eventually will be able to detect millions of expressions. Such devices may never replicate human emotional experience, but if their developers are correct, even modest emotional talents would change machines from data-crunching savants into perceptive actors in human society.

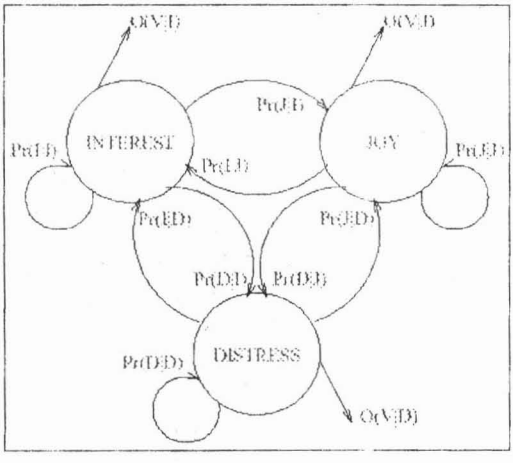

Figure 2: The stage (e.g. Interest, Distress or Joy (Courtesy from MIT Media Lab)

One particular way we can model emotion states is as a set of discrete states with defining characteristics that the user can transition to and from. Figure 2 illustrates the idea of emotion transition. Each emotional state in the diagram is defined by a set of features. Features may be just about anything we can measure or compute, example: the rise time of a response, or the frequency range of a peak interval. Therefore, an important part of the emotion recognition process consists of identifying functions of these features which differentiate one state from another. Each state in this model is integrated into a larger scheme which includes other emotion states the user can move to and from. A model like this one is trained on observations of suitable signals (physiological or other signals through which emotion content is manifested) to be able to characterize each state and estimate the transition probabilities. Next section will introduce the basic principles in affective computing.

DISCUSSIONS

Principles in Affective Computing

Affective computing converts personal emotion into bits [8]. Before converting the emotion into bits or into the computer, individual affective state must be captured. There is two ways to capture the individual emotion, either using contact-less devices or contact devices to the human body. For example, the contacts less devices are camera and microphone. As for the physical contact, sensors like galvanic skin respond sensors, pulse, electrocardiogram, blood volume pressure and respiration sensors are used to detect emotion state, all this devices are fully connected to human body. Such devices can gather continuous data without interrupting users. Figure 3 shows the example of galvanic skin response sensor and a sample of data.

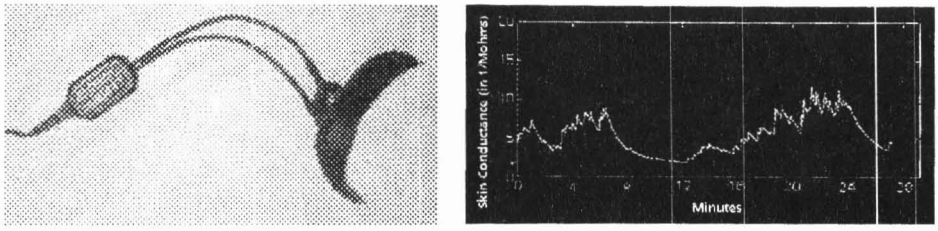

Figure 3: The Galvanic Skin Sensor Device and Captured Data

Computers cannot recognize human thought but computers can recognize human physiological even including such thing as physiology, behavior and even words selection when talking. Before a computer can recognize our emotion, there are several important steps are follow. The first step is to capture human affective state, primarily from facial expression, body temperature, body gesture or heart rate pulse. All this affective state will be going to feature extraction module, in this module this input will be filter to get only the important feature. Consider emotion detection through facial expression system, the salient feature in of this system is the formation of lips and eyebrow. The detected features will be extracted using image processing process (gray scale, thresholding and edge detection) [10]. Once the emotional data is captured and put into context, it must be analyzed and interpreted using learning algorithm. Figure 4 below shows the general affective pattern recognition module.

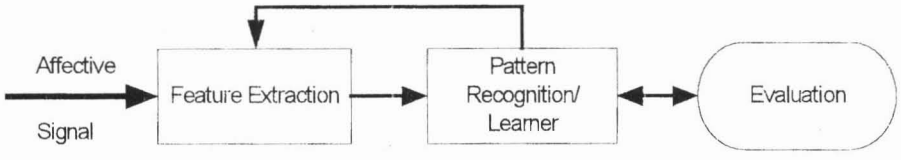

Figure 4: Affective Pattern Recognition Module

Several learning algorithms namely Neural Networks, Hidden Markov Chain, Bayesian Networks and Support Vector Machine are among learning method to classify emotional conditions (5). The evaluation module evaluates the output for the system whether the system is capable to recognize the image correctly or not. Most of the feedback is based profoundly to the specific applications that utilized the input-output signals.

Applications of Affective Computing

Perhaps the most fundamental application of affective computing will be to inform next-generation human interfaces that are able to recognize, and respond to, the emotional states of their users. Users who are becoming frustrated or annoyed with using a product would "send out signals" to the computer, at which point the application might respond in a variety of ways -- ideally in ways that the

user would see as "intuitive". Beyond this quantum leap in the ability of software applications to respond with greater sensitivity to the user, the advent of affective computing will immediately lend itself to a host of applications, a number of which are described.

Affective Learning

Learning process might begin with curiosity and fascination. Education has emphasized conveying a great deal of information and facts, and has not modeled the learning process. When teachers present material to the class, it is usually in a polished form that omits the natural steps of making mistakes (feeling confused), recovering from them (overcoming frustration), deconstructing what went wrong (not becoming dispirited), and starting over again (with hope and maybe even enthusiasm). Learning naturally involves failure and a host of associated affective responses. Learning may stun because or this negative feeling, so learning might be fail. Let say, if the learner can avoid or proceed beyond this negative feeling then or learner are accompany with tutor, teacher or friend that can give support when the learner seem to get into negative feeling. For sure learning process more delight and joyful. In e-learning process, student learned by him/her self without tutor or teacher to accompany them. So the student might get into negative feeling. In this situation affective computing can be used to interact with the student. Interactive agent might be the medium between student and the system (Figure 5).

Figure 5: The Interactive Agent, Merlin (Courtesy: Microsoft Corp)

If student seem to be confused or frustrated, agent (recognize via facial expression or force of key stroke) might intuitively hint or motivate, so student become more eager to study more. Another example to detect student mood is from finger pressure in touch pad at laptop. The goal of the affective learning is to help keep the student's exploration going, by occasionally prompting with questions or feedback, and by watching and responding to the affective state of the student watching especially for signs of frustration and boredom that may precede quitting, for signs of curiosity or interest that tend to indicate active exploration, and for signs of enjoyment and mastery, which might indicate a successful learning experience. The system is not a tutor that knows all the answers, but a player on the side of the student, there to help him or her learn, and in so doing, learn how to learn better.

Affective Medicine

Perhaps the most common emotion people feel in interacting today's technology are frustration, irritation and other feeling relate to stress. What could technology do if could sense that the user is frustrated or otherwise in some unusual emotion state? Could the system change or be change, so as to reduce frustration in the future, or could it help the user to feel less stress. Several studies have been conducted examining the impact of stress on immunity. For an example Sheldon Cohen, a psychologist at Carnegie-Mellon University exposed people to a cold virus after assessing how much stress they were experiencing in their live. Of course, a robust immune system usually resists a virus, so more exposure does not mean you get sick. Cohen founds that 27% of the low-stress subject came down with the cold while 47% of the high-stress people came down with the cold [9]. This study shows that stress exposed our body to sick. With the advancement of affective computing technology, this situation may reduce when computer can detect and respond to the human stress. Being able to detect such emotional elements will allow preventive medicine to take place and the medical community will have better access towards the conditions of patients (or the potential one) [1].

Affective Car

Another interesting potential application is the development of smart car. Developed in collaboration with Sony Corporation, the POD (Figure 6) is an IT-centered vehicle that proposes new relationships between cars and their drivers. The pod (the name of which is based on the concept of gently enveloping and protecting the car's occupants) is personified to help it detect the feelings of the driver and to express itself. Using various sensors that detect and store information on the drivers' preferences at home and at work, driving conditions the car can gauge the driver's level of skill and hurriedness. The sensors offer information on the smoothness of steering wheel, accelerator, brake operation, difference with regular driving conditions, as well as the driver's pulse and degree of perspiration. If the user drives too fast or get to close to other vehicles, the computer system will issue an alert from the display or playing calming music. The car called Pod can also convey the driver's mood to other drivers or pedestrians, using light attached to the front and rear. The sensors built into the car's steering mechanism provides rich input of driver's affect state – through driver's pulse and sweat level. The signal can be used to indicate the signs of agitation and tiredness.

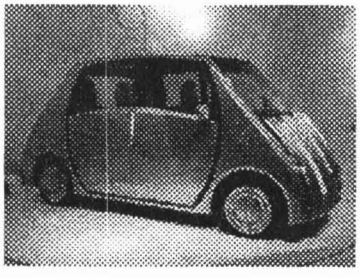

Figure 6: The POD, an Affective Car (Courtesy: Toyota Corp.)

The most profound feedback the car has is an array of lights which change color according to the emotion of the driver and car itself. These lights change to one of four colors which reflect the mood of the car both inside, to the driver and passenger, and outside, to fellow motorists. During regular operation, the car turns orange to reflect that is happy to both be with the driver and running with no anomalies. In the event that gas runs out, or the driver leaves the car alone for a long time, the POD turns blue to represent sadness. The POD also proposes a new driving operation method, by packaging the steering, accelerating and braking controls on a single "drive controller" for easy hands-only drive-by-wire operation. Toyota have taken the POD and proven the car can be more than just a tool. The POD turns the driver into a partner. As the car-user relationship deepens, both the POD and the people using it can grow.

CONCLUSION

This paper highlight some basic introduction about affective computing, principal, correlation between emotion and computers and application. It is anticipated that in the next future, affective computing will be a standard features for computer user or to HCI technology. The current research in affective computing is on the medical area such as to detect and overcome human stress, on the wearable computing is affective glasses that can detect user affective state from eyes and on e-Learning, where the interface agent can respond to student understanding level. Affective computing will answer the old question about the capability of computer to understand us. The answer is "Yes", with the advancement in artificial intelligence technology and with the current technology like affective computing, we can build a system that can understand our emotion, in near future.

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